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REPORT

REVIEW OF THE IMPACT OF INVASIVE ALIEN SPECIES ON SPECIES PROTECTED UNDER THE CONVENTION ON MIGRATORY SPECIES (CMS)

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REVIEW OF THE IMPACT OF INVASIVE ALIEN SPECIES ON SPECIES PROTECTED UNDER THE CONVENTION ON MIGRATORY SPECIES (CMS)

FOR THE CONVENTION ON THE CONSERVATION OF MIGRATORY SPECIES OF WILD ANIMALS (CMS),

UNITED NATIONS PREMISES, BONN, GERMANY

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ACRONYMS

AEWA	African-Eurasian Waterbirds Agreement
ACAP	Agreement for the Conservation of Albatrosses and Petrels
ACCOBANS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
CABI ISC	CABI Invasive Species Compendium
COP	Conference of the Parties
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention
CR	Critically Endangered
DAISIE	Delivering Alien Invasive Species Inventories for Europe
EN	Endangered
EPPO	European and Mediterranean Plant Protection Organization
EC	European Council
EU	European Union
GISD	Global Invasive Species Database
GROMS	Global Register of Migratory Species
BWM	International Convention for the Control and Management of Ships' Ballast Water and Sediments
IPPC	International Plant Protection Convention
IUCN	International Union for Conservation of Nature
IAS	Invasive Alien Species
ISSG	Invasive Species Specialist Group
LC	Least Concern
MEAs	Multilateral Environment Agreements
NT	Near Threatened
NGO	Non-Governmental Organization
RMUs	Regional Management Units
SSAP	Single Species Action Plans
STDF	Standards and Trade Development Facility
SWOT	State of the World's Turtles
FFWRI	The Florida Fish and Wildlife Research Institute
UNEP	United Nations Environment Programme
VU	Vulnerable
OIE	World Organization for Animal Health
WTO	World Trade Organization

GLOSSARY

Alien Species - IUCN

Alien species (non-native, non-indigenous, foreign, exotic) means a species, subspecies, or lower taxon occurring outside of its natural range (past or present) and dispersal potential (i.e. outside the range it occupies naturally or could not occupy without direct or indirect introduction or care by humans) and includes any part, gametes or propagule of such species that might survive and subsequently reproduce.

Invasive Alien Species - IUCN

The International Union for Conservation of Nature (IUCN) describes invasive species as "animals, plants or other organisms introduced by man into places out of their natural range of distribution, where they become established and disperse, generating a negative impact on the local ecosystem and species." Invasive species can negatively impact human health, the economy (i.e. tourism, agriculture), and native ecosystems. These impacts may disrupt the ecosystem processes, introduce diseases to humans or flora and fauna, and reduce biodiversity.

Categories of the IUCN Red List of Threatened Species

The IUCN Red List of Threatened Species classifies species in terms of the risk of extinction. It provides taxonomic, conservation status and distribution information on plants and animals that have been globally evaluated using the IUCN Red List Categories and Criteria. The assessment is designed to determine the relative risk of extinction and highlight and classify those plants and animals that are facing a higher risk of extinction. Categories include 'Critically Endangered (CR)', 'Endangered (EN)', 'Vulnerable (VU)', 'Lower Risk/ Conservation dependent (LR)', 'Near Threatened (NT)', 'Least Concern (LC)'. Plants and animals declared 'Extinct (EX)' or 'Extinct in the Wild (EW)' are also included. Those species that cannot be assessed due to lack of information are listed as 'Data Deficient (DD)'. Those species that face the highest risk of extinction belong to the top three classifications of CR, EN and VU. http://www.iucnredlist.org

EXECUTIVE SUMMARY

This study undertook an assessment of the impacts of Invasive Alien Species (IAS) on migratory species that are protected under the Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) Appendix I and II with the aim of:

- Identifying those migratory populations which are most threatened by IAS
- Specifically assessing the impact of IAS on migratory species on islands
- Identifying those CMS listed species which are known to be invasive
- Evaluating how the threat of IAS on migratory species is likely to develop in the light of climate change and identifying those CMS listed species which will be most severely affected as a result
- Identifying gaps in the international regulatory framework where CMS could play a role in relation to IAS;
- Identifying synergies with other organizations that are already working on IAS management and where CMS could benefit from initiatives already underway.

This report is divided into two parts, PART I that assesses the impact of IAS on CMS listed species and PART II which evaluates the gaps in the international regulatory framework in relation to the management of IAS and identifies synergies between organisations that address this threat so as to promote collaboration

Part I

Extent of the impact of IAS

Key findings of this assessment on the extent of the impact of IAS on migratory species globally and especially on island ecosystems are as follows:

- Just over one third of species protected under CMS Appendix I and II are under some level of threat from IAS.
- Most of these migratory species that are impacted by IAS occur in the terrestrial/marine biome followed by those in the terrestrial and terrestrial/freshwater biome.
- Seabird and marine turtle populations in their breeding/nesting grounds on island ecosystems are most under the threat of IAS
- Predominant threat mechanisms are predation, habitat loss, disease transmission, competition and interspecific hybridization.

Migratory species that are known IAS

An assessment was undertaken of those CMS listed species that are known to be invasive in their introduced range. Only three species on the CMS Appendix I and II are well known IAS. They include introduced population of aoudad (*Ammotragus lervia*), mouflon (*Ovis ammon*) and the Sacred ibis (*Threskiornis aethiopicus*).

An additional initial analysis was undertaken of comparing all migratory species names listed in the Global Register of Migratory Species (GROMS) with list of known IAS in the two global resources of IAS information – the IUCN Invasive Species Specialist Group's Global Invasive Species Database (GISD) and the CAB International's Invasive Species Compendium (ISC). 91 migratory species, most of them migratory fish species are known IAS. The introductions of a majority of these fish species have been intentional, either through the aquaculture trade or through the aquarium trade.

Impacts of IAS on CMS listed species in light of climate change

Biological Invasions and climate change are both drivers of biodiversity loss. A warming globe and predicted impacts such as changes in precipitation, increased weather events such as tropical cyclones and hurricanes, flooding and coastal erosion, shift in species ranges and species phenology, decline in species richness, sea level rise, ocean acidification etc. is likely to exacerbate the IAS threat. This preliminary review indicates that all CMS listed migrants that are currently under risk by IAS will continue to be vulnerable with climate change disturbances providing more opportunities to the IAS for establishment and impacts. Climate change predicted changes may also enable novel pathways of introduction and spread thus increasing the risk to newer migrant populations

Part II

Gaps in international regulatory framework related to IAS

In recognition of the urgent need to address the impact of IAS on biodiversity, several global conventions and agreements have developed policies to address this issue. An analysis of the state of current policy in relation to IAS was undertaken through a dedicated desk review. Additionally an analysis was undertaken to identify gaps as well as synergies. It is apparent that the inadequate action related to the management of IAS is not a result of gaps in international policy but rather it is caused by inadequate implementation of existing international provisions at national level.

Synergies between organisations working on IAS management

An important development at the international level is the increase in inter-sectoral cooperation on IAS issues between institutions and organisations. In this context, systematic cooperation between different global conventions and multilateral environmental agreements can definitely provide greater and more effective opportunities to address biodiversity issues, including those related to the management of IAS.

With the aim of further developing and strengthening the relevant IAS policy within the CMS and other MEAs, a draft Resolution including Recommendations has been proposed.

INTRODUCTION

Invasive alien species (IAS) [1] are organisms that have been transported from their native environment to a new environment, they have characteristics that allow them to out-compete native species, alter community structure, and ecosystem processes.

IAS are a key threatening process driving biodiversity loss. According to the Millennium Ecosystem Assessment (2005), IAS are one of five most important direct drivers of biodiversity loss and change in ecosystem services. This fact has been recognized at the international level and a number of multilateral environment agreements (MEAs) including the Convention on Biological Diversity (CBD), the Ramsar Convention on Wetlands, the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM) (adopted in 2004 but not yet in force), and the Convention on the Conservation of Migratory Species of Wild Animals (CMS) address this threat. The updated CMS Strategic Plan 2006-2014 recognizes the need for action to address the threat of IAS on migratory species.

IAS can interact with migratory species in a number of ways resulting in cumulative negative impacts; for example as a threat on their breeding sites, on their stopover and wintering grounds, and also during migrations. These impacts may result in local extinction or decline in population numbers as well as changes to migration patterns.

IAS impact native species (including migratory species) and their habitats through a number of mechanisms, including- predation, habitat degradation (grazing, herbivory, browsing, rooting/digging and trampling), competition, hybridization, disease transmission, parasitism, poisoning/toxicity, bio-fouling etc.

A changing climate is expected to exacerbate this threat increasing the vulnerability of native species and ecosystems to the impacts of IAS. Predicted changes related to climate change - such as frequency of extreme events such as storms and fire events - can affect the rate of invasions, potentially increasing the impacts caused by IAS (Diez *et al*. 2012; Genovesi 2009; Walther *et al*. 2009). With regards to migratory species, climate change can cause a shift in the range and ecological patterns of some species, with potential impacts on their vulnerability to biological invasions (Jetz *et al*., 2007).

Information on the extent of this threat and identification of priority areas for action are critical to its management. Information on the scale and severity of the threat on individual

[1] IUCN definition: Invasive Alien Species means an alien species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity. <http://www.cbd.int/invasive/terms.shtml>

species populations from specific IAS is critical to prioritising management action. Ensuring that appropriate legislation, protocols, policies and procedures are in place and operating, is vital- to underpin the effective management of IAS.

MIGRATORY SPECIES PROTECTED UNDER CMS APPENDIX I AND II

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) aims to conserve terrestrial, aquatic and avian migratory species throughout their range. The CMS lists threatened migratory species under two Appendices:

Appendix I - Endangered migratory species: Migratory species that have been categorized as being in danger of extinction throughout all or a significant proportion of their range.

Appendix II - Migratory species conserved through Agreements: Migratory species that have an unfavourable conservation status or would benefit significantly from international co-operation organised by tailored agreements.

Species listed belong to five classes Aves (birds), Mammalia (mammals), Actinopterygii (ray-finned fish), Reptilia (reptiles), Chondrichthyes (cartilaginous fish) and Insecta (insects). **Please see the breakdown below in Table 1**

TABLE 1: BREAKDOWN OF CLASSES IN CMS APPENDIX I AND II FEBRUARY 2013

Class	Species Protected under CMS Appendix 1 & II Feb 2013
Actinopterygii (ray-finned fish)	20
Aves (birds)	177 + 10 (migratory species belonging to 10 families and genus)
Chondrichthyes (cartilaginous fish)	8
Insecta (insects)	1
Mammalia (mammals)	103 + 2 (migratory species belonging to 2 families)
Reptilia (reptiles)	9 + 2 (migratory species belonging to 2 families)

PART I

IMPACTS OF INVASIVE ALIEN SPECIES ON MIGRATORY SPECIES PROTECTED UNDER CMS APPENDIX I AND II

An assessment was undertaken to evaluate the extent of impact of IAS on migratory species protected under the CMS Appendix I and II. [2]

Migratory species names listed in the CMS Appendices were extracted into an inventory and subsets were created such as Aves, Reptilia, Mammalia, Chondrichthyes and Actinopterygii (**see Supporting Inf. 1.1 for details**). In the first instance data and information related to the distribution and location of native range, nesting sites, breeding sites of these species was compiled. Thereafter a desktop literature survey[3] and data mining was undertaken to document and record all information related to the impact of IAS on these species in their native range, breeding sites, and nesting and stopover sites. Major global databases were researched including the Global Invasive Species Database (GISD), IUCN Red List of Threatened Species (IUCN Red List), BirdLife Data Zone, FishBase, CABI Invasive Species Compendium (ISC), SWOT database (State of the World's Turtles), ACAP (Agreement for the Conservation of Albatrosses and Petrels) Data Portal *etc*. Journal articles and other reports were also searched.

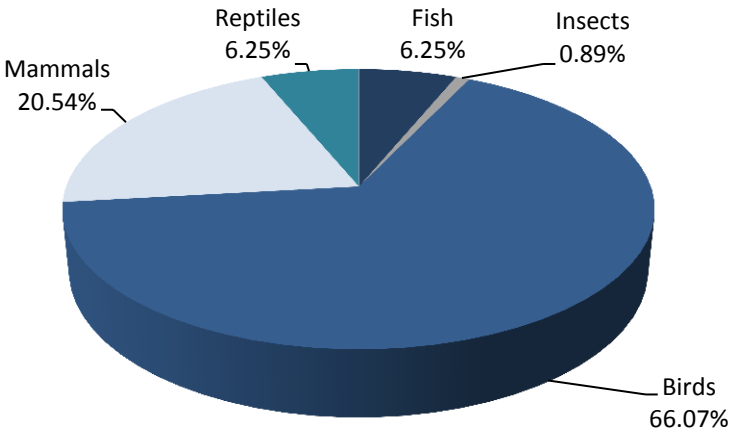
Additionally, the impact of IAS on CMS listed species on island ecosystems was recorded in detail.

The results of this assessment indicate that CMS listed birds are most impacted by the spread of IAS followed by mammals, reptiles and fish (**see Fig 1 for breakdown**).

[2] Please note that species included in 14 families/genus (Accipitridae, Anatidae, Cathartidae, Charadriidae, Cheloniidae, Dermochelyidae, Falconidae, Gruidae (*Grus* spp.), Muscicapidae, Phoenicopteridae, Recurvirostridae, Rhinolophidae, Scolopacidae and Vespertilionidae) listed in Appendix II were not included in the main assessment but were treated separately. Conclusions drawn from this assessment are also included in the results

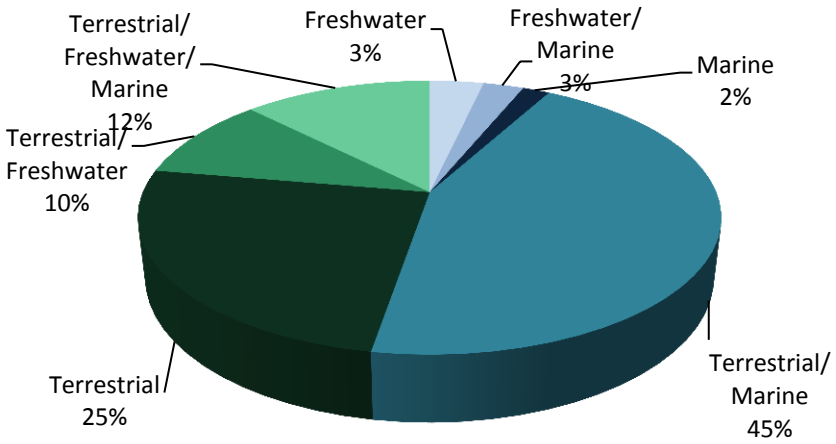
[3] While the Literature survey has been comprehensive it is possible that many records of impact the information of which is not easily available could have been missed

FIGURE 1: CMS LISTED *TAXA* UNDER IMPACTS OF INVASIVE ALIEN SPECIES



Species that occur in the terrestrial/marine biome such as seabirds in their nesting/breeding sites on islands and turtles in their nesting/breeding sites on beaches, are the most at risk by IAS, followed by birds and mammals in the terrestrial biome and birds that occur in the terrestrial/freshwater biome (**see Fig 2 for details**).

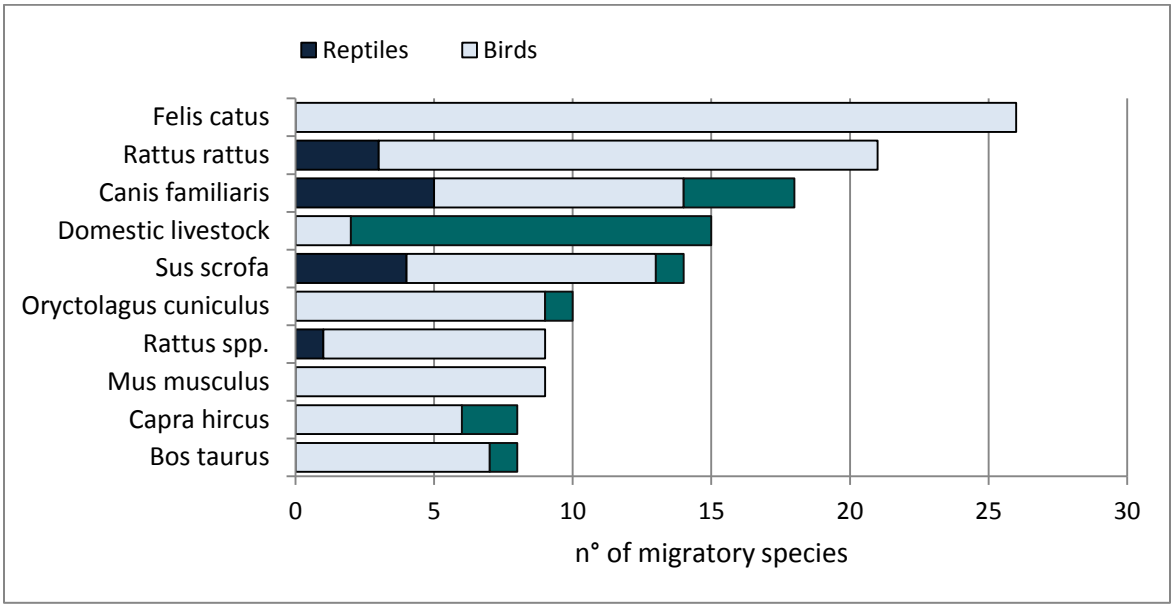
FIGURE 2: BIOMES THAT ARE MOST UNDER THREAT BY INVASIVE ALIEN SPECIES



78 IAS (**see Supporting Inf. 8**) have been recorded as having some measure of impact on CMS listed species. The top ten IAS include introduced mammal predators (cats (*Felis*

catus), rats (black rat *Rattus rattus* as well as other *Rattus* species), dogs (*Canis lupus*)[4], pigs (*Sus scrofa*) and house mouse (*Mus musculus*)) and introduced herbivores (European rabbits (*Oryctolagus cuniculus*), goats (*Capra hircus*) and domestic livestock (eg. *Bos taurus*)). Cats have impacts on the largest numbers of migratory species followed by the black rat and dog (**see Fig 3 for details**).

FIGURE 3: TOP TEN INVASIVE ALIEN SPECIES AND NUMBERS OF MIGRATORY SPECIES IMPACTED



Predation of adults and juveniles of species and nest predation is the predominant threat mechanism (45% of the total; n=136), followed by habitat degradation (27%, n=81); disease transmission and competition have been described in 9% and 6% of cases. Other reported impact mechanisms are grazing /herbivory (n=12), trampling (n= 11), interspecific hybridisation (n=4), and physical disturbance (n=4) (**see Fig 4**).

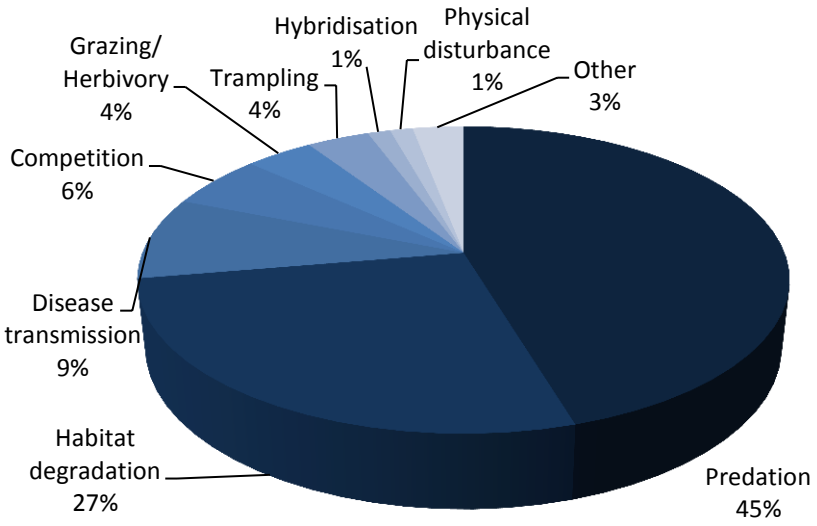
Cats and foxes are predators that consume all life stages of their prey; they are also known to consume other small predators like rats and mice. Rats, mice and pigs are more generalist omnivores generally consuming only some life stages of the prey such as eggs and nestlings. These mammalian predators are found to have severe impacts on birds mostly seabirds and turtles in their nesting sites. Introduced predatory fish and other aquatic species are a major threat to migratory fish species.

Browsing and trampling by introduced herbivores such as goats, rabbits and livestock can cause significant degradation of habitats of migratory species. Livestock and introduced ungulates are a threat to migratory Artiodactyla competing for food resources and habitat.

[4] Also referred to as *Canis familiaris*

The spread of invasive alien plant species are another cause of habitat alteration and loss. The spread of introduced and invasive grasses and macrophytes also alter habitats of bird species through competition and displacement of native plant species. For example: the intentional introduction of ornamental and "useful" plant species such as ironwood (*Casuarina* spp.) for erosion control and planting as wind breaks along coastland has had impacts on dune ecosystems, on native dune plant species and nesting grounds of turtles. *Casuarina* plantings on sand dune berms result in significant loss of nesting habitat (**see Case study on *Casuarina* below**)

FIGURE 4: INVASIVE ALIEN SPECIES THREAT MECHANISM BREAKDOWN



The spread of alien pathogens is also a serious threat to migratory species. For example migratory bird species especially water-birds are both victims and vectors of the highly pathogenic avian influenza. Species especially those belonging to orders Anseriformes (waterfowl) and Charadriiformes (shorebirds and gulls) seem to be the most susceptible to this pathogen.

Interspecific hybridisation is a concern among sturgeon populations

The impacts of IAS are explained in more detail below by Class highlighting those migratory populations that are most threatened.

BIRDS

This assessment indicates that CMS listed birds are most under the threat of IAS. 177 bird species in all are included in the CMS Appendices.[5] The predominant bird species include waders, gulls and auks some of which are pelagic and other occupying coastal environments (43). This is followed by albatrosses, petrels and shearwaters (36); long legged wading birds with large bills- storks, herons, egrets, ibises and spoonbills (21) and then terrestrial song birds the Passeriformes (20). Also included are large cranes, smaller crakes and rails, raptors and geese, ducks and swans among others.

CMS Appendices include 36 species of albatrosses, petrels and shearwaters. 30 of these species are protected under the Agreement on the Conservation of Albatrosses and Petrels (ACAP) [6]. ACAP is a multilateral agreement that seeks to conserve albatrosses and petrels. Data and information on the breeding/nesting sites of these species was recorded from information largely gathered from information provided by the ACAP Secretariat, ACAP documents and also from scientific literature. A search was conducted for information on any IAS impacts on the listed birds and their habitats in each of the sites. All this information was recoded in a matrix (**see Supporting Inf. 2.1**).

- 30 of the 36 listed albatrosses, petrels and shearwaters are under some threat from IAS. Almost all sites that are under the threat of IAS are located on islands and the majority of them in the sub-Antarctic and in the Southern Ocean. Also included are sites in Hawaii and the Japanese Bonin Ogasawara Islands.

CMS Appendices includes 68 bird species protected under the African-Eurasian Waterbirds Agreement (AEWA)[7]. AEWA covers 255 species of birds ecologically dependent on wetlands for at least part of their annual cycle, including many species of divers, grebes, pelicans, cormorants, herons, storks, rails, ibises, spoonbills, flamingos, ducks, swans, geese, cranes, waders, gulls, terns, tropic birds, auks, frigate birds and even the southern African penguin. The Agreement area stretches from the northern reaches of Canada and the Russian Federation to the southernmost tip of Africa, covering 119 Range States from Europe, parts of Asia and Canada, the Middle East and Africa. Currently 71 countries and the European Union (EU) have become a Contracting Party to AEWA (as of 1 June 2013) (**see Supporting Inf. 2.2**)

- 16 (23 per cent) of the 68 bird species protected under AEWA are under some threat from IAS. The predominant threat to these species is predation (by introduced mammals- cats, dogs, rats, mustelids, foxes and fish), habitat alteration and competition by invasive alien plants and invasive fish species, disease

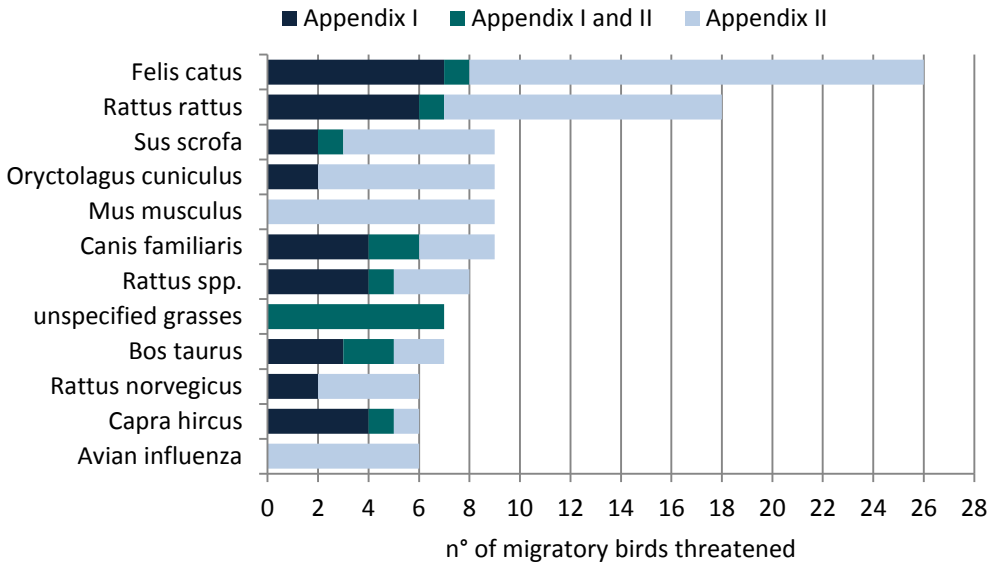
[5] See Supporting Inf. 1.2- Also included are species under the following families Anatidae, Accipitridae, Charadriidae, Cathartidae, Falconidae, Gruidae, Muscicapidae, Phoenicopteridae, Recurvirostridae and Scolopacidae although these are not included in the assessment
[6] Agreement on the Conservation of Albatrosses and Petrels (ACAP) <http://www.acap.aq/>
[7] African-Eurasian Waterbird Agreement < http://www.cms.int/species/aewa/aew_bkrd.htm>

transmission (avian influenza and avian cholera) followed by habitat degradation due to browsing and trampling by introduced herbivores (goats and livestock).

The top ten IAS that impact bird species protected under CMS I and II (see Fig 5) include predators cats, rats, pigs and mice; herbivores (rabbits, goats and livestock); invasive alien plants and disease (avian influenza, avian pox and cholera)

- Cats , dogs, *Rattus* spp. (Norway rat (*R. norvegicus)* and *black rat*), house mouse, feral pigs, small Indian mongoose (*Herpestes auropunctatus*[8]), are the major predators
- Habitat degradation due to trampling by introduced mammals- goats and both feral and domestic livestock.
- Habitat destruction due to herbivory- goats, both feral and livestock, European rabbit (*Oryctolagus cuniculus*), brushtail possums (*Trichosurus vulpecula*) in New Zealand

FIGURE 5: TOP TEN INVASIVE ALIEN SPECIES THAT IMPACT BIRDS PROTECTED UNDER CMS I AND II



Predation, disease transmission and habitat degradation (due to trampling), habitat destruction (due to herbivory) and habitat alteration due to the spread of invasive plants are the primary impact mechanisms

[8] Also referred to as *Herpestes javanicus* in literature

Avian influenza, pox & avian cholera, erysipelas are the potential disease threats; vectors include the Southern house mosquito (*Culex quinquefasciatus*), Black Salt Marsh Mosquito (*Aedes taeniorhynchus*) and the bacterium *Erysipelothrix rhusiopathiae*.

Habitat alteration due to the spread of invasive alien plant species like introduced and invasive grasses including cordgrass (*Spartina alterniflora*), introduced and invasive macrophytes like water hyacinth (*Eichhornia crassipes*), competition for food resources and habitat with introduced and invasive fish species are other significant threats.

Although not a typical IAS issue, the genetic integrity of wild populations of the EN Saker Falcon (*Falco cherrug*) is under threat due to hybridisation with escaped or released hybrid falcons, thousands of which are bred in captivity. BirdLife International asked for "a ban on the production and keeping of hybrid falcons in the EU and beyond due to the unacceptably high risk of unnatural genetic introgression to native wild falcon populations in the EU, and especially to the globally threatened Saker Falcon (*Falco cherrug*)" (Kenward and Larson, 2006; BirdLife International 2008).

- Migratory seabird populations in their nesting/breeding sites on island ecosystems are most under risk by IAS
- Migratory birds belonging to orders Anseriformes (waterfowl) and Charadriiformes (shorebirds and gulls) seem to be the most susceptible to the pathogenic avian influenza.
- Migratory water-birds in terrestrial and terrestrial/freshwater biomes are most at risk by predators, the spread of invasive alien plants and competition with invasive fish

REPTILES

Seven turtle species are listed on the CMS Appendix I & II- Green turtle (*Chelonia mydas*), Loggerhead turtle (*Caretta caretta*), Hawksbill turtle (*Eretmochelys imbricata*), Kemp's Ridley turtle (*Lepidochelys kempii*), Olive Ridley turtle (*Lepidochelys olivacea*), Leatherback (*Dermochelys coriacea*) & *Podocnemis expansa* (only Upper Amazon populations and Appendix II - other populations of *P. expansa*).

Hawksbill turtle, Leatherback, Kemp's Ridley turtle are classified as 'Critically Endangered (CR)' in the IUCN Red List of Threatened Species. Green turtle and Loggerhead are classified as 'Endangered (EN)', Olive Ridley turtle as 'Vulnerable (VU)'. The South American River turtle is classified as at 'Least Concern (LC), however the Upper Amazon populations are considered to be at a greater risk than the other populations.

Data/information on nesting sites and breeding grounds of the listed turtle species provided by the publishers of the SWOT Database (The State of the World's Sea Turtles)[9]. 4845 sites were recorded in 129 countries and territories for the seven species (Loggerhead 699, Green turtle 1304, Leatherback 751, Hawksbill 1434, Kemp's Ridley 42, and Olive Ridley 414). A literature survey was undertaken to identify IAS threats on these sites and information compiled in a matrix (**see Supporting Inf. 3**)

- Turtles are most at risk by IAS in their nesting/breeding sites
- Species most under threat from IAS – from the worst impacted to the least include – EN Green turtle, EN Loggerhead, CR Hawksbill, CR Leatherback, and VU Olive Ridley

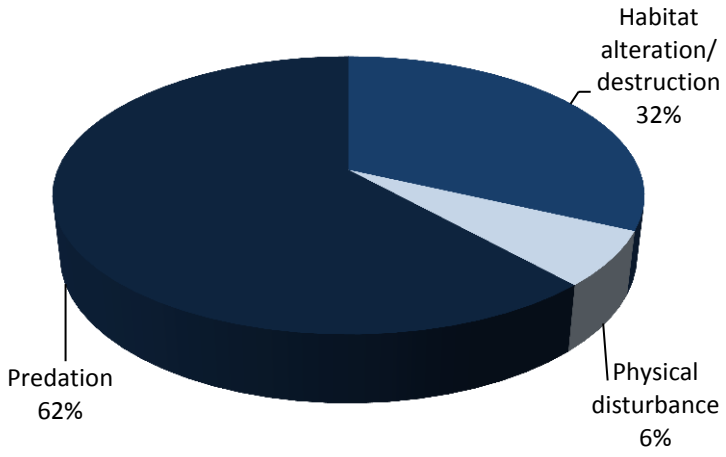
The three main impact mechanisms are predation (eggs and hatchlings), habitat alteration resulting in decline in population numbers and loss of habitat and physical disturbance (**see Fig 6**)

- Predators from most to least destructive include dogs, feral pigs, small Indian mongoose, nine-banded armadillo (*Dasypus novemcintus*), *Rattus* spp., cats, red fox (*Vulpes vulpes*), *Varanus* sp. and raccoon (*Procyon lotor*).
- Some insights gained on the locations where this threat is most pervasive- armadillo (USA mostly in Florida), mongoose (mostly in the Caribbean region), feral pigs (islands including the Caribbean islands, Indonesia etc.) *Rattus* spp. (mostly in the Pacific region), cats (mainly in Hawaii), red fox (Australia)
- Physical disturbance (combined with predation) from the most to least destructive include feral pigs and the red imported fire ant (mainly in the USA)
- Habitat alteration due to the spread of invasive alien plant species- from the most destructive to least includes agave (*Agave americana*), Brazilian rubber tree (*Schinus terebinthifolius*), ironwood (*Casuarina equesetifolia*), *Ipomoea* sp., beach vitex (*Vitex rotundifolia*).

[9] SWOT--The State of the World's Sea Turtles- SWOT database online: <http://seamap.env.duke.edu/swot>

- The pathway of introductions of these invasive plant species has been mainly through intentional plantings for landscape improvement (including stabilizing dunes) and through the ornamental plant trade (**see Case Study on *Casuarina***).

FIGURE 6: INVASIVE ALIEN SPECIES THREAT MECHANISM RELATED TO MARINE TURTLES PROTECTED UNDER CMS I AND II



Two Crocodylia are protected under CMS the Critically Endangered fish-eating gharial (*Gavialis gangeticus*) (CMS Appendix I) and the saltwater or estuarine crocodile (*Crocodylus porosus*) (CMS Appendix II). Habitat alteration due to anthropogenic pressures is the biggest threat to the survival of the fish-eating gharial, no IAS impacts are known.

The salt water crocodile occurs in inland lakes, swamps and marshes as well as coastal brackish waters and tidal sections of rivers. It is native to Australia; Bangladesh; Brunei Darussalam; Cambodia; India; Indonesia; Malaysia; Myanmar; Palau; Papua New Guinea; Philippines; Solomon Islands; Sri Lanka; Vanuatu; Viet Nam (Crocodile Specialist Group, 1996). Invasive alien plants are a threat to these species wetland habitats and may potentially impact on its survival. One such example is the Ord River Floodplain in Western Australia, a Ramsar designated site which contains a high density population of saltwater crocodiles. Invasive alien plants such as Noogoora Burr (*Xanthium pungens*), Parkinsonia (*Parkinsonia aculeate*), Leucaena (*Leucaena leucocephala*) and Neem (*Azadirachta indica*). The introduced and invasive cane toad (*Rhinella marina*) is also a potential threat.

CASE STUDY CASUARINA EQUESETIFOLIA L. IMPACTS ON TURTLE NESTING SITES

Casuarina equesetifolia L. is native from northern Australia throughout Malaysia, southern Myanmar and the Kra Isthmus of Thailand, Melanesia and Polynesia. It has been widely introduced globally for coastal landscaping, as wind-breaks and for erosion control. It is commonly known as Australian pine, ironwood, she-oak etc. Casuarina is a fast-growing tree which produces heavy shade and thick litter beneath it, reducing habitat value. Its dense monoculture thickets displace native dune and beach plant species. Once established, Casuarina alters light, temperature, soil chemistry and hydrology of the habitats it invades.

Casuarinas have shallow root systems and are prone to fall in weather events. Uprooted Casuarina trees impact on dune formation and also act as physical obstructions to nesting turtles. Shading from Casuarina alters the temperature of the sand dunes. Sea turtles exhibit temperature-dependent sex determination in which the temperature of the sand influences the sex of the hatchlings, and it is believed that this shading may impact the sex ratio of hatchlings. There are conflicting conclusions if standing Casuarina causes shading and alters hatchling sex ratios. Schmelz and Mezich (1988), Mrosovsky *et al* (1995) and Foley *et al* (2000) conclude that shading caused by Casuarina, (including other vegetation and buildings) alter hatchling sex ratios. Schmid *et al* (2008) concluded from their study that removal of Casuarina "did not appear to affect incubation temperatures and consequently hatchling sex ratios of nesting turtles".

Casuarina has been planted extensively along beaches in Florida (USA), in India (for example along the coasts in Chennai and Orissa), in Bangladesh (for example along Sonadia Is.), in the Caribbean (for example in the Bahamas) etc. where its spread has degraded turtle nesting habitat. All these areas are prime nesting sites for many of the threatened turtle species.

Casuarina has been planted along the east coast of India. Most of these plantings have been undertaken by the Forestry Department's after extreme weather events like cyclones with the intention of providing protection to the coastal communities and habitats. Chaudhari *et al* (2009) summarise the impacts of Casuarina plantings in the fore dunes along beaches in Chennai. The authors observe that these plantings especially those in the fore dunes have detrimental impacts rather than the beneficial impacts they were intended to have.

Casuarina was introduced more than 100 years ago to Chennai. Extensive plantings were undertaken after the 2004 tsunami when the World Bank funded an Emergency Tsunami Restoration Programme (ETRP) in Chennai state, which included the establishment of 'bio-shield' shelterbelts on beaches…continued

CASE STUDY CASUARINA EQUESETIFOLIA L. IMPACTS ON TURTLE NESTING SITES…CONTINUED

Turtle conservation and other non-governmental organizations that became aware of these negative impacts, rallied together and engaged with the Government, the forestry department and World Bank Officials to reverse this damage. A Government Order was subsequently passed to remove plantings from turtle nesting habitats (Dattari 2011) which were carried out.

Casuarina planting in Orissa, India was undertaken after the cyclones in 1971 and 1999. Casuarina planting along the high tide line has been reported as restricting and limiting the nesting area for turtles. An assessment (Tripathy & Rajashekar (2009)) was undertaken of the threats to nesting Olive Ridley turtles at Rushikulya rookery in Orissa State. While turtle mortality was found to be at lower levels than other sites along the Orissa coast, the assessment found that Casuarina planting close to the high tide level, beach erosion and artificial lighting were likely threats to these nesting turtles.

Five of the seven turtles protected under CMS nest on Bangladesh's beaches. Illegal harvesting of turtle eggs (by humans and predation by dogs), by-catch in offshore fisheries, alterations of sand dunes and nesting beaches (planting and construction activity) are identified as the major threats to these turtle populations. The revised Bangladesh Wildlife Preservation (Amendment) Act in 2010 provides legal protection to all the listed turtles; however it has been reported that threats are on-going. A study conducted by MarineLife Alliance (Islam et al (2011)) monitoring turtle nesting sites at Sonadia Island from 2005-2010 concluded that the major threats to turtle nesting sites was a) dog predation, b) disturbances during shrimp fry collection, c) beach seine fishing, d) egg poaching and e) alteration of the nesting beach by Casuarina plantation. Casuarina plantings on Sonadia were undertaken by the Forest Department between the years 2008 to 2009.

Five of seven turtles protected under CMS Appendix I and II nest on Florida's beaches. In fact, 90 percent of all loggerhead nesting in the United States occurs in Florida, the majority of this on the east coast of Florida. The Florida Fish and wildlife Research Institute (FFWRI) identifies illegal harvesting, habitat encroachment and pollution as major threats to nesting turtles along Florida's beaches. Casuarina plantings have been identified as 'interfering with turtle nest construction'. Casuarina was planted extensively in Florida along beaches, canals and roads as windbreaks in the early 20th century. Monocultures of Casuarina encroach on nesting site areas especially after an event which causes some disturbance. Casuarina spp. have a prohibited status in Florida and the removal of Casuarina is being advocated and carried out on an on-going basis. Herbicidal and mechanical control have been undertaken to remove Casuarina. Biological control is also being considered.

Continued cultivation and use of this species as wind-breaks, or for erosion control or as shelter belts along coastal ecosystems globally, especially on key turtle nesting sites needs to be discouraged.

trees, Date Palms (*Pheonix dactylifera*) and bellyache bush (*Jatropha gossypifolia*) are a threat to the ecological integrity of this wetland. The potential spread of the invasive cane toad (*Rhinus marinas*) into this area is another threat freshwater crocodiles are known to have died from ingesting the toads in Katherine Gorge (Northern Territory) (Ramsar Sites Database 2013a).

In Kakadu National Park where saltwater crocodiles are common in the flood plains, feral water buffalo (*Bubalus bubalis*) and feral pigs degrade habitat; and cane toads are also a threat (Department of Sustainability, Environment, Water, Population and Communities, 2013).

Invasive alien aquatic plants are a threat to some of the wetlands where the saltwater crocodile occurs, these invasive macrophytes have the potential to degrade the quality of crocodile habitat. Invasive spiny naiad (*Najas marinas*) is one such species found in the Maduganga Ramsar designated site, home to the saltwater crocodile and many other threatened species (Ramsar Sites Database 2013b)

- Marine turtles in their nesting/breeding sites are most at risk by IAS
- Some of the habitat of the saltwater crocodile (inland lakes, swamps and marshes as well as coastal brackish waters and tidal sections of rivers) is under threat by the spread of invasive alien plant species

A recent study, Wallace *et al* (2011) evaluated, compared and organized spatially and biologically distinct marine turtle Regional Management Unites (RMUs) according to status and threat criteria. This study included the identification of the world's 11 most endangered marine turtles based on the highest risk and threat scores. Five established hazards to marine turtles were considered in the threat matrix a) fisheries by catch b) **take**, c) coastal development, d) pollution and pathogens and e) climate change.

- 'Take'—was defined to include direct utilization of turtles or eggs for human use (i.e. consumption, commercial products) relative to population size—as low= 1, medium =2, or high = 3. When take was scored as 'high,' the type(s) of take contributing most to this assessment: a) **egg and hatchling loss (feral animals)**; b) egg utilization (legal and illegal); c) nesting female take; d) adult/immature take) was specified.

- Of those RMUs categorized as High Risk-High Threats, 11 were considered the most endangered marine turtle RMUs in the world, five occur in the Indian Ocean and four are Hawksbill turtles. 'Fisheries by catch' and 'take' are the most pervasive threats to marine turtles in the Indian Ocean, particularly in the northern areas.

Management of the predation threat by removal of predators has been proven to result in positive conservation outcomes. This is an excerpt from a biological review of Australian marine turtle species- the Flatback (The State of Queensland Environmental Protection Agency, 2007) with reference to two islands

- ***Curtis Island****: An estimated 90-95% of clutches were lost to feral dog predation during the late 1970s-1988. Effectively zero predation by dogs in 1993 followed the removal of the dogs. By the late 1990s, predation by foxes (Vulpes vulpes) had become significant. In 2001, a fox-baiting project was introduced to reduce egg loss.*
- ***Wreck Rock****: An estimated 90-95% of clutches were lost to fox (V. vulpes) predation during 1976-82. As a result of a 1080 baiting project, there has been approximately zero fox predation of N. depressus eggs in the last few years.*

MAMMALS

Data and information was collated of known impacts of IAS on terrestrial mammal species protected under CMS (**see Supporting Inf. 4**). Of the 103 mammals listed in the CMS appendices more than half are marine mammals (51 cetaceans, 4 species of sea cows, 3 true seals and a fur seal and sea lion). 10 of these marine mammals are protected under Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS)[10], and 11 are protected under Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS)[11]. The other predominant groups which are all terrestrial include bovines, bats and deer.

IAS are not reported to impact most of the marine mammals. The introduced predator comb jelly (*Mnemiopsis leidyi*) native to Western Atlantic waters and introduced to the Black Sea, Caspian Sea and the North and Baltic seas has an impact on the survival of short-beaked common dolphin (*Delphinus delphis*) & harbour porpoise (*Phocoena phocoena*) both listed also under the ACCOBAMS & ASCOBANS. The abundant comb jelly's predation leads to decline in prey, sprat and anchovy that are food resources for the short beaked common dolphin and harbour porpoise.

One of the threats to the Black Sea Bottlenose Dolphin (*Tursiops truncatus* ssp. *ponticus*) is potential disease infection and 'genetic pollution from the intentional and accidental

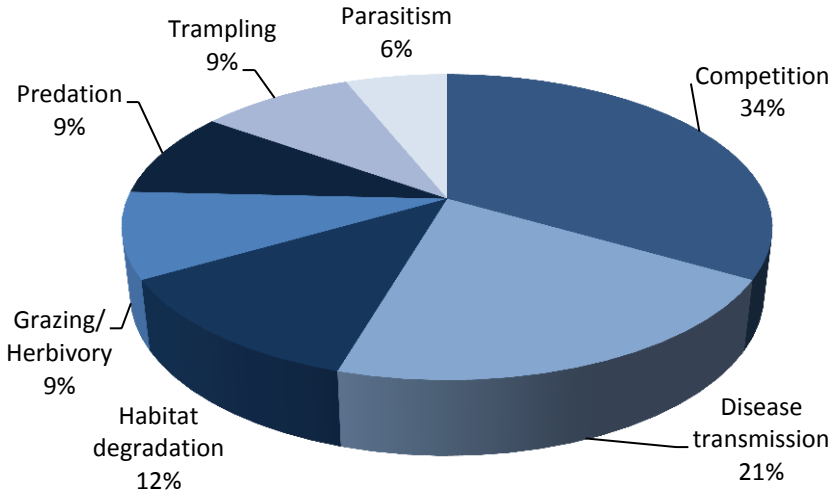
[10] Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) < http://www.cms.int/species/ascobans/asc_bkrd.htm>

[11] Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS <http://www.cms.int/species/accobams/acc_text.htm>

(escapees) release of captive bottlenose dolphins and other marine mammals from dolphinaria or oceanaria (Veit *et al* 1997)

In the case of terrestrial mammals, an analysis of these data indicates that cloven-hooved mammals (Artiodactyla) bovines, deer and camel species are risk by the threat of IAS. The predominant threat mechanism is competition followed by disease transmission, habitat degradation and herbivory (**see Fig 7**). Domestic livestock and introduced herbivores are major competitors competing for food and other resources. Domestic livestock are also reservoirs of disease. Trampling by these domestic herds also degrades habitat.

FIGURE 7: INVASIVE ALIEN SPECIES THREAT MECHANISMS RELATED TO MAMMALS PROTECTED UNDER CMS I AND II



The Patagonian heumel (*Hippocamelus bisulcus*) is listed as Endangered (EN) in the IUCN Red List of Threatened Species. Population numbers have declined mostly due to overkill, impacts of both domestic and feral livestock that include competition, loss of food resources due to grazing by introduced herbivores and disease transmission (cattle, sheep, goats, deer (red deer (*Cervus elaphus*) and fallow deer (*Dama dama*)), pigs, and horses (*Equus* sp.)) and change in land use to agriculture. Dogs are known to predate on young fawns and even adults causing severe declines in local populations. In one study dogs are known to have killed 36% of marked fawns and also adults (Jimenez *et al* 2011).

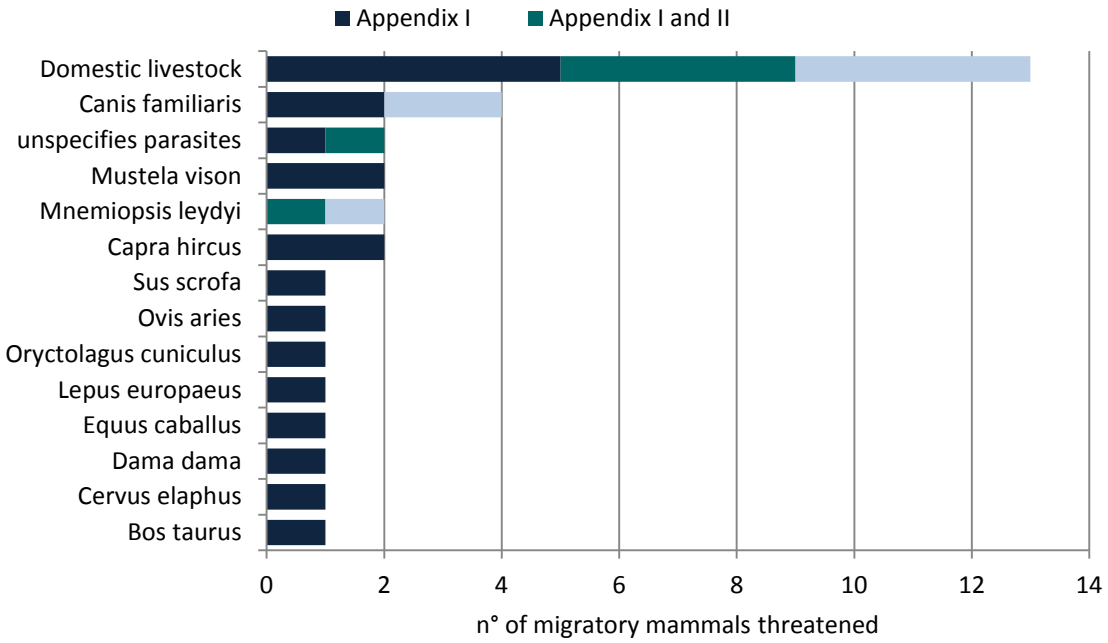
- Migratory Artiodactyla (Cervidae, Bovidae and Camelidae) are most at risk by IAS
- The Baltic, North Sea and Black sea populations of the short-beaked common dolphin and harbour porpoise are under threat by the impacts of the predatory comb jelly
- Migratory Serenia (aquatic herbivorus mammals), Proboscidea (elephants), Primates (the two Gorilla sp.), Chiroptera (bats), a majority of the Cetaceans, a majority of the Carnivores (except for the mustelids) are presently not at risk by IAS

Migratory Serenia (aquatic herbivorus mammals), Proboscidea (elephants), Primates (the two *Gorilla* sp.), Chiroptera (bats), a majority of the Cetaceans, a majority of the Carnivores (except for the mustelids) are presently not at risk by IAS

The Argentinian and Chilean populations of the marine otter, *Lontra felina* and the southern river otter, *Lontra provocax* are both threatened by the introduction and spread of the American mink (*Neovison vison*).

Domestic livestock impact the most migratory mammals. **See Fig 8 for top ten IAS that impact mammals protected under CMS I and II**

FIGURE 8: TOP TEN INVASIVE ALIEN SPECIES THAT IMPACT MAMMALS PROTECTED UNDER CMS I AND II



RAY-FINNED AND CARTILAGINOUS FISH

Six Chondrichthyes or cartilaginous fishes are listed under the CMS Appendices. These include sharks (great white (*Carcharodon carcharias*), whale shark (*Rhincodon typus*), shortfin (*Isurus oxyrinchus*) and longfin mako (*Isurus paucus*), one species of mackarel shark (*Lamna nasus*), basking shark (*Cetorhinus maximus*), Cape shark (*Squalus acanthias)*), and the giant oceanic manta ray (*Manta birostris*).

Twenty Actinopterygii or rayfinned fish are listed under the CMS appendices. The list includes 19 sturgeons and the 'Critically Endangered (CR)' Mekong giant catfish (*Pangasianodon gigas*).

Of the 19 sturgeons species 15 are listed as Critically Endangered (CR) in the IUCN Red List of Threatened Species and one each as Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC). A review of the impacts of IAS (**see Supporting Inf. 5**) on these listed species indicates that CR populations of Russian sturgeon (*Acipenser gueldenstaedtii*) in the Black Sea and Sea of Azov, CR populations of the stellate sturgeon (*Acipenser stellatus*) in the Black Sea and Caspian Sea are under threat from a carnivorous predator, the introduced comb jelly which impacts the species food sources (Qiwei, 2010). The comb jelly was accidentally introduced *via* ballast water of ships to the Black sea in the early 1980s, where it has had a catastrophic effect on the entire ecosystem. In the last two decades of the twentieth century, it has invaded the Azov, Marmara, and Aegean Seas and recently introduced into the Caspian Sea *via* the ballast water of oil tankers

- Chondrichthyes or cartilaginous fish are under no known risk by IAS
- Actinopterygii or rayfinned fish predominantly sturgeon are under risk by IAS
- Sturgeon population in the Black Sea, Caspian Sea, Azov Sea are under threat by the introduced predatory comb jelly
- Lake sturgeon populations in their native range in Canada and the United States are at risk by introduced larval predators, other introduced aquatic species that alter habitats
- Interspecific hybridisation among sturgeons is an on-going and potential risk

Lake sturgeon (*Acipenser fulvescens*) populations in its native range in Canada and the United States (St. Lawrence River basin, Hudson Bay, Lake Champlain (Vermont - New York), Lake Winnebago - Fox River complex (Wisconsin), Mississippi River headwaters (Minnesota), Mississippi River (northern Louisiana), Missouri River (southern South Dakota) are under the most threat by IAS mostly due to a) habitat alteration due to the invasion of the zebra mussel, b) predation including larval predation by the round goby, common carp and rusty crayfish, c) preying and parasitism by the parasitic sea lamprey and toxicity due to lampricides used to control sea lampreys. The conservation status of the Lake sturgeon in the IUCN Red List of Threatened Species is 'Least Concern (LC)'. Lake sturgeon are listed on the CITES Appendix II, and listed under provincial legislation as 'Threatened' in New Brunswick, Manitoba, Alberta, Newfoundland, Quebec, Ontario and

Saskatchewan. Populations in these areas are being monitored and conservation actions implemented.

See Table 2 for the list of IAS that impact fish species protected under CMS I and II

TABLE 2: INVASIVE ALIEN SPECIES THAT IMPACT FISH SPECIES PROTECTED UNDER CMS I AND II

Species names
Dreissena polymorpha (zebra mussel)
Cyprinus carpio (common carp)
Mnemiopsis leydyi (comb jelly)
Neogobius melanostoma (round goby)
Orconectes rusticus (rusty crayfish)
Petromyzon marinus (parasitic sea lamprey)
Sturgeon (Acipenser spp.; Huso huso)

Interspecific hybridisation between sturgeon species is another threat. The beluga European sturgeon is reported to be hybridising with starry sturgeon (*A. ruthenus*). The Siberian sturgeon introduced in captive breeding facilities is recorded as having hybridized with *A. naccarii* in Italy in the 1990s. There is concern of the impacts of introduced Acipenseriformes and their hybrids on native species especially in the Po River (CITES, undated).

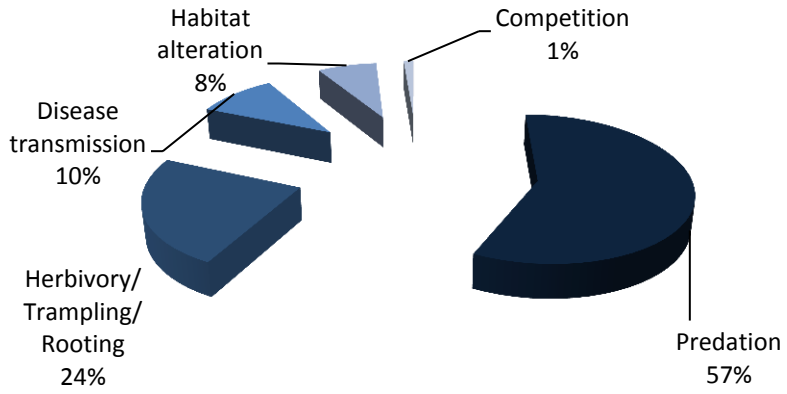
IMPACTS OF INVASIVE ALIEN SPECIES ON MIGRATORY SPECIES PROTECTED UNDER CMS I AND II ON ISLAND ECOSYSTEMS

Close to half of those CMS listed species that are impacted by invasive alien species occur on island ecosystems (**see Supporting Inf. 6**). These include five species of marine turtles (Loggerhead, Green Turtle, Leatherback, Hawksbill Turtle and Olive Ridley) and 44 species of birds mostly belonging to family Diomedeidae and Procellariidae.

Turtle populations (breeding and nesting grounds) most under the risk of IAS are located in the Caribbean and the Pacific region. The primary threat mechanism is predation by introduced mammals - dogs, rats, cats, pigs, and mongooses.

Nesting and breeding sites of bird species most under the risk of IAS are located predominantly in the sub-Antarctic islands and also in Pacific islands and islands in the Mediterranean. The primary threat mechanism is predation by introduced mammals, followed by herbivory and trampling by ungulates and livestock, potential disease transmission, habitat alteration due to the spread of introduced plants and competition for food resources (**see Fig 9 for the threat mechanism breakdown**).

FIGURE 9: INVASIVE ALIEN SPECIES THREAT MECHANISM RELATED TO MIGRATORY SPECIES ON ISLAND ECOSYSTEMS



Although the impacts of IAS on island ecosystems are severe, islands offer enhanced opportunities for the effective and efficient prevention, eradication, and control of IAS. Eradications have proved to be a very effective and successful conservation intervention. Frequent targets of eradication campaign include rodents (Howald *et al*. 2007) and feral cats (Nogales *et al*. 2004), as well as invertebrates and invasive plants (Genovesi 2011). Over 1,000 successful island eradications[12] of invasive vertebrates have been implemented globally, resulting in positive conservation outcomes including remarkable recoveries of endangered species and ecosystems (Keitt *et al*. 2011) (**see Case study of the Macquarie Island Pest Eradication Project**)

[12] See the Database of Island Invasive Species Eradications (DIISE) < http://eradicationsdb.fos.auckland.ac.nz/ >

CASE STUDY MACQUARIE ISLAND PEST ERADICATION PROJECT

Macquarie Island is a sub-Antarctic island 1500km southeast of Hobart, Tasmania. It has been designated as a World Heritage Area. The island sustains a very high concentration of seabirds (approximately 3.5 million), though the surrounding marine areas, which are the foraging grounds of these species are not protected (Parks & Services, 2008). The island also supports breeding colonies of four species of albatross, and these are the light-mantled sooty albatross (*Phoebetria palpebrata*), which is the most abundant, the black-browed albatross (*Thalassarche melanophrys*), the grey-headed albatross (*Thalassarche chrysostoma*) and the wandering albatross (*Diomedea exulans*). Furthermore, four species of penguins – king penguins, gentoo penguins, rockhopper penguins and the endemic royal penguin breed on the island. Other present seabird species include the endemic Macquarie Island cormorant, great skuas, kelp gulls and Antarctic terns (Parks & Wildlife Service, 2009a). Macquarie Island is also the breeding and moulting ground for up to 80,000 elephant seals (*Mirounga leonina*) (Department of Sustainability, Environment, Water, Populations and Communities, 2010a).

The arrival of Europeans on Macquarie Island was accompanied by the introduction and subsequent establishment of a number of non-native alien species and this has resulted in extensive ecosystem and landscape damage (SEWPaC, 2010a). These species include cats, weka (*Gallirallus australis*), rodents (rats and mice), and rabbits (SEWPaC, 2010a). Weka were removed from the island by 1989, and after an intense eradication programme, cats were also eradicated by 2000 (Parks and Wildlife Service & Biodiversity Conservation Branch, 2007). Rodents and rabbits remain a severe threat to the island's biodiversity. Widespread grazing by rabbits has led to a destruction of landscape and modification of vegetative communities, which function as important breeding habitat for burrowing seabirds. Degradation of breeding habitat can affect the breeding success of these seabirds. Furthermore, the loss of important vegetation has caused soil destabilisation and extensive erosion, which can further result in habitat destruction and events such as landslides (Parks & Wildlife Service, 2009b).

Rodents, especially black rats, actively predate on the eggs and chicks of nesting petrels. Ship rats have been identified as a continuing threat affecting up to nine seabird species on the island. Ship rats and house mice are also responsible for inhibiting plant regeneration and reducing successful seedling recruitment due to severe seed predation.

In June 2007, an agreement was made between the Tasmanian and Australian governments to jointly fund approximately $25 million to implement a rodent and rabbit eradication on Macquarie Island (SEWPaC, 2010b). The eradication methodology included two steps: 1) the aerial broadcast of bait containing brodifacoum via helicopter and use of global positioning system computers for precise coverage, in order to eliminate rodents and remove more than 95% of rabbits, and 2) the use of field teams as a follow-up to the first method in order to completely eradicate surviving rabbits. A number of techniques will be employed, including daylight and spotlight shooting, burrow fumigation, use of trained dogs and intensive trapping over a four year period (Parks & Wildlife Service and BCB, 2007)....continued

CASE STUDY MACQUARIE ISLAND PEST ERADICATION PROJECT…CONTINUED

Eradication of rodents and rabbits will enable a recovery of heavily grazed vegetative communities, increased plant regeneration and ecosystem restoration, increased breeding success among seabird populations, and reduced predation stress on eggs and chicks.

Some of the outcomes for non-completion of the eradication project include: the degradation of World Heritage values for which the island was listed, biodiversity loss of the sub-Antarctic region, which is a criterion for the island's designation as a Biosphere Reserve, and failure to aid the restoration of natural ecological processes of the island (Parks & Wildlife Service, 2007).

In 2010, the aerial broadcast of poisoned bait commenced and was completed in July 2011 (DIPWE, 2008). In January 2011, 200kg of carrots contaminated with Rabbit Haemorrhagic Disease Virus (RHDV) or calcivirus were distributed to areas of high rabbit concentrations in order to decrease non-target mortality by scavenging seabirds. The operation was a success and rabbit numbers fell. One of the advantages of the operation was a greater availability of poisoned bait from the aerial broadcast for rats and rice (Parks &Wildlife Service, 2011a).

A review was undertaken on the mortality of non-target species during the aerial baiting operation. A number of suggestions were made to mitigate non-target mortality. A key finding of the report was "that the positive impacts of a successful modified aerial baiting operation were highly likely to outweigh any short term negative impacts resulting from the aerial baiting operation" (Parks and Wildlife Service, 2011c).

In November 2011, recovery in the island's vegetation was observed with new growth of tussock plants and certain megahber species (*Pleurophyllum hookeri* and *Stilbocarpa polaris*). An increase in burrowing seabird activity, especially in inland valleys, was also noted (Parks & Wildlife Service, 2011b).

By February 2012, it was found that grey petrels had the highest breeding success rate (87%) since monitoring commenced in 2005, and the species was also found to be nesting in new areas around the island. Burrow occupancy rates for sooty shearwaters and white-headed petrels were observed to have increased. Hundreds of active burrows of blue petrels, which have been breeding in smaller offshore islands due to rat predation, were discovered on Macquarie Island (Parks & Services, 2012). As of January 2013, field teams will be using trained dogs to scour the island and detect any traces of rodents. Biosecurity procedures are being tightened considerably in order to diminish the risk of re-invasion of the island as a result of stowaways in cargo (Parks & Wildlife Service, 2013).

Research and innovation has resulted in complex eradication events being implemented (**see below the eradication of rodents and cats from islands – where is it at in 2013?)**

THE ERADICATION OF RODENTS AND CATS FROM ISLANDS – WHERE IS IT AT IN 2013?

As at April 2013 two of the biggest rodent eradication projects in the world are underway on Macquarie Island in the Southern Ocean and South Georgia in the South Atlantic. Macquarie (12800ha) is looking positive so far for a good result. Aerial baiting is currently being undertaken on South Georgia which is many times larger.

New challenges being faced are eradications on inhabited islands and very remote islands in the Pacific. Lord Howe Island, a World Heritage Area, has a community of about 400 permanent residents and plans are underway to eradicate rats and mice from the island. Understandably there are mixed feelings about the use of poison by residents, which add complexity to the project.

In 2011 a much talked about concept was finally put into action and proven to work. One of the biggest hurdles for rodent eradications in remote parts of the Pacific is just getting there. Another is being able to land the team and equipment safely and to apply the rodenticide over difficult terrain. These problems can be solved by aerial application of rodenticide which requires helicopters and a ship to carry them –all very expensive. In 2011 a multi-project voyage was undertaken which shared the cost of a ship and helicopters, making each individual project not only more affordable, but allowed a more robust methodology to be used.

A chronic challenge still being worked on is our ability to prevent invasive species reaching islands or reinvading them after they have been removed. This is the 'Achilles heel' of many projects as it requires on-going vigilance and a change of lifestyle by some who visit pest –free islands.

Recent setbacks have been a small number of projects which have failed in tropical latitudes for indeterminate reasons. These projects serve to remind us that our understanding of the ecology and mechanisms involved in achieving eradication is not complete. On the bright side, the good planning and attention to detail in the delivery of these projects has allowed us to eliminate many of the common reasons for eradication failure, and sharpen our focus on things we do not know for sure.

Cat eradications continue to be undertaken around the world using a variety of approaches. More are now 'factored in' as a target species in a multi-species eradication design which not only provides efficiencies, but can also help control undesirable ecological outcomes from removing single pest species and leaving others behind.

Contributed By Keith Broome, Technical Advisor Invasive Alien Species, Department of Conservation, New Zealand

IMPACTS OF INVASIVE ALIEN SPECIES ON MIGRATORY SPECIES IN A CHANGING CLIMATE

One of the key messages of the Millennium Ecosystem Assessment (2005) is that the most important direct drivers of biodiversity loss and ecosystem service changes are habitat change, **climate change, IAS**, overexploitation of resources, and pollution.

Global warming is evident- there are increases in air and ocean temperatures, melting of snow and ice at high altitudes and Polar Regions and, rising sea levels (IPCC 2007). Changes in natural systems have been observed as a result of a changing climate- for example upward shifts in plant and animal ranges (Patterson and Guerin 2013),

WHAT DOES A WARMER GLOBE MEAN?

Some of the key projected changes in the near and long term under different scenarios of global warming include melting of sea ice and contraction of snow cover, changes in precipitation including intensity, sea level rise, and changes in frequency and intensity of tropical storms, hurricanes and typhoons, flooding, storm surges and coastal erosion (IPCC 2007).

HOW DO THESE CHANGES IMPACT IAS?

IAS can interact with climate change, it is expected that a changing climate will only facilitate increased biological invasions and the spread of IAS (Hellmann *et al*. 2008; Rahel & Olden 2008; Sorte *et al* 2013), causing drastic range shifts, in some cases worsening the impacts of IAS (Bellard et al In press).

Changes in temperatures and climate pattern may lead to changes in species phenology (there could be shift from one to two generations in certain species due to warmer and prolonged summers) (Walther *et al* 2002), a shift in species ranges (Walther *et al* 2002, Parmesan and Yohe 2003; Visser & Both 2005; Kudo *et al* 2011; Costa *et al* 2013, Rabitsch *et al* 2013); a shift in host ranges (Patterson and Guerin 2013).

IAS by their very nature are successful colonizers and possess traits that allow them to take advantage of opportunities presented. Climate change associated disturbances (such as droughts, wildfire, increased insect infestations and outbreaks, fire and ocean acidification), compounded by other non-climatic drivers (land-use change, pollution etc.) will likely impact on the resilience of ecosystems making them more vulnerable to biological invasions.

Changes in thickness and extent of glaciers are projected to impact on ecosystems in the Polar region, specific habitats and ecosystem in both the North and South Polar regions are likely to become more vulnerable to biological invasions (IPCC 2007). Climate change is likely to facilitate a greater influx of alien species into Polar Regions both the Arctic and

Antarctic; both these regions are particularly vulnerable to the impacts of a changing climate (Hulme *et al* 2012). These IAS may compete with native and endemic species causing loss in biodiversity (Neilsen and Wall 2013). Mid and high latitude islands are projected to be especially vulnerable to biological invasions with a rise in temperature (IPCC 2007).

Other consequences of climate change that could aid biological invasions are possible changes in global trading patterns, novel and new pathways will provide more opportunities. Some examples include planting after an extreme weather event using species that can potentially be invasive as in the case of Casuarina planting in India (see Case study of Casuarina plating and turtle nesting sites)

HOW IS THE THREAT OF IAS ON CMS LISTED MIGRATORY SPECIES LIKELY TO DEVELOP IN THE LIGHT OF CLIMATE CHANGE AND WHICH ARE THE CMS LISTED MIGRANTS THAT WILL BE MOST AFFECTED?

Key findings from this assessment on the extent of on-going IAS impacts on CMS listed species indicate the following:

- Migratory seabird populations in their nesting/breeding sites on island ecosystems are most under risk by IAS
- Migratory birds belonging to orders Anseriformes (waterfowl) and Charadriiformes (shorebirds and gulls) seem to be the most susceptible to this pathogenic avian influenza.
- Migratory waterbirds in terrestrial/freshwater biomes are most at risk by the predators, the spread of invasive alien plants and competition with invasive fish
- Marine turtles in their nesting/breeding sites are most at risk by IAS
- Some of the habitat of the saltwater crocodile (inland lakes, swamps and marshes as well as coastal brackish waters and tidal sections of rivers) are under threat by the spread of invasive alien plant species
- Migratory Artiodactyla (Cervidae, Bovidae and Camelidae) are most at risk by IAS due to competition with introduced livestock and other ungulates
- The Baltic, North Sea and Black sea populations of the short-beaked common dolphin and harbor porpoise are under threat by the impacts of the predatory comb jelly
- Actinopterygii or rayfinned fish predominantly sturgeons are under risk by IAS these include sturgeon population in the Black Sea, Caspian Sea, Azov Sea, and Lake sturgeon populations in their native range in Canada and the United States

Coastal areas and islands are at increased risk from erosion and sea level rise especially low-lying regions in Africa, heavily populated delta regions in Asia and coastal communities of North America (IPCC 2007). Small Island states will likely be especially vulnerable to sea level rise (flooding, storm surges and erosion); coral bleaching and deterioration of coastal areas.

Large numbers of CMS listed migratory species (seabirds and marine turtles) utilize coastal areas and islands as wintering grounds and breeding and nesting sites. Disturbances to these habitats as a result of extreme weather events are likely to make them vulnerable to biological invasions.

Climate change related disturbances in coastal areas reduce the resilience of ecosystems. IAS which are pioneer species are known to have established in coastal areas after weather events (such as opuntia (*Opuntia dellini)* and lantana (*Lantana camara)* in Sri Lanka), these species could potentially invade and degrade turtle nesting habitats (Conservation of Migratory Species in Sri Lanka (CMS/StC28/Inf. 6.3) undated).

Known IAS such as ironwood have been promoted and planted as shelter belts in many coastal areas of India and Bangladesh after weather events intentioned to prevent erosion of dunes. These plantings especially in the fore dunes can reduce turtle nesting sites. Ironwood has shallow roots and when planted in the fore dunes can get uprooted easily in a weather event, these uprooted trees obstruct dune formation and can reduce the quality of turtle nesting sites (Chaudhari *et al* 2009)

Habitat changes associated with predicted climate change are likely to have an impact on seabirds. For example species may be forced to move their nesting sites to other areas more prone to mammal predator invasions. Sea level rises could destroy nests forcing seabirds to look for alternative sites which may be vulnerable to IAS.

Specific habitats and ecosystem in both the North and South Polar regions are projected to become more vulnerable to biological invasions in a warming climate (IPCC 2007; Smith 2007). The sub-Antarctic islands are home to large populations of threatened seabirds and other species. While the impact of introduced mammals is on-going, habitat changes could mean an increased threat from IAS.

Migratory bird species especially water birds are both victims and vectors of the highly pathogenic avian influenza. Species especially those belonging to orders Anseriformes (waterfowl) and Charadriiformes (shorebirds and gulls) seem to be the most susceptible to this pathogen. A northward shift in the geographic range of many bird species has been recorded as a result of climate change. There is a concern that changes in the migratory patterns and ranges of wild birds that are vectors of pathogens are likely to increase the frequency of these pathogens reaching Northern ranges such as Canada (Patterson and Guerin 2013)

Decrease in species richness in the coastal areas of the Mediterranean Sea has been predicted due to the consequences of climate change both due to loss of climatically suitable ranges and range-shifts to northern latitudes. Species such as starry sturgeon and the Danube sturgeon are likely to be impacted with range modifications both in the

freshwater and marine biome that they use (Albouy *et al* 2013); they could be vulnerable to introduced species in their new ranges.

Additional stresses have been predicted on wetland ecosystems as a result of increased temperatures, changes in precipitation and hydrology and rise in sea level (IPCC 2007, Junk *et al* 2012). Freshwater and wetland habitats of many migrant birds as well as reptiles are likely to be impacted. Invasive aquatic plant species are a particular threat (Junk *et al* 2012).

In the case of migrant terrestrial mammals changes in precipitation can impact habitats grasslands (Tyler *et al* 2012) and wetlands (Junk *et al* 2012), making the competition with livestock and other introduced ungulate more acute. For example an increase in precipitation could have negative impacts on Grevy's zebra which thrives in arid climates. Loss of arid grassland could mean increased competition from moist grass grazers such as livestock (Tyler *et al* 2013).

This preliminary review indicates that all CMS listed migrants that are currently under risk by IAS will continue to be vulnerable with climate change disturbances providing more opportunities to the IAS for establishment and impacts. Climate change predicted changes, and mitigation policies aimed at reducing the emissions of carbon dioxide may also enable novel pathways of introduction and spread of invasive species thus increasing the risk to newer migrant populations.

CMS LISTED MIGRATORY SPECIES THAT ARE INVASIVE IN THEIR INTRODUCED RANGE

Three species protected under CMS I and II are well known invasive species in their introduced range with clear evidence of impacts on native species. These include introduced population of aoudad (*Ammotragus lervia*), mouflon (*Ovis ammon*) and the Sacred ibis *Threskiornis aethiopicus* (*Threskiornis aethiopicus aethiopicus* is listed under CMS II).

Trampling and browsing by introduced aoudad (especially in the Canary Is.) and mouflon (for example in the sub-Antarctic Ile Haute of the Kerguelen Islands) has had severe impacts on the survival of endemic plant species. **A case study on the introduction and invasion of aoudad in the Canary Is., Spain is presented below**.

Sacred ibis is described as "intra-African migrant, making nomadic or partially migratory movements". Sacred ibis have been maintained in zoological parks in many countries in the world. Many are maintained as free populations with the result that many feral populations have established around these zoological parks. In Europe Sacred ibis have been reported in Spain (including the Canarias), France, Italy, the Netherlands, Portugal, Germany, Luxembourg, Belgium and the UK. Outside Europe Sacred ibis establishment of colonies have also been reported in Florida (USA) and in Bahrain (United Arab Emirates). Breeding populations have been recorded in Spain, the Canary Is., France (Western France) and Italy

Sacred ibis have been recorded as predating eggs in seabird colonies. In western France ibis have been recorded to be - predating on eggs of Sandwich Terns (*Sterna sandvicensis*), Common Tern *(S. hirundo*) (both on CMS Appendix II), and Mallard (*Anas platyrhynchos*) and preying on juveniles of Black Terns, Lapwings (*Vanellus vanellus*) and the Herring Gull (*Larus argentatus*). Colonies of incubating pairs of Black Terns (*Chlidonias niger)* Listed on CMS Appendix II) and Whiskered Terns (*C. hybrid*) have also been reported as destroyed. In southern France they have been reported to predate on nests of the cattle egret and compete for nesting sites with cattle egrets and little egrets (*Egretta garzetta*) (BirdLife International 2013; Yésou and Clergeau 2006). While the conservation impacts of the Sacred ibis are not classified as 'high' there are concerns that they could become severe in the future. A review on the status of introduced non-native waterbird species in the area of the African-Eurasian Waterbird Agreement (2nd edition)(Banks *et al* 2008) categorised 32 waterbird species (a majority of them migratory) introduced outside their native range as having some risk to native waterbirds. Risks include hybridization, competition, predation and habitat degradation. The Swan goose (*Anser cygnoides* listed on CMS Appendix I) introduced to Europe and the lesser white fronted goose (*A. erythropus* listed on CMS Appendix I and AEWA) introduced to Finland/Sweden and the UK, both included in this list.

As mentioned earlier migratory bird species especially water birds are both victims and vectors of the highly pathogenic avian influenza. Species especially those belonging to orders Anseriformes (waterfowl) and Charadriiformes (shorebirds and gulls) seem to be the most susceptible. Although the primary mode of spread of avian influenza (especially in Asia) has been the poultry trade, migratory water birds have been cited as a secondary pathway of spread. New Research suggests wild water birds may play a role in the spread of avian influenza (see http://www.werc.usgs.gov/ResearchTopicPage.aspx?id=17)

The beluga whale (*Delphinapterus leucas*) and the grey seal (*Halichoerus grypus*) have been introduced outside their native range in the Black Sea although no specific impacts have been recorded as yet (Birkun, 2002; Reeves & di Sciara, 2006; Gladilina, *et al* 2013).

Sturgeons are used widely in aquaculture through Europe. Escapees from aquaculture facilities or released fish have the potential to hybridise with wild sturgeon leading to loss of genetic variability. The beluga European sturgeon is reported to be hybridising with starlet (*A. ruthenus*). The Siberian sturgeon introduced in captive breeding facilities is recorded as having hybridized with the Adriatic sturgeon (*A. naccarii*) in Italy in the 1990s. There is concern of the impacts of introduced Acipenseriformes and their hybrids on native species especially in the Po River. The starry sturgeon *A. stellatus* are recorded as having interbred in its natural habits with Ship sturgeon (*A. nudiventris*), starlet (*A. ruthenus*) and Danube sturgeon (*A. gueldenstaedtii*) (Environmental Impacts of Aliens Species in Aquaculture 2008)

Red deer *Cervus elaphus* (sub-species *Cervus elaphus barbarus* and *Cervus elaphus yarkandensis* are listed under CMS I and CMS II) are also known to be invasive in their introduced range. Red deer were introduced to several countries, including in North and South America, New Zealand and Australia. In Argentina they have invaded several National parks, impacting native flora and fauna and possibly disrupting ecological processes. Of particular concern is possible competition with an endangered deer endemic in the southern parts of Chile and Argentina. Red deer have shown an important overlap of resource use with the Patagonian huemul, (CMS Appendix I) in the *lenga* forest habitat, *Nothofagus pumilio.* These included use of habitat and the dietary trophic niche. The amplitude of the ecological niche of the red deer was more than that of the huemul, suggesting that the red deer might be more flexible and opportunistic than the huemul in the use of the natural resources. There is also concern in New Zealand that feral deer can act as vectors of Bovine TB. Deer also compete with domestic herbivores (Smith-Flueck 2003).

CASE STUDY AOUDAD (*AMMOTRAGUS LERVIA*) INVASION AND MANAGEMENT IN THE CANARY ISLANDS

Ammotragus lervia (Pallas 1777) commonly known as aoudad, arrui, Barbary sheep, uaddan, mouflon À manchettes are native to Algeria, Chad, Egypt, Libya, Mali, Mauritania, Morocco, Niger, Sudan and Tunisia.

Aoudads have been introduced to Spain (mainland Spain and La Palma Is., Canary Is.), Italy, Croatia, northern Mexico and the United States of America mostly intentionally as game species for sport hunting.

Aoudads are listed as 'Vulnerable (VU)' in the IUCN Red List of Threatened Species. The species is also listed on the CMS Appendix II and on Appendix II of the Convention on International Trade in Endangered Species (CITES).

In its introduced range in Spain, aoudad (just for the Canary Is.) is included of the Spanish Catalogue of Invasive Exotic Species

AOUDAD IN THE CANARY IS.

The Canary Is. are a Spanish archipelago located just off the northwest coast of mainland Africa. The Canary Is. are one of Spain's 17 autonomous communities and an outermost region of the European Union. The islands include (from largest to smallest): Tenerife, Fuerteventura, Gran Canaria, Lanzarote, La Palma, La Gomera, El Hierro, La Graciosa, Alegranza, Isla de Lobos, Montaña Clara, Roque del Este and Roque del Oeste

The Canary Is. is a biodiversity hotspot and close to 40% of the native flora are endemic species. A large number of these endemic floras are classified as threatened in the IUCN Red List of Threatened Species and in the Atlas of Threatened Flora of Spain. The survival of these species is under severe threat due to the impact of introduced herbivores including goats), sheep, mouflon (*Ovis orientalis*), European rabbit and aoudad all intentionally introduced. Goats reportedly introduced by the earliest inhabitants, rabbits in the 15th century and aoudad in the 1970's for sport hunting. Introduced herbivores trample and overgraze and have turned many areas bare causing major declines in some plant species populations likely leading to extinction.

On the Canary Is. aoudads are mainly restricted to Caldera de Taburiente National Park on La Palma Is., and mouflon on Teide National Park and surroundings (Tenerife Is.). The Caldera de Taburiente National Park consists of some of the largest tracts of protected pine forest in the Canary Is. These forests are dominated by the endemic pine *Pinus canariensis*. While the understory of the pine forests is species poor, high levels of species diversity has been noted in the interior cliff areas. The park is noted to include about 390 plant species (18 of which are Macaronesian endemics, 86 of which are Canary endemics). 28 of species (of which 15 are classified as threatened) are restricted to La Palma….continued

CASE STUDY AOUDAD (AMMOTRAGUS LERVIA) INVASION AND MANAGEMENT IN THE CANARY ISLANDS…CONTINUED

On La Palma and Tenerife browsing and trampling by aoudad (and rabbits, goats and mouflon) are the main threat to the survival of many threatened plant species- the La Palma endemics- the Critically Endangered (CR) Centaurea (*Cheirolophus santos-abreui*) and Cienfuegos (Lotus pyranthus); the Endangered (EN) Col de Risco (*Crambe microcarpa*); the Vulnerable (VU) Retamón (*Genista benehoavensis*) and Bencomia de Cumbre (*Bencomia exstipulata*); and *Lactuca palmensis* listed as Least Concern (LC). Also, impacted is the EN La Palma and Tenerife native Garbancera canaria (*Cicer canariense*) (classification in IUCN Red List of Threatened Species). Studies conducted on the food habits of the aoudad and mouflon found that these introduced mammals feed on many of the threatened endemic species.

Aoudad are known to have been introduced to the Canary Is. by ICONA (the former Institute for Nature Conservation, part of the Ministry of Agriculture) in the early 70s, as a game species for hunting purposes. They are now present in natural reserves as well as private rangelands. 300 individuals were recorded in 1994 and ~250 in the early 2000's most of them in the Caldera de Taburiente National Park on La Palma. Once the extent of the impacts of herbivores especially aoudad on endangered vegetation was realised control of these population was implemented in the 80's. However in the late 90's the hunting lobby brought pressure on the Park management resulting in three different options being considered; a) total eradication b) construction of fences to contain the populations; and c) maintaining low populations such that the damage to vegetation would be not be severe. Option (c) was considered to be the best solution. A management plan was developed in 2000 by Park authority to manage introduced herbivores including rabbits, goats and aoudad.

A National Park Decree 27/2005 was enacted on March 1st approving the plan for the management of these introduced herbivores. One of the clear objectives of the Decree was the eradication of the aoudad. While eradication is a considered objective, aoudads are themselves threatened in their native range.

Main sources: IUCN Red List of Threatened Species 2013, Gobierno de Canarias brochure 2008, Casinello (1998, 2000), Casinello *et al* (2004, 2006), Garzon-Machado *et al* (2010, 2012)

Reviewed by: Juan Luis Rodriguez Luengo, Gobierno de Canarias

MIGRATORY SPECIES THAT ARE INVASIVE IN THEIR INTRODUCED RANGE

The UNEP (United Nations Environment Programme)/CMS Secretariat initiated the development of the Global Register of Migratory Species (GROMS) database in 1997, in co-operation with the Zoological Research Museum Alexander Koenig in Bonn, funded by the Federal Environment Ministry and scientifically supported by the German Federal Agency for Nature Conservation. This database was updated in 2004 and lists 4471 known migratory species.

A preliminary assessment was made of how many of these listed migratory species were known to be invasive in their introduced range, by comparing this list with IAS listed in three major invasive species databases- the Global Invasive Species Database (GISD) and the CABI Invasive Species Compendium.

The results of this comparison indicate that 93 migratory species (4 mammals, 21 birds and 68 fish) (**see Supporting Inf. 7.2**) listed in GROMS 2004 (**see Supporting Inf. 7.1**) are classified as invasive in their introduced range (**See Table 3 below for the breakdown**).

An additional 18 migratory waterbird species that were listed in the 2008 review on the status of introduced non-native waterbird species in the area of the AEWA (2nd edition) (Banks *et al* 2008) as having some risk to native waterbirds have been included in **Supporting Inf 7.3**. The risk categorisation was based on evidence gathered as part of the review.

Some of the well-known migratory bird species that are invasive in their introduced range include the Sacred ibis, Ruddy duck (*Oxyura jamaicensis*), Egyptian goose (*Alopochen aegyptiaca*), Canada goose (*Branta canadensis*), brown headed cow-bird and shiny cowbird (*Molothrus ater* and *M. bonariensis*), house sparrow (*Passer domesticus*), great kiskidee (*Pitangus sulphuratus*) and European starling (*Sturnus vulgaris*). Many of the bird species have been intentionally introduced for example through the pet trade, for the purpose of biocontrol etc.

The Ruddy duck native to North America was imported into wildfowl collections in the United Kingdom in the 1940's. It subsequently escaped, spread as far as Spain and formed feral populations, where they threaten the globally endangered white-headed duck *(Oxyura leucocephala*) with extinction through introgressive hybridisation and competition.

The brown-headed cowbird and shiny cowbird, both brood parasites have expanded from their native range and are a potential threat to native bird species in North America.

The great kiskadee is a common and well known bird in its native range of South America and the southern end of the United States. 200 individuals were intentionally introduced to Bermuda from Trinidad in 1957 in a failed attempt as biological control agents for

introduced anole lizards (particularly the Jamaican anole (*Norops grahami*). The great kiskadee has had severe impacts on native biodiversity in Bermuda. It was implicated in the extinction of the native Bermudian cicada (*Tibicen bermudiana*) in the late 1990's. It is a significant predator of the only endemic terrestrial vertebrate in Bermuda, the CR Bermudian skink (*Eumeces longirostris*). It also predates on the eggs and chicks of native bird species such as the Bermuda catbird (*Galeoscoptes bermudianus*), chick-of-the-village (*Vireo griseus bermudianus*) and the eastern bluebird (*Sialia sialis*)

TABLE 3: MIGRATORY SPECIES THAT ARE KNOWN TO BE INVASIVE IN THEIR INTRODUCED RANGE

Taxon	GROMS	Known Invasive Alien Species
Mammals	298	4
Birds	2225	21
Reptiles	10	0
Fish	1926	68
Invertebrates	12	0
	4471	**93**

Some of the well-known migratory fish species that are known to be invasive are yellowfin goby (*Acanthogobius flavimanus*), alewife (*Alosa pseudoharengus*), walking catfish (*Clarias batrachus*), the goldfish (*Carassius auratus*), bullseye snakehead (*Channa marulius*), common carp (*Cyprinus carpio*), the mosquitofish *Gambusia affinis* and *Gambusia holbrooki*, ruffe (*Gymnocephalus cernuus*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*), grass carp (*Ctenopharyngodon idella*) and *Tilapia zillii*. Fish species have been general introduced intentionally for the purpose of aquaculture, through the aquarium and ornamental fish trade or as biocontrol agents as in the case of the mosquito fish. Transportation through ballast water of ships is another pathway of introduction.

The yellowfin goby is native to Asia and has been introduced to Australia and the west coast of North America through ship ballast water and hull fouling. Yellowfin goby is known to potentially alter fish communities and hasten the decline of native species. In California yellowfin goby introductions have been associated with extirpations of an endangered species of fish - the tidewater goby (*Eucyclogobius newberryi*) from certain bodies of water. It also competes with native species for food sources.

In its native, tropical range, *Tilapia zillii* is important as a food fish as well as for aquaculture. *T. zillii* provided 70% of Egypt's fish production, however outside its native range, this freshwater fish has the ability to establish itself even in highly salinated waters, only being held back by a low tolerance to cold water. Often introduced for use in aquatic weed control, *T. zilli* can alter native benthic communities through the elimination of macrophytes and exhibits aggressive behaviour towards other fish species.

Some of the well-known migratory mammal species that are invasive in their introduced range include the aoudad, mouflon, red deer and the dog. These mammals have been intentionally introduced for livestock purposes, and as game species for hunting. There is a thriving industry for hunting aoudad in the United States in Texas and other states.

PART II

ROLE OF CMS IN RELATION TO INVASIVE ALIEN SPECIES

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) includes some specific provisions dealing with IAS. In particular, according to Article III4c "*Parties that are Range States of a migratory species listed in Appendix I (endangered migratory species) shall endeavour" …"to the extent feasible and appropriate, to prevent, reduce or control factors that are endangering or are likely to further endanger the species, including strictly controlling the introduction of, or controlling or eliminating, already introduced exotic species*". Moreover according to Article V5 the agreements adding to Annex II (migratory species to be the subject of agreements) should provide for but not be limited to: "*conservation and, where required and feasible, restoration of the habitats of importance in maintaining a favourable conservation status, and protection of such habitats from disturbances, including strict control of the introduction of, or control of already introduced, exotic species detrimental to the migratory species*".

This provision has been further developed within the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (The Hague, 1995). According to Article III 2g the Parties shall prohibit the deliberate introduction of non-native waterbird species into the environment and take all appropriate measures to prevent the unintentional release of such species if this introduction or release would prejudice the conservation status of wild flora and fauna; when non-native waterbird species have already been introduced, the Parties shall take all appropriate measures to prevent these species from becoming a potential threat to indigenous species. The binding Action Plan in Annex 3 (see point 2.5) of the Agreement requires Parties to prohibit alien animal and plant introductions detrimental to listed bird species, to take precautions to prevent accidental escape of captive non-native birds, and to take measures to ensure that already introduced species do not pose a potential hazard to listed species.

IAS are considered in the updated CMS Strategic Plan 2006-2014 (UNEP/CMS/Conf.10.22) as one of the threats to migratory species, recognizing the inter-linkages between IAS and migratory species and the need to deal with this issue. As a consequence, to ensure the favourable conservation status of migratory species thereby contributing to global sustainability, and to ensure that migratory species benefit from the best possible conservation measures, a specific Resolution on IAS is to be adopted at the next COP 11,

according to the CMS Strategic Plan. For this purpose some preliminary studies were carried out by the Secretariat, stressing the importance and ensuring that the future management of migratory species and their habitats adequately takes into account consequent impacts and risks posed by IAS. The study also showed that it is crucial for governments and conservation managers to monitor migratory species processes to better understand how and to what extent they are affected and to respond to these threats. Thus, three important elements need to be addressed:

- Improvement of understanding of interactions between IAS and threatened migratory species;
- Development of priorities for intervention; and
- Improvement in international cooperation and development of adaptable management strategies.

A more detailed presentation of the future strategies, accompanied by a summary of the current state of knowledge on IAS and their impact, including on migratory species, as well as an overview of the current actions to address invasive species, is included in the document UNEP/CMS/ScC17/Doc.11, "*Invasive alien species and migratory species*", discussed at the 17th Meeting of the Scientific Council.

The Convention, in cooperation with its daughter instruments and other partner organizations, develops International Single Species Action Plans (SSAP) for endangered species included in Appendix I and, where needed, ensures the inclusion of provisions to prevent and/or control IAS. The CMS/AEWA SSAP for the White-headed duck, also supported by the EU and the Bern Convention, provides a good example of international coordination among countries concerned with the presence of the alien Ruddy duck. The plan in fact aims to increase White-headed duck population size and range through: managing key sites, raising awareness, and controlling and preventing the threat of hybridization posed by the non-native Ruddy duck.

Finally, in 2010, the Common Wadden Sea Secretariat, which supports the Agreement on the Conservation of Seals in the Wadden Sea as well as the Trilateral Sea Cooperation, adopted the Wadden Sea Plan 2010. This Plan foresees intensified support and efforts to harmonize approaches to the prevention, management and monitoring of aquatic and terrestrial invasive species introductions. It also foresees the development of a common strategy for dealing with invasive species associated with ballast waters and aquaculture at the next Ministerial Conference in 2013.

THE AFRICAN-EURASIAN MIGRATORY WATERBIRD AGREEMENT (AEWA)

The African-Eurasian Migratory Waterbird Agreement (AEWA) covers 255 species of birds ecologically dependent on wetlands for at least part of their annual cycle, including many species of divers, grebes, pelicans, cormorants, herons, storks, rails, ibises, spoonbills, flamingos, ducks, swans, geese, cranes, waders, gulls, terns, tropic birds, auks, frigate birds and even the South African penguin. The Agreement provides for coordinated and concerted action to be taken by the Range States throughout the migration system of water-birds to which it applies. The AEWA Agreement area covers 119 Range States plus the EU. Parties to the Agreement are called upon to engage in a wide range of conservation actions which are described in a comprehensive Action Plan. This detailed plan addresses such key issues as species and habitat conservation, management of human activities, research and monitoring, education and information, and implementation. AEWA contains a provision that requires Parties to prohibit the deliberate introduction of non-native waterbird species into the environment and take all appropriate measures to prevent the unintentional release of such species if this introduction or release would prejudice the conservation status of wild flora and fauna; when non-native waterbird species have already been introduced, Parties are required to take all appropriate measures to prevent these species from becoming a potential threat to indigenous species.

In relation to the conservation of migratory waterbirds, in 2002 AEWA adopted '*Guidelines on Prevention of Introduction of Alien Migratory Waterbird Species and their Control*' (Resolution 2.3, binding instrument). The AEWA Guidelines urge countries to put monitoring systems in place to regularly assess the status of alien species, including in waterbird collections, provide essential data for risk evaluation and include alien species in regular waterbird inventories. Appendix I of the Guidelines provides guidance on assessment of risks posed to biodiversity by alien waterbird species within the AEWA region and includes a provisional classification of each species as high, medium or low risk.

In addition, in 2006, AEWA adopted Guidelines on Avoidance of Introductions of Non-Native Waterbird Species (see UNEP/CMS/ScC17/Doc.11). These guidelines focus on the importance of putting in place appropriate measures to prevent the unintentional release of non-native waterbird species that might threaten native flora and fauna as well as to control those that have already been introduced and proved to be high-risk. A study on the impact of invasive alien aquatic weeds on waterbird habitats in Africa was discussed at the 10th Meeting of the AEWA Technical Committee in September 2011(AEWA TC10.44).

THE AGREEMENT ON THE CONSERVATION OF ALBATROSSES AND PETRELS (ACAP)

The Agreement on the Conservation of Albatrosses and Petrels (ACAP) is a multilateral agreement which seeks to conserve albatrosses and petrels by coordinating international activity to mitigate known threats to albatross and petrel populations. ACAP came into force in February 2004 and currently has 13 member countries and covers 30 species of albatrosses and petrels.

One of the measures listed under Article III (General Conservation Measures) is the elimination or control of non-native species detrimental to albatrosses and petrels.

Action Plan 1 (Species Conservation) contains provisions that focus on the impacts of non-native taxa on ACAP listed species and their habitats. It urges Parties to a) take action to prevent the introduction of non-native animals, plants, hybrids or disease causing organisms to habitats where they could be detrimental to albatross and petrel populations; b) take measures to the extent feasible to control and where possible eradicate non-native animals, plants, hybrids and disease causing organisms that are or have the potential to be detrimental to albatross and petrel populations; and c) where feasible to protect breeding sites of albatross and petrels from habitat degradation, disturbance of habitats and minimization or elimination of damage caused by introduced non-native animals, plants, hybrids and disease causing organisms.

ACAP has also adopted Conservation Guidelines that aim to assist with the development of plans for the eradication of introduced vertebrates from breeding sites of ACAP species (see UNEP/CMS/ScC17/Doc.11). These guidelines relate mainly to islands, where introduced mammals seriously threaten the breeding success of seabirds, but many of the same principles apply to mainland sites.

INTERNATIONAL REGULATORY FRAMEWORK AND INVASIVE ALIEN SPECIES

In recognition of the urgent need to address the impact of IAS on biodiversity, several international organizations and agreements have developed policies dealing with this issue. Over 40 international and regional instruments contain provisions for measures to be undertaken at global and, regional levels for the conservation of biodiversity in relation to the threats of biological invasions. An exhaustive and comprehensive review of the global legal framework related to IAS was first published by Shine *et al.* (2000). Successively, several works have been summarising the progress of the policy development of the issue, which is continuously and rapidly evolving. Examples are the detailed analysis carried out by Miller *et al.* (2006) and Kettunen *et al*. (2009). This section is prepared through a desk review of such key analysis, duly amended and updated on the basis taking into account the recent documents dealing with invasive alien species, including the more recent analysis for gaps and synergies made by ad hoc groups to further develop and strengthen the relevant policy within MEAs, particularly the CBD (see below).

In this section a number of relevant MEAs and international regulatory frameworks of interest for potential synergies with the CMS are reported and analysed (see UNEP/CMS/ScC17/Doc.11). These include: the Convention on Biological Diversity (CBD), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on Wetlands (Ramsar Convention), the International Convention for the Control and Management of Ships' Ballast Water and Sediments (IMO), the International Plant Protection Convention (IPPC), the World Organisation for Animal Health (OIE), the Standards and Trade Development Facility (STDF), and some key regional instruments such as the Bern Conventions, and the Antarctic Treaty.

THE CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

The Convention on Biological Diversity (CBD), is the first major global agreement on the conservation and sustainable use of biodiversity, and is now ratified by over 190 Parties. The CBD – which is a binding instrument - provides a comprehensive approach to the issue of the prevention of introduction and management of spread of invasive alien species, and urges the contracting parties, to undertake measures addressing the problem of IAS. Article 8(h) of this comprehensive strategy recommends that "each Contracting Party shall, as far as possible and appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species."

Within the CBD framework, a key development in relation to IAS was the adoption of fifteen *Guiding Principles for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species*. The Guiding Principles were agreed at CoP 6 in 2002 (The Hague, the Netherlands) and annexed to COP Decision VI/23 (Alien

species that threaten ecosystems, habitats or species). These principles are intended to assist governments and other organisations in the implementation of Article 8(h) of CBD and in the development of effective strategies and action plans to prevent the introduction of, and promote control and eradication of IAS at the national and regional levels.

IAS are also formally addressed through other CBD decisions, such as Decision VII.13 aken at COP 7 in 2004 (Kuala Lumpur, Malaysia) which established an *Ad Hoc Technical Expert Group* to address gaps in the international regulatory frameworks on IAS. The gaps and inconsistencies in the international regulatory framework on IAS were indeed the focus of the discussion held at COP 8 in 2006 (Brazil). As a result Decision VIII/27 set out detailed recommendations to address gaps identified in the current regulatory framework (eg gaps related to pathways, such as aquaculture/marine culture, ballast water and biofouling - particularly hullfouling - civil air transport, tourism, international development assistance and emergency relief). The Decision VIII/27 highlighted also the need for risk analyses and assessments on potentially IAS that are subject to export. In addition, the Decision VIII/27 further emphasised the importance of capacity building, adequate funding and exchange of information and experience. Amongst its general provisions, Decision VIII/27 also:

• notes that actions to address IAS need to be taken at regional as well as other levels and the importance of consistency among actions and efforts at the various levels;

• emphasises the appropriateness of regional and sub-regional approaches in particular;

• encourages the development, as appropriate, of regional guidance under appropriate regional bodies or institutions to address particular gaps in the international regulatory framework; and

• encourages Parties, other Governments, and regional bodies to develop procedures and/or controls to ensure that cross-border impacts of potential IAS are considered as part of national and regional decision-making processes, taking into account already existing procedures and controls for IAS that are pests of plants under the International Plant Protection Convention.

IAS have been formally designated as a cross cutting issue within the CBD's programme of work, which means that issues related to IAS must be addressed where appropriate through the CBD's other programmes and activities. Besides, biological invasions and IAS are recognized as a major threat particularly to island biodiversity and way of life. In fact at COP 8 the CBD adopted also the first ever programme of work dedicated to island biodiversity. Parties and relevant organizations were invited to provide information for the in-depth review of implementation of the programme of work on island biodiversity by the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) at its 16th meeting, in May 2012. Out of Europe overseas, Ascension Island, Cayman Islands and the

French Overseas submitted voluntary reports and contributed to the In-Depth Review which took place during COP 11 in 2012. In addition, a report on the implementation of the CBD in Europe overseas was submitted by IUCN.

At COP 10 in 2010 (Nagoya, Japan) the CBD adopted the Strategic Plan for Biodiversity 2011–2020. The plan consists of five strategic goals, including 20 Aichi Biodiversity Targets. Target 9 under Strategic Goal B (Reduce the direct pressures on biodiversity and promote sustainable use) states "*[b]y 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment*". In 2011, at the margins of the 15th SBSTTA meeting, the Executive Secretary of the Secretariat of the CBD and the Global Director, Biodiversity Conservation Group, of the International Union for Conservation of Nature (IUCN) signed a supplementary agreement for the implementation of the Strategic Plan for Biodiversity 2011-2020 in relation to IAS. The ISSG and the IUCN Invasive Species Initiative have agreed to work together with the CBD Secretariat to promote implementation to achieve the Target 9 and support relevant initiatives concerning IAS.

Also other Aichi targets are relevant for the work on invasive species; in particular: Target 5 (By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced), because of the impacts caused by invasive species on these components; Target 11 (By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes), considering the effect of invasions on protected areas such as islands, and – more importantly - Target 12 (By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained) considering that invasive species are acknowledged as a primary cause of extinctions, in particular for what concerns birds nesting on islands.

The result of a report of the meeting of the Ad Hoc Technical Expert Group on addressing the risks associated with the introduction of alien species as pets, aquarium and terrarium species, and as live bait and live food, led to CBD decision XI/28 (UNEP/CBD/SBSTTA/15/INF/1).

The recent CBD decision XI/28 also addressed ways and means to address gaps in international standards regarding IAS. According to CBD decision XI/28 the Parties, concerned about the potential risks associated with the intentional and unintentional

release or escape of individuals of captive-bred alien populations and genotypes of pets, aquarium and terrarium species, or species used as live bait and live food, which may have an impact on native genetic diversity, and noting the need to document these and develop guidance on how to deal with them, requested the Executive Secretary to collect case studies and to explore measures, in collaboration with relevant international organizations, on how to deal with such risks. The CBD Conference of the Parties also recognizing the relevance, importance and applicability of existing international standards, guidelines and recommendations to addressing the risks associated with the introduction of alien species, and to managing pathways to prevent their introduction and spread, in order to achieve Target 9 of the CBD Strategic Plan for Biodiversity 2011-2020, and for this reason requests the Executive Secretary, in line with paragraph 3 (c) of CBD decision X/38 and in collaboration with the relevant international organizations that set international standards, guidelines and recommendations, to develop, subject to the availability of financial resources, a practical, non-prescriptive toolkit for CBD Parties on applying existing international standards, guidelines and recommendations, and to disseminate it, *inter alia*, through the clearing-house mechanism of the CBD, no later than COP 12.

THE CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF WILD FAUNA AND FLORA (CITES)

The CITES, also known as the Washington Convention, is an international agreement between governments whose aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Among the multilateral environmental agreements, the CITES is relatively unique, in that it imposes a number of direct and specific obligations to Parties (governments), related to national legislation, and to administrative and enforcement activities at a national level. This treaty provides world-wide controls on international trade on endangered species through a system of permits and certificates which guarantee an effective enforcement of its provisions. Generally speaking, CITES is only addressed to species endangered by international trade, with the level of control depending on how endangered the species is. This means that all species endangered by other factors such as habitat destruction or domestic trade cannot be protected under this treaty. CITES applies to all the species listed in its appendices, whether alive or dead, as well as their parts and products. CITES is a complex treaty, which has continually evolved over the past 40 years, and which has a number of resolutions related to its interpretations, definitions and applications. For many years CITES has been among the conservation agreements with the largest membership, with now 177 Parties.

The enforcement of CITES is based on a complex administrative system which all parties must implement to regulate and control movement of species at international level. This system depends on the issue of import and export certificates provided that specific conditions are met, for example, after execution of adequate monitoring of trade both at

entry points and in the wild. This convention does not include any provision directly related to IAS. However CITES has recognized the importance of cooperation with the CBD on this topic and has shown increasing interest in IAS issues. For instance, according to Resolution Conf. 13.10 on *Trade in alien invasive species* - based on Decisions adopted by the COP 10 in 1997 (Harare) and amended at the COP 14 in 2007 (The Hague) – Parties are recommended to:

a) consider the problems of invasive species when developing national legislation and regulations that deal with the trade in live animals or plants;

b) consult with the Management Authority of a proposed country of import, when possible and when applicable, when considering exports of potentially invasive species, to determine whether there are domestic measures regulating such imports; and

c) consider the opportunities for synergy between CITES and the Convention on Biological Diversity (CBD) and explore appropriate cooperation and collaboration between the two Conventions on the issue of introductions of alien species that are potentially invasive.

The implementation of this resolution was somehow anticipated by the European Union (EU). In fact, although the EU not yet a Party to the CITES in its own right, has implemented the convention since 1984 through Council Regulation (EEC) No. 3626/82, as amended and updated (following the adoption of the single market in January 1993, which abolished controls on trade between Member States) by Council Regulation (EC) No. 338/97, currently further amended. The new EU Wildlife Trade Regulations entered into force on 1 June 1997, and incorporate all CITES provisions, as well as some additional, stricter, although more elastic, measures, among which the possibility to suspend trade on certain IAS. The section below, describes the detail of such regulation more in detail, with the aim of showing virtues and shortcomings of the implementation at a regional level of provisions set by an international agreement in relation to the problem of IAS.

INVASIVE ALIEN SPECIES IN THE CONTEXT OF THE EU WILDLIFE TRADE REGULATION

The implementation of the CITES at the EU level provides an interesting example of a use of this convention for preventing the introduction of IAS. CITES is implemented in the EU through a set of Regulations known as the EC Wildlife Trade Regulations. Although these Regulations are directly applicable in all EU Member States, the necessary enforcement provisions are transferred into national legislation and supplemented with national laws.

While the EU Wildlife Trade Regulation sets out the EU rules applying to trade in endangered species in wild fauna and flora, it also contains some provisions aiming at preventing the introduction of invasive alien species that can harm native biodiversity. As one of its main objectives, the Regulation establishes a permitting system whereby

specimens of species listed in its Annexes can only be imported into and exported from the EU, subject to the issuance by the competent authority of the relevant Member State of a CITES permit or certificate, which must be presented to the border customs office at the point of introduction. Species are listed in the Annexes to the Regulation, according to their listing in the Appendices to CITES and to their conservation status. In addition, Annex B of the Regulation contains species in relation to which it has been established that the introduction of live specimens into the natural habitat of the EU would constitute an ecological threat to wild species of fauna and flora indigenous to the EU (Article 3 (2)(d)).

The Regulation includes provisions allowing to suspend the importation into the EU of live specimens of certain species, where it has been established that their introduction into the natural environment of the EU presents an ecological threat to wild species of the fauna and flora indigenous to the EU (Article 4 (6)(d)). Up to now, Council Regulation (EC) No 338/97 has been used to suspend the import of 7 invasive alien species:

- the Ruddy Duck
- the American Bull Frog (*Rana catesbeiana*)
- the Red-eared Terrapin (*Trachemys scripta elegans*)
- the Painted Turtle (*Chrysemys picta*)
- three squirrel species (*Callosciurus erythraeus*, *Sciurus carolinensis*, *Sciurus niger)*

As remarked during the Joint meeting Member States IAS experts and WTR Scientific Review Group experts (Brussels, 5 February 2013) the CITES Management Committee and the Scientific Review Group (SRG) have discussed on several occasions trade suspensions for IAS and more recently have also debated on the link between the future EU legislative instrument on IAS and the provisions in Council Regulation (EC) No 338/97 relating to invasive species. Different options have been expressed on this matter and advantages and disadvantages to the approaches have been presented. Some of the members of the SRG and the CITES Management Committee are in favour of continue using the provisions of the Regulation for IAS. In this context, in the interim period before the adoption and entry into force of the dedicated legislative instrument, the SRG and the CITES Management Committee decided to adopt a certain number of criteria which could be used to elaborate a list of species for inclusion of additional IAS in the Annexes of Council Regulation (EC) No 338/97. Pending the entry into force of the future EU legislation on IAS, the SRG and the CITES Management Committee agreed at their meetings of June and July 2012 to the following text:

Article 6 (d) of Council Regulation (EC) No 338/97 lays down that the Commission may establish restrictions on the introduction into the EU of species for which it has been established that their introduction into the natural environment of the EU presents an ecological threat to wild species of fauna and flora indigenous to the Union. Pending the entry

into force of the future EU strategy on IAS, this provision should only be used in relation to species meeting the criteria in Article 6(d) above and which:

- are in international trade or are likely to enter international trade as live specimens, and

- are capable of establishing viable populations in the wild.

One of the core elements discussed was whether there was a need to prove that an urgent action was necessary to justify the listing under the Wildlife Trade Regulation, in the interim period before the entry into force of the dedicated legislative instrument. However, there was no consensus within the SRG and the Management Committee whether the need for emergency measures should be added as an additional criterion. This has emerged from the realisation that a listing under the Wildlife Trade Regulation bringing about a trade suspension would be quicker (around 9-12 months) than a listing under the future dedicated legislative instrument on IAS. In this context, and on the basis of the above criteria, some Member States, through the SRG meetings, have proposed a number of invasive alien species that they would wish to list in Annex B of the Wildlife Trade Regulation in order to suspend their trade.

THE RAMSAR CONVENTION

The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971) contains no explicit provision on alien invasive species.

However, at COP 7 in 1999 (San José, Costa Rica), a specific Resolution VII/14 on *Invasive Species and Wetlands* was adopted. This resolution emphasises the threat that alien species pose to the ecological character of wetlands and to wetland species, terrestrial and marine, if they become invasive. It acknowledges that adequate control of invasive species is often expensive and eradication is usually impracticable once these species are established, which means that prevention and early intervention are the most cost-effective techniques that can be employed against invasive species.

The Resolution directs the Ramsar Scientific and Technical Review Panel (STRP) to prepare guidance for Parties on legislation or other best practice management approaches that incorporate risk assessment, in order to minimise the introduction of new and environmentally dangerous alien species into a jurisdiction, as well as the movement or trade of such species within a jurisdiction. Parties are urged *inter alia* to:

- address the environmental, economic and social impacts of invasive species on wetlands;
- prepare inventories and assessments of alien species in wetlands within their jurisdictions;
- establish control or eradication programmes;

- review existing legal and institutional measures pursuant to Resolution VII.7 and, where necessary, adopt legislation or programmes to prevent the introduction of new and environmentally dangerous alien species into their jurisdiction and their movement or trade within their jurisdictions;
- develop capacity for the identification of new and environmentally dangerous alien species (including those being tested for agricultural and horticultural use); and
- facilitate awareness of, and resource the identification and control of, new and environmentally dangerous alien species.

The STRP has established an Expert Working Group on Invasive Species to implement this mandate.

Another specific Resolution VIII.18 on *Invasive Species and Wetlands*, was adopted in 2002 (Valencia, Spain). This resolution, urges Parties to:

• address wetland IAS issues in a decisive and holistic manner, making use of tools and guidance developed by various institutions and under other conventions (e.g. CBD Guiding Principles);

• identify the presence of IAS in Ramsar sites and other wetlands, the threats they pose to these sites' ecological character and the actions underway or planned for prevention/mitigation; and

• undertake a risk analysis of alien species that may pose a threat to the ecological character of wetlands.

According to Resolution XI.3 of the last Ramsar COP 11, the implementation of Ramsar Strategic Plan 2009-2015 contributes to the "Aichi Biodiversity Targets". In relation to Invasive alien species, according to Strategy 1.9, the plan is to a) Encourage Contracting Parties to develop a national inventory of invasive alien species that currently and/or potentially impact the ecological character of wetlands, especially Ramsar Sites, and ensure mutual supportiveness between the national inventory and IUCN's Global Register on Invasive Species (GRIS); b) develop guidance and promote procedures and actions to prevent, control or eradicate such species in wetland systems.

THE INTERNATIONAL MARITIME ORGANISATION (IMO) CONVENTION ON BALLAST WATER MANAGEMENT (BWM)

The International Maritime Organisation (IMO) developed a mandatory instrument for the control of ships' ballast water: the International Convention for the Control and Management of Ships' Ballast Water and Sediments (adopted in February 2004). In fact international shipping provides pathways for transmission of marine IAS of high ecological significance via exchange of ballast water. The aim of the Convention is thus to prevent,

minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments.

The Convention will require all ships to implement a Ballast Water and Sediments Management Plan. All ships will have to carry a Ballast Water Record Book and will be required to carry out ballast water management procedures to a given standard. Existing ships will be required to do the same, but after a phase-in period. Parties to the Convention are also given the option to take additional measures, which are subject to criteria set out in the Convention and to IMO Guidelines. Parties should also ensure that ballast water management practices do not cause greater harm than they prevent to their own environment, human health, property or resources or to those of other States.

In July 2005, the IMO's Marine Environment Protection Committee (MEPC) adopted 'Guidelines for uniform implementation of the International Convention for the Control and Management of Ships' Ballast Water and Sediments'. The Guidelines cover ballast water management equivalent compliance; approval of ballast water management systems; ballast water management and development of ballast water management plans; ballast water exchange and procedures for approval of ballast water management systems that make use of Active Substances.

The BWM Convention is to enter into force 12 months after ratification by 30 States with 35 per cent of the world's fleet tonnage. In March 2012, there were 36 Contracting States to the Convention, yet representing only 29,07 per cent of the world's tonnage.

In addition, the IMO is currently implementing Phase 2 of the Global Ballast Water Management Programme (Globallast) that aims to build awareness, regional cooperation and developing country capacity to implement the IMO Guidelines and prepare for the BWM Convention ratification and implementation.

The strategic importance of the BWM Convention is also recognised by the CBD COP 7 (Decision VIII/27) which urges Parties and other Governments to ratify and implement the BWM Convention as soon as possible and to address, in their national legislation, the issue of domestic translocation of ballast water by vessels requiring equivalent compliance with but not covered by that Convention. Also, since there is no binding convention to address marine hull fouling as an IAS pathway, through Decision VIII/27, the CBD COP calls on the IMO to address this and encourages Parties and other Governments to implement controls at national level, for example through appropriate measures (regulations and standards) on marine biofouling as a pathway for introduction and spread of IAS, including for recreational vessels. The Decision also encourages Parties to ratify and implement the 2001 IMO Convention on the Control of Harmful Antifouling Systems on Ships (AFS Convention), whose main objective is to prohibit the use of harmful organotins (eg TBT) in anti-fouling paints used on ships and establish a mechanism to prevent the potential future

use of other harmful substances in anti-fouling systems. Although the Convention's purpose is to reduce unwanted impacts on the receiving environment, this may indirectly affect potential IAS that are moved in hull fouling.

In fact, the role of IMO in this context is also emphasised by the outcome of the Rio+20 conference on sustainable development - The future we want - which took place in Rio de Janeiro, Brazil, in June 2012, according to which: "We note the significant threat that alien invasive species pose to marine ecosystems and resources and commit to implement measures to prevent the introduction, and manage the adverse environmental impacts, of alien invasive species, including, as appropriate, those adopted in the framework of IMO".

THE INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)

Air travel has facilitated the spread of alien species rapidly, and over greater distances than ever before. International organisations involved in the regulation of these pathways have been active in developing measures to address risks from IAS. With regard to the spread of IAS through air transport pathways, the International Civil Aviation Organization (ICAO) first addressed the issue of introductions via civil air transportation in 1998 through the Resolution A32-9 on preventing the introduction of invasive alien species (non-binding instrument). Over the years, this Resolution has been updated by stronger recommendations, e.g. Resolutions A33-18 in 2001, A35-19 in 2004 and A36-21 in 2007. The latter Resolution urges all Contracting States to support one another's efforts to reduce the risk of introducing, through civil air transportation, potentially invasive alien species to areas outside their natural range, and requests the ICAO Council to continue working with the appropriate organizations in this regard.

Also in this case the strategic importance of this organisation in dealing with the IAS issue, is emphasised by the CBD Decision VIII/27 which encourages Parties and other Governments to promote collaboration at the national level among relevant agencies responsible for matters of IAS and/or civil air transport (eg, civil aviation, transport, customs, trade, plant protection, and the environment) so that all relevant issues are raised through national participation in the ICAO. In addition, at COP 8 and COP 11 (see CBD Decision XI/6 Cooperation with other conventions) the parties to the CBD have identified tourism as a particular pathway for IAS - one that has obvious links to civil aviation. This has encouraged the World Tourism Organization, IATA, and other relevant international organizations to promote public awareness of the role of tourism as a pathway for the introduction and spread of invasive alien species.

THE INTERNATIONAL PLANT PROTECTION CONVENTION (IPPC)

The International Plant Protection Convention (IPPC) is an international treaty relating to plant health. The IPPC is a binding instrument which provides a framework for

international cooperation to prevent the spread of pests of plants and plant products between countries and to promote appropriate measures for their control within countries. It defines 'pest' as 'any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products' and covers direct and indirect damage by pests to both wild and cultivated plants. The IPPC, the international standards-setting body recognized in the WTO's SPS Agreement, takes into account the threat that alien species can pose to plants. Therefore some of its standards and quarantine rules tackle the problem. In fact IAS are covered by the IPPC to the extent that they qualify as pests of plants or plant products. Alien pests and diseases of plants can have significant negative impacts on both individual plant species and entire ecosystems. Where native plants do not have resistance towards alien pests or diseases, the effects of these invaders can often be very severe. Therefore regulatory measures related to pests and diseases of plants form an integral part of the international IAS framework.

While the Convention applies mainly to quarantine pests involved with international trade, it extends to the protection of natural flora and plant products. It also includes both direct and indirect damage by pests, thus including weeds. The provisions extend to cover conveyances, containers, storage places, soil and other objects or material capable of harbouring plant pests.

The World Trade Organisation's Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement), mandates the use of international standards to promote harmonisation of national phytosanitary and sanitary measures that affect trade and to avoid disguised barriers to trade. WTO Members may only apply measures that differ from international standards where this is technically justified by risk assessment. The SPS Agreement identifies the IPPC as the reference body for international standards in relation to pests of plants and plant health.

An important development is the adoption of guidance under the revised IPPC with regard to pests that affect unmanaged ecosystems. For example the IPPC Supplement on 'Analysis of environmental risks' to ISPM No.11 (Pest risk analysis for quarantine pests) focuses on plants that are potential weeds, even where they do not directly impact on agricultural systems. According to the Supplement, a species that is allowed entry based on available information but subsequently moves from the intended environment to an unintended environment and becomes problematic may be treated as if it had just arrived and is a new pest. The IPPC provisions regulating the entry of a pest can thus be applied to the domestic movement of an organism years after its introduction. The Supplement also provides for control of pests that can cause indirect impacts on biodiversity and ecosystem function as well as direct impacts to plants.

The IPPC Supplement on 'Guidelines on the understanding of potential economic importance and related terms including reference to environmental considerations' to ISPM 5 (Glossary of Phytosanitary Terms) clarifies that pest risk analysis can account for environmental concerns in economic terms by using monetary or non-monetary values and that market impacts are not the sole indicator of pest consequences. Accordingly, Contracting Parties have the right to adopt phytosanitary measures with respect to pests for which the economic damage caused to plants, plant products or ecosystems within an area cannot be easily quantified.

Under the IPPC, the European and Mediterranean Plant Protection Organization (EPPO) is the regional plant protection organization for Europe. EPPO maintains an alert list of IAS. At the pan-European level, EPPO has established an Ad Hoc Panel on Invasive Alien Species in 2002. The Panel has developed a list of plants considered to pose an important threat to plant health, environment and biodiversity in the EPPO region. EPPO recommends that countries in which biodiversity is endangered by these species take measures to prevent their further introduction and spread or manage unwanted populations (eg publicity, restriction on sale and planting, control).

WORLD ORGANISATION FOR ANIMAL HEALTH (OIE)

Introductions of exotic animal diseases and parasites are often considered primarily a threat to agricultural production and human health. However, such introductions can also have severe effects on susceptible native species and ecosystems. As for plant pests, measures taken in relation to animal pathogens by WTO Members need to be consistent with the provisions of the SPS Agreement. The World Organisation for Animal Health (Office International des Epizooties or OIE) is identified in the SPS Agreement as the reference body for international standards on animal health. WTO Members may apply national sanitary measures different from those in OIE standards only where this is scientifically justified.

Specific "Guidelines for assessing the risk of non-native animals becoming invasive" have been published by OIE in November 2011. In fact in the framework of the international movement of animals, it is important to analyse both the risk of a non-native animal becoming invasive and the risk of pathogens being introduced with the animal. These different risks should be assessed as separate, sequential and complementary processes. The OIE standard for import risk analysis covers the potential movement of pathogens. The guidelines developed in the document mentioned above are intended to address the complementary process of assessing the risk of non-native animals becoming invasive.

STANDARDS AND TRADE DEVELOPMENT FACILITY (STDF)

The Standards and Trade Development Facility (STDF) is a partnership involving a number of international organizations, to help developing countries deal with international standards on food safety and animal and plant health), and two of the three standards-setting organizations recognized in the SPS Agreement, the IPPC, and OIE.

The SPS Agreement (Annex A) defines "SPS measures" as including "any measure applied to prevent or limit other damage within the territory of the Member from the entry, establishment or spread of pests", in addition to measures taken to protect human, animal and plant life or health from risks arising, inter alia, from "pests". The terms "animal" and "plant" in the SPS Agreement include wild fauna and wild flora, and "pests" includes weeds. Since "other damage" may include environmental damage caused by pests, measures applied to prevent or limit other damage within the territory from the entry, establishment or spread of IAS falls under the definition of an SPS measure (see STDF Briefing n.9, October 2012).

In relation to trade as main pathways of IAS, the STDF, in collaboration with the International Plant Protection Convention (IPPC) and the World Organisation for Animal Health (OIE), organized a Seminar on International Trade and Invasive Alien Species (IAS) in Geneva on 12-13 July 2012.

The seminar sought to: (a) raise awareness about the mutually supportive objectives of the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) and Convention on Biological Diversity (CBD), and the contribution of effective SPS systems to help protect against the entry of harmful species, including pests, diseases and other IAS

(b) foster collaboration between the SPS and the CBD "communities" at both regional and national levels; and

(c) review initiatives that aim to build national and/or regional capacities to manage the entry and spread of IAS, including pests and diseases, and discuss common challenges, good practices, and additional capacity building efforts required (e.g. needs assessments, pest risk analysis (PRA), surveillance, development of training toolkits and materials, etc.)

As a result, among the recommendations in a paper presented to the seminar was a call for a decision in the WTO to deal more specifically with the problem and to clarify further how WTO rules apply.

The seminar also underlined that strengthening SPS capacity is the first line of defense in managing the risks linked to invasive alien species. A number of key actions were identified to control such species more effectively, including:

- boosting continuing efforts to improve the way the relevant international organizations work together, support each other and strengthen each other's ability to implement the SPS Agreement and global biodiversity conventions
- ensuring existing international standards are implemented better, to prevent trade from spreading harmful alien species — and developing new standards where needed
- boosting countries' ability to undertake scientific risk analysis and other studies, particularly in developing countries
- improving coordination between ministries and other agencies within countries, between countries and within regions — the agencies' concerned have diverse responsibilities, from law enforcement, customs and trade to agriculture, fisheries, forestry and environmental protection
- enhancing cooperation between governments and industry
- raising public and political awareness
- studying potential risks associated with the growth in Internet trade, and how to address them

INTER-AGENCY LIAISON GROUP ON INVASIVE ALIEN SPECIES

With decision IX/4 on gaps and inconsistencies in the international regulatory framework, the Conference of the Parties of the Convention on Biological Diversity requested the Executive Secretary to collaborate with the secretariats of the international organizations relevant to invasive alien species to explore the extent to which existing international instruments recognize and address threats from invasive alien genotypes. Following this decision the CBS Secretariat established an Inter-agency Liaison Group on invasive alien species, inviting several key organisations such as IPPC, OIE, CITES, WTO, SPS. It also invited the IUCN to take part to the Liaison Group, providing technical support on the issue.

The general purpose of the Liaison Group is to facilitate cooperation among re**l**evant organizations to support measures to prevent the introduction and mitigate the impacts of invasive alien species, including in particular on the international trade and movement of species. The Liaison Group aims at ensuring that policies and activities are complementary so as to optimize efficiency build synergies and avoid any unnecessary duplication.

THE BERN CONVENTION AND THE COUNCIL OF EUROPE STRATEGY

The "Convention on the Conservation of European Wildlife and Natural Habitats," includes over 50 contracting parties, among which the European Community. This agreement, managed by the Council of Europe, includes important provisions and recommendations dealing with IAS. In fact, according to article 11.2b, each Contracting Party undertakes "to strictly control the introduction of non-native species."

Under the Bern Convention, a specialized IAS Expert Group has prepared a number of technical documents and papers for the Council of Europe in order to promote sound implementation of provisions dealing with IAS, particularly to help member states identify adequate management and control measures against IAS. The Bern Convention IAS Expert

Group has continued to hold meetings bringing together IAS experts from a range of Convention's Member States.

Besides, over the years many relevant recommendations have been adopted, e.g. addressing native species threatened by IAS or IAS themselves, on the eradication of non-native terrestrial vertebrates and on IAS threats to biological diversity on islands and other isolated ecosystems, on specific codes of conducts, etc. Some code of conduct of relevance are the one on zoological gardens and aquarium, recently adopted, and those on hunting and on pets, as well as the guidelines for protected areas.

A major achievement of the Bern Convention was the approval in 2003 by the Council of Europe of the "*European strategy on invasive alien species*" (T-PVS (2003) 7), which promotes the development and implementation of coordinated measures and efforts throughout the region to minimise the adverse impact of IAS on Europe's biodiversity, economy and human health and wellbeing (Genovesi and Shine, 2003). The Strategy is a binding instrument with input from a wide range of stakeholder and non-governmental organisations. The Strategy offers advice to the Contracting Parties on measures to prevent unwanted introductions and tackle IAS. The Convention's Standing Committee has recommended that Contracting Parties draw up and implement national strategies on IAS, taking the Strategy into account, and cooperate, as appropriate, with other Contracting Parties and Observer States in the prevention of IAS introduction, the mitigation of their impacts on native flora and fauna and natural habitats, and their eradication or containment where feasible and practical (Recommendation No. 99).

The European Strategy for IAS is closely aligned with the CBD Guiding Principles and aims to promote regional consistency and best practice in their implementation. However, the Strategy also provides guidance to some issues that are not addressed within the Guiding Principles framework, e.g. recovery and restoration of species and habitats affected by invasions. Besides the European Strategy provides an appropriate instrument for joint implementation as it recognises the importance of the role of other international bodies and institutions, NGOs and the private sector.

THE ANTARCTIC TREATY

The Antarctic Treaty and related agreements that regulate international relations with respect to the Antarctica are collectively called the Antarctic Treaty System or ATS.

The Antarctic Treaty was signed in Washington on 1 December 1958 by 12 countries whose scientists had engaged in activities in and around Antarctica in 1957–1958. It came into force in 1961. The affected area extends into the region south of latitude 60° South. This text, composed of 14 articles, was ratified September 16, 1960 by France and became effective June 23, 1961.

Other agreements adopted at treaty consultative meetings and ratified by governments that make some reference to non-native or alien and invasive species include:

The Agreed Measures for the Conservation of Antarctic Fauna and Flora adopted in 1964 to protect endemic and native wildlife and plants. The provisions include a requirement for permits to take or harm birds and seals, and rules to prevent the uncontrolled introduction of non-indigenous organisms.

The International Convention on the conservation of flora and fauna of Antarctica adopted at the Diplomatic Conference held in Canberra (Australia), May 20, 1980. makes a reference to the introduction of alien species and impacts on the environment calling to prevent changes or minimize the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, given the state of knowledge available regarding the direct and indirect impact of the operation, the effect of the introduction of alien species, the effects of associated activities on the marine ecosystem and those of environmental changes to enable the sustained conservation of marine living resources of Antarctica.

The Protocol on Environmental Protection to the Antarctic Treaty was signed October 4, 1991 and entered into force January 14, 1998. This agreement provides for the protection of the Antarctic environment through five specific annexes on marine pollution, fauna and flora, environmental impact assessments, waste management, and protected areas. It includes references to the importation of animals and plants and precautions to prevent the introduction of micro-organisms.

GAPS WITHIN THE INTERNATIONAL INVASIVE ALIEN SPECIES FRAMEWORK

In the international context, some work has already been done to identify gaps in the international regulatory framework, for example under the auspices of the CBD Ad Hoc Technical Expert Group established further to Decision VII.13. This Expert Group concluded that several of the problems related to control of IAS do not result from gaps in the international regulatory framework, but are caused by inadequate implementation of existing international provisions at national level. Thus, for most pathways for the introduction and spread of IAS, the underlying factor influencing and hindering the implementation of CBD Article 8(h) is inadequate national capacity (Miller 2006). The Expert Group also identified a lack of formal standards set at international level to deal with some IAS pathways. Current developments within the SPS Agreement might be filling this gap, for example, addressing organisms that are invasive but do not qualify as pests of plants as defined by the IPPC (eg 'hitchhiker' organisms such as ants and spiders).

Despite the many recent advances, other major gaps identified in the binding international regulatory framework – and not yet fully and satisfactorily overcome - relate not only to hull fouling and civil air transport but also to IAS pathways such as conveyances; aquaculture/mariculture; military activities; emergency relief, aid and response; international development assistance; scientific research; tourism; pets, aquarium and garden pond species, live bait and live food and plant seeds; biocontrol agents; ex-situ animal breeding programmes; incentive schemes linked to reforestation (eg carbon credits); and inter-basin water transfer and canals.

Inconsistencies identified in existing frameworks include unintended protection of IAS as a part of national nature conservation legislation and international conventions and other agreements; and inconsistency in terminology and lack of clear guidelines on the interpretation of relevant legislation (UNEP/CBD/AHTEG/IAS/1/2, UNEP/CBD/SBSTTA/11/16, see also Murphy and Cheeseman 2006).

The Expert Group proposes several specific actions to address these gaps and inconsistencies (UNEP/CBD/SBSTTA/11/INF/4). These involve improved implementation of existing international agreements and regional approaches or action by national government agencies. Collaboration amongst government agencies and international bodies/instruments is of high importance. Sharing of best practice, development of codes of practice and increasing education and public awareness are also recognised as crucial factors in addressing IAS problems. In order to address animals that are IAS but are not pests of plants under IPPC, options proposed include the expansion of the mandate of the World Organisation for Animal Health (OIE) beyond a limited number of animal diseases,

the development of a new instrument, the development of binding requirements under an existing agreement or agreements or the development of non-binding guidance.

In order to address the problem of limited financial and technical resources hindering national implementation of biodiversity-related Multilateral Environmental Agreements (MEAs) the United Nations Environment Programme (UNEP) is currently developing practical tools to assist countries to improve the implementation of their MEA obligations. The UNEP project on Issues-Based Modules for Coherent Implementation of Biodiversity-related Conventions aims to provide structured information on concerns that are dealt with by a number of MEAs. IAS constitute one of the project modules. The project will identify IAS-related implementation requirements under different international and regional agreements and cluster these obligations according to the various activities required to prevent and manage IAS. This project will provide an important tool to assist countries address gaps in IAS frameworks and streamline implementation at the national level. It is as a "work in progress" and will be updated at regular intervals to reflect relevant obligations and/or commitments taken by national governments.

SYNERGIES BETWEEN CMS AND OTHER ON-GOING INVASIVE ALIEN SPECIES MANAGEMENT INITIATIVES

According to the working document no.11 of the 17th CMS Scientific Council Meeting, invasive species are a global issue that requires collaborative effort at regional and local levels, especially through prevention, early detection and rapid response. Measures that prevent international movement of invasive species and promote rapid detection at borders are less costly than control and eradication. Prevention requires collaboration among governments; economic sectors and non-governmental and international organizations (see UNEP/CMS/ScC17/Doc.11). For this reason in recent years increasing attention has been paid to enhancing synergies between different international MEAs and other biodiversity-related conventions with the aim of improving coherent and effective implementation of MEAs and avoid duplicated and contradicting of work (Kettunen *et al* 2006).

Indeed according to doc. UNEP/CMS/Conf.10.28 "Cooperation with organizations concerned with the conservation of migratory species is one of the key functions of the CMS Secretariat as mandated by Article IX of the Convention. Furthermore, the CMS Strategic Plan 2006-2011 (which is expected to be extended to 2014, by CMS COP10 through draft Resolution 10.5/Rev.1) recognizes that the objectives of CMS and other biodiversity-related conventions are mutually supportive and that strengthening a network of partners and establishing a dialogue with other key sectoral groups whose activities have impacts on migratory species are crucial to promoting CMS and its mandate".

Besides, according to the CMS Strategic Plan 2015–2023 (UNEP/CMS/Resolution 10.5), a cross cutting issue to be adopted and implemented in all activities, where appropriate, as one of nine identified Operational Principles is to cooperate closely with relevant multilateral environmental agreements and key partners to maximize synergies and avoid duplication. This Operational Principle fully reflects the CMS fundamental working philosophy. In fact CMS has entered into a number of collaborative relationships with these and other intergovernmental organizations in order to maximize synergies and avoid duplication. For example, joint work programmes have been developed between CMS and CITES, CMS and CBD, and between CMS, AEWA and Ramsar.

Thus, an important development at the international level is the clear growth in inter-sectoral cooperation on IAS issues between different institutions and organisations. In this context, joint initiatives specifically focusing on IAS were also undertaken. For example, already in 2004, a liaison group between the five biodiversity-related conventions (CMS, CBD, CITES, Ramsar and the World Heritage Convention) was set up (CBD Decision VII/26, also CITES Resolution 13.10). Cooperation between these conventions has lead to several shared activities, including establishment of joint work plans. Cooperation agreements also exist between other conventions that support the CBD's objectives (see Miller et al. 2006

for further details). For example, CMS, AEWA, and Ramsar Convention Work Programme (2002-2003) identified pilot projects for IAS.

The document UNEP/CMS/Conf.10.28, "Report on Synergies and Partnerships", which highlights the current state of development of initiatives and activities undertaken with partners within and without formal arrangements highlights the key developments during the last years resulting from cooperation between CMS and a large number of organizations, including MEAs; other international and national governmental organizations; non-governmental organizations (NGOs) and the private sector. The Secretariat has entered into a number of partnerships, usually formalized through Memoranda of Cooperation or similar documents. A number of these include a joint programme of work or list of activities that are regularly updated.

For example, the CMS is member of the Liaison Group of Biodiversity-related Conventions (Biodiversity Liaison Group) set out by the Parties to the CBD, in decision VII/26 (further supported by several follow up decisions of the governing bodies of the member secretariats, including CMS Res.8.11 and Res.9.6). Six secretariats of biodiversity-related conventions are currently comprising the Biodiversity Liaison Group together with the CMS: among them the CBD, the CITES, the Ramsar Convention. To facilitate knowledge management by accessing a range of strategic documents and information tools of the biodiversity-related conventions a single web portal at www.inforMEA.org has been realised, the United Nations Information Portal on Multilateral Environmental Agreements. Besides specific activities that these Secretariats undertake jointly in the framework of their bilateral formal partnerships and programmes of work and in addition to being active within the BLG, the Secretariats of the four biodiversity-related conventions adopted in the 1970s (these being Ramsar, CITES, CMS and the WHC) have significantly enhanced their institutional collaboration in the last years.

Systematic cooperation between different conventions and agreements can definitely provide greater and more effective opportunities to address biodiversity issues, including those related to IAS. In fact in this context, joint initiatives specifically focusing on IAS were undertaken. For example, already in 2004, a liaison group between the five biodiversity-related conventions (CMS, CBD, CITES, Ramsar and the World Heritage Convention) was set up (CBD Decision VII/26, also CITES Resolution 13.10). Cooperation between these conventions has lead to several shared activities, including establishment of joint work plans. Cooperation agreements also exist between other conventions that support the CBD's objectives (see Miller et al. 2006 for further details). For example, CMS, AEWA, and Ramsar Convention Work Programme (2002-2003) identified pilot projects for IAS.

By way of example, a Memorandum of Cooperation between the CMS and CBD Secretariats has been in force since 1996. In relation to this, among the other things CBD Decision XI/6 *Cooperation with other conventions, international organizations, and initiatives*, reiterates the importance of cooperation among the biodiversity-related conventions, the Rio conventions and other relevant instruments for achieving full implementation of the CBD and the Strategic Plan for Biodiversity 2011-2020. The Decision also welcomes the joint work plan 2012-2014 between the CBD and the CMS (as reviewed in document UNEP/CMS/Inf.10.36 and welcomed by the Conference of the Parties to the CMS by Resolution 10.21). In relation to the activities relevant to the IAS issue, the plan foresees collaboration between the Secretariats through their joint membership of the Scientific Task Force on Wildlife Diseases.

The strategic importance of this cooperation in relation to IAS can be seen considering that the joint work plan 2012-2014 between the CBD and the CMS also foresees that the Secretariats will enhance cooperation, policy coherence and implementation with regard to work on cross-cutting issues, such as IAS, in a manner consistent with their respective mandates, governance arrangements and agreed programmes of work. This will be achieved by such measures as joint participation at relevant meetings.

A Memorandum of Understanding was concluded between the Secretariats of CMS and CITES in 2002 to reinforce the collaboration in relation to specific initiatives (see CITES Resolution Conf. 13.3). On the other hand, CITES Resolution Conf. 13.10 (Rev. CoP14) on "Trade in alien invasive species" recommends that the Parties consider the opportunities for synergy between CITES and the CBD and explore appropriate cooperation and collaboration between the two Conventions on the issue of introductions of alien species that are potentially invasive

Also the cooperation between the Ramsar Secretariat and the CMS Secretariat is facilitated by a Memorandum of Understanding (first signed in 1997, renewed 2011) and a Joint Work Plan (2012-2014) which represents a flexible framework for collaboration with the CMS and its wetland-relevant sister Agreements and Memoranda. This is emphasised by Resolution 5.19 adopted by AEWA MOP5 on the 'Encouragement of further Joint Implementation of the African Eurasian Waterbird Agreement and the Ramsar Convention', as well as other opportunities for synergy between Ramsar and AEWA, including the African Initiative under AEWA and related projects (supported by the government of France). Another relevant inter-sectoral cooperation document is the 5th CBD/Ramsar Joint Work Plan for 2011-2020, through which Ramsar delivers its lead implementation role for wetlands in CBD programmes of work, including inter alia on inland waters, marine and coastal biodiversity and protected areas, as well as the revised CMS/Ramsar Joint Work Plan, as flexible frameworks for collaboration with the CBD, the CMS, and its wetland-relevant Agreements and Memoranda (see Ramsar Resolution XI.6)

Finally, a long-standing cooperation between Secretariat of the Bern Convention and the CMS Secretariat was formalized through the signing of a Memorandum of Understanding which took place at the Bern Convention's Standing Committee Meeting in November 2009. The CMS Secretariat had consulted the ASCOBANS, ACCOBAMS, EUROBATS and AEWA secretariats during the drafting of the Memorandum. cross-cutting issues of mutual concern such as invasive species were identified as priorities for both treaties as issues of mutual interest.

CONCLUDING COMMENTS

This report provides baseline information on the extent of the impacts of IAS on migratory species protected under CMS, the migrant populations that are most vulnerable and what are the mechanisms of this threat. The outcomes of these threats are likely lead to decline is migrant populations, and, degradation and loss of their preferred habitat. The on-going and predicted impacts of a changing climate will only exacerbate this threat.

Migrant species are also known to show invasive traits in their introduced ranges. These are predominantly fish species that been widely been introduced as part of the aquaculture trade and the pet and aquarium trade.

The analysis of the international regulatory framework related to the management of the threat of biological invasions highlights the need for better implementation of regulations at national levels. Recommendations and draft resolutions have been elaborated for consideration.

An attempt has been made to be comprehensive, focusing on critical areas in the time allowed for the development of this report.

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