



"People and Wetlands: The Vital Link"
**7th Meeting of the Conference of the Contracting Parties
to the Convention on Wetlands (Ramsar, Iran, 1971),
San José, Costa Rica, 10-18 May 1999**

Background Document

Invasive species and wetlands¹

**Outline of a keynote presentation to the 7th Conference of the Contracting
Parties to the Convention on Wetlands (Ramsar, Iran, 1971)**

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Preamble

1. Sustainable use of wetlands, "wise use" in the Ramsar Convention context, includes the management of threats to the biodiversity and ecological integrity of wetlands. Invasive species are an increasing threat to the existence of wetlands as we know them, and the following is a consideration of how to treat that threat within the policy framework of the Convention on Wetlands.
2. Noting that the issue of invasive species is an area identified for cooperative action in the Joint Work Plan between the Convention on Biological Diversity (CBD) and the Ramsar Convention (Ramsar COP7 DOC 15.4), this paper aims to promote through COP7, and the ensuing meeting of the Subsidiary Body on Scientific, Technical and Technological Advice of the CBD in June 1999, a coordinated approach to addressing the problem posed by invasive species. This paper has been developed in cooperation with the IUCN Invasives Species Specialist Group and the IUCN Global Initiative on Invasive Species.

Introduction

3. There are many examples of invasive species causing species extinctions, damage to populations of wild and domesticated organisms, and significant alteration of ecosystems. The destruction wrought by invasives is through predation, introduction of disease, competition for food and other resources, hybridisation, and habitat degradation. These problems are likely to become more acute with increasing global trade, global change and changing land use patterns. They are especially relevant to wetlands, where much damage has been caused in both tropical and temperate areas. There is a need to understand, recognise and manage infestations of invasives in wetlands and to be prepared for new arrivals and changes in status of otherwise benign species. Wetlands are especially vulnerable to invasives because of their

¹ Refer also to the related paper Ramsar COP7 DOC 15.14.

position as ecotones or interfaces between terrestrial and aquatic environments that makes them susceptible to invasion from both spheres.

What are invasive species?

4. Invasive species are organisms that have been introduced intentionally or accidentally outside of their natural range. The draft IUCN guidelines on invasive species separates them from natives and aliens thus:
 - a **native species** (or indigenous species) is a species, subspecies, or lower taxon occurring within its natural range and dispersal potential (i.e. within the range it occupies naturally or could occupy without direct or indirect introduction or care by humans);
 - an **alien species** (introduced, non-indigenous, foreign, exotic) is a species, subspecies or lower taxon occurring outside of its natural range 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, gamete or propagule of such species that might survive and subsequently reproduce;
 - an **invasive species** is an alien species which becomes established in natural or semi-natural ecosystems or habitats, is an agent of change, and threatens native biodiversity (species, populations and/or ecosystems).
5. These definitions apply in wetlands as in other ecosystems and refer to plants, animals and micro-organisms. There are many opportunities for invasions in wetlands, as the range of terrestrial to aquatic (and marine) habitats is so great and the chances of habitats changing as a result of wetland modification, pollution, nutrient enrichment, etc., are very great. For example, the drainage of a swamp for agriculture can result in the modification of a regime of water-logging that previously kept some plants “in check”; the consequence can easily be that a previously benign native species becomes an alien invasive because the ecosystem has been changed by humans. Similarly, an altered flooding regime of a river or floodplain can change the fish community structure so that an alien, introduced species suddenly has an advantage and becomes invasive.
6. The addition of pollutants or nutrients to a wetland system may give the opportunity for an alien species that was starved of nutrients (and so “just surviving”) to become invasive since there is no longer any limitation to its growth. Or the pollution of a wetland may reduce the diversity and density of native species and permit the expansion of an alien to invasive species once competition is removed. These are additional to the more familiar introduction of exotics to wild or modified ecosystems. These may become invasives because of their ability to compete with local species or because of their invasion of ecological niches that are not completely occupied.

Effects of invasives on wetlands and other water-dependent ecosystems

7. Wetland invasives can establish in many parts of a wetland system but most often have some relationship with water (fresh, brackish or marine) which enables their establishment and often enhances their spread more easily than in many purely terrestrial systems. Invasive species can settle in or on the waters of a wetland and so use the water as a medium for dispersal and expansion. They can invade water-logged soil, the interface between water and land and even the wetland plants that are submerged or emerge from wetland waters. The effects of wetland invasives on ecosystems, people and biodiversity are many and varied - the main ones are listed below.

8. **Effects in relation to water**

- Alteration (often impediment) of flow and changes in natural cycles of flow, as, for example, where submerged wetland plants block stream flows, alter stream flow patterns and reduce water passage
- Alteration (mostly reduction) of quantity and sometimes also in timing (seasonality), as, for example, where emergent invasive plants slow the drainage of flooded areas or prevent normal flooding from occurring by reducing runoff and retaining waters - and even increasing evapotranspiration with consequent loss of water
- Alteration (usually lowering of acceptable standards) of water quality in its broadest sense (including eutrophication, de-oxygenation, fouling, poisoning and reduction of nutrients)
- Reduction or loss of hydrological benefits of wetland function, as, for example, when invasive wetland plants replace the natives that take the energy (and so damage) out of floods or enhance ground water recharge
- Alteration of wetland functions downstream of invasions and across national and international borders. These effects are often not realised within the affected country as well as in the wetland where the invasives have their primary effect. A dramatic example is the build-up of invasive floating water weeds in one upstream country (due to increased availability of nutrients) which then leads to a dramatic release of these plants after heavy rains because the hydrological balance has changed. This in turn leads to invasions of the released weed downstream and then a series of effects all the way down the watershed - involving increased evapotranspiration and water loss, blockage of water ways, altering of stream flows and fouling of hydropower installations, etc.

9. **In relation to wetland products, uses and users**

- Alteration of fisheries often resulting in dramatic declines due to invasives competing with fishable species, preying upon fishable species or generally disturbing the balance of species and populations in a fishery. This is due to invasive fish, invasive crustaceans and other invertebrates and fish parasites and diseases - themselves the invasives or passengers with the invading aliens

- Reduction of wetland grazing and browsing most often caused by invasive wetland plants bringing about plant community changes that reduce access to grazing; but also by alien grazers and the introduction of weeds or pathogens of the wetland food plants
- Impairment of crops in wetlands by alien competitors and pathogens and also by hybridisation
- Reduction or prevention of access to wetlands and their products due to growths of invaders that block routes to and from wetlands or by the invasion of wetlands by alien species (animals and plants) that are harmful to the users of wetlands
- Reduction or prevention of wetland transport again by blockage of waterways or the invasion of access routes by alien invaders that are harmful to people and their livestock
- Increase in human health hazards, especially bilharzia, malaria, and other water-borne pathogens that are encouraged by aliens (or are aliens themselves) as well as snakes, crocodiles, aggressive fish, etc.
- Increase of risks of drowning and other results of coverage of the water surface, especially by invading floating water weeds, but also in association with alien wetland animals that are feared by wetland users.

10. **In relation to wetland biodiversity**

- Reduction in wetland species abundance with extremes in extinction. This arises from competition for space, nutrients and “places to live”, from predation, from “overgrazing” by invasive herbivores (be they molluscs, insects or vertebrates) and from pathogens and parasites introduced with invasive species
- Reduction in wetland species diversity arising as above and from habitat changes caused by aliens
- Alteration of wetland species/population integrity and wetland species community structure - as above
- Alteration of wetland species distribution
- Alteration of wetland ecosystems - and even wetland conversion to dryland condition. Invasive plants may alter the water relations of a wetlands as well the availability of nutrients and sunlight to other species; invasive animals may cause direct changes in vegetation by grazing, browsing and trampling or indirect changes as predators of native grazers and browsers. These effects can occur below the water surface, at the water surface, or in water-logged soil and wetland edges.

11. The economic and social effects of these impacts of invasives in wetlands can be drastic, and even those seen to be of little significance in the short term can add up to serious consequences over time. Two classic examples of this are the dramatic invasions in Lake Victoria, East Africa, by the exotic floating weed Water Hyacinth (Pontederiaceae, *Eichhornia crassipes*) and the purposely-introduced predatory fish, the Nile perch (Centropomidae, *Lates niloticus*). Water hyacinth had been in the Nile River system (of which Lake Victoria is part) for decades but began to cause trouble in 1990 when it first started to spread around the lake. By late 1998 it was estimated to cover 1% of the lake's surface - but this is the 1% that is also occupied by people and their infrastructure of cities, towns, villages and fisheries. These invasive weeds grow well in the climatic and nutrient conditions of Lake Victoria and are now causing millions of dollars of damage to the fisheries, lake transport, water supply, hydropower generation, people's access to the lake and human health, as well as unmeasurable effects on lake biodiversity and changes to the wetland ecosystems that fringe Lake Victoria.
12. Nile perch is a large and edible predatory fish that was introduced to Lake Victoria from its native waters in the separate sub-catchment of the Albertine Rift lakes and from Lake Turkana in the 1950s. It was brought to the lake to enhance the fishery and make large fish more available to the many millions of peoples of the lake shore. Nile perch was hardly seen for twenty years after its release but has increased so much over the past two decades that it now dominates the fish biomass of the lake as well as the fishery. This invasive alien species has now reduced many other species of lake fish to remnant populations and may have caused several species extinctions and other as yet-undefined changes to the biodiversity of the lake and its fringing wetlands. It has also changed the nature of the Lake Victoria fishery so that many other species are not available to local fishers, and it is the basis of a large export industry which takes much of the available fish biomass away from the area into the markets of Europe, North America and other faraway consumers. This biomass export has had serious consequences for local people's livelihoods and diets and may be affecting the nutrient status of the lake, as there is no return of some of the components of fish flesh among the hundred's of thousands of tonnes exported each year.

Organisms that can become invasive in wetlands

13. Below are **some** likely wetland candidates or contenders for the role of invasives in water-dependent ecosystems:

Lower Plants

- Cyanohpyta - blue/greens such as *Anabaena*, *Microcystis*
- Chlorophyta - Green algae; *Spirogyra* & friends, red "blood" and orange waters of the *Volvox* series, *Chara* and *Nitella*,
- (Floating) liverworts such as *Ricciocarpus*.

Tracheophytes

- (Floating) ferns - *Salvinia*, *Azolla*,
- (Emergent) ferns of many freshwater and brackish wetland species,
- (Floating, emergent and bank-rooted) grasses - *Vossia* and many, many others,

- Sedges - Cyperaceae in all its forms,
- Typhaceae - bulrushes and reeds,
- Araceae - especially *Pistia*,
- Pontederiaceae - *Eichhornia*, *Pontederia*, etc.,
- Limnocharitaceae - *Hydrocleys*,
- Hydrocharitaceae - *Elodea*, *Lagarosiphon*, *Stratiotes*, etc.,
- Lemnaceae - the various “duckweeds”,
- other (small) families of flowering wetland plants, especially monocots and some dicots such as Lythraceae - *Lythrum salicaria*
- Many “big” families such as Legumes, Umbellifers and Polygonaceae.

Invertebrates

- Molluscs - especially freshwater (and brackish) bivalves and snails, not forgetting disease vectors,
- Crustaceans - freshwater crayfish, freshwater crabs, prawn-farm escapes
- Insects - especially flies, mosquitoes, not forgetting disease vectors

Vertebrates

- Fish - deliberate introductions to lakes, rivers and dams - exotics and species indigenous to the region but not to the water body or wetland of concern:
 - accidental escapes from aquaculture, aquariums
 - movement from introductions
 - non-accidental escapes from pets, ponds, aquaria
 - escapes from mariculture
- Amphibians - such as the notorious Cane Toad
- Reptiles - snakes and lizards in island situations
- Birds - such as exotic mynahs, crows that displace waterbirds
- Mammals - such as the coypu and some smaller semi-aquatic rodents.

Methods of control

14. Control of invasives in wetlands follows the normal methods for other ecosystems but does have a special involvement of water in many cases.

- **Mechanical Control** by removal, destruction, trapping or catching; this involves finding and handling the invasive organisms and physically removing them from the ecosystem. This can be effective but rarely results in sustainable control, as it requires continuing effort and is usually not capable of removing all individuals from an invasive population - i.e., eradication is not an option in most cases, so that this form of control usually needs to persist for as long as the invasive is a problem.

- **Chemical Control** by pesticides, herbicides and poisons - few of which are specific. This method is fraught with problems of application and effects on non-target species, but may be the only solution in some cases. Chemicals with short half-lives or minimal residues are most desirable and those with specificity to the target invasive most valuable of all.
- **Biological Control**, especially for exotics and usually with exotic biocontrol agents. This method is based on the belief that most invasives are “kept under control” in their native (and so non-invasive) habitat by a range of parasites, pathogens and predators - those agents which keep every species in harmony with its surroundings and balance its growth and spread. When an invasive establishes itself in a new habitat or ecosystem, often in another part of the world remote from its home range, it is without those controlling parasites, pathogens and predators and so can grow and spread accordingly. Biological control requires that some of those controlling organisms from the invasive species’ home range be found, bred and released to control the exotic in its new habitat and thus reduce its growth and spread and impact in its “new home”.
- **Ecosystem Manipulation** (management) such as watershed management, water management, pollution control, competition with crops or local species. These techniques remove other advantages that an invasive may have in its “new home” and so reduce its growth, spread and effects.
- **Integrated Management** and strategies using some or all of the above in strategic combinations.
- **Prevention and Control** using quarantine and regulation of exports, imports and markets. This requires that the invasives are recognised and that there is agreement between states and mechanisms to ensure vigilance and action to stop the movement of species concerned.

Solutions

15. **What do wetland managers and wetland programme operatives need to understand invasives and manage infestations?**
 - **AWARENESS** - general understanding of invasives and the threats they pose, with special attention to wetlands and water-dependent ecosystems of all types.
 - **INFORMATION and TRAINING** - recognition, expertise, management options, control details - general principles for invasives with specialised information and training for invasive species of wetlands and the effects they have on wetlands.
 - **EXPERIENCE** - recognition of impending infestation or invasion, ability to predict from first signs, exposure to the reality of the effects of invasives, practical experience of

control options; general principles for invasive with specifics for both tropical and temperate wetland systems.

- WILLINGNESS to be vigilant and to monitor existing and potential invasions and infestations. This needs to come not only from the wetland managers, but also from their institutions and the policy-makers and decision-makers who determine their direction.

16. **Role of countries and government organizations in wetland invasives**

- AWARENESS - of the issues and the seriousness of wetland invasions and their consequences to wetlands, people and biodiversity, as well as the costs of control, the time needed for effective control, and the risks of lack of control.
- MECHANISMS - to address potential and actual invasions and quarantine facilities to prevent their spread. This requires that there be mechanisms to mobilise opinion as well as resources and finances to manage existing invasions and be prepared to reduce the risk of new wetland invasions.
- WILLINGNESS - to recognise and act on developing and threatening invasions.
- POLICIES and REGULATIONS to implement management mechanisms for invasions - to support the wetland managers, as above.
- QUARANTINE and other REGULATIONS to prevent and limit the **spread** of wetland invasives once they have become established. This requires understanding of the role of water in the dispersal and growth of wetland invasives as well as a recognition that they can spread downstream and across borders.
- RESEARCH and MONITORING to back up the efforts at control and to measure their effectiveness - as well as to measure the effects of the invasives on wetlands, biodiversity and people and to estimate the costs of their control or otherwise to provide information for future strategies.

17. **Role of NGOs and civil society in combating wetland invasives**

- AWARENESS and EDUCATION on the importance and effects of wetland invasives and the needs for management and control.
- LOCAL ACTION and COMMUNITY RESPONSES to existing and threatening invasives - from community action and awareness-raising to landcare and cooperative wetland management.
- NOVEL SOLUTIONS to invasive control and utilisation of invasives. NGOs can have the capacity and interest to develop new uses for invasive species and different control

mechanisms that take time and innovation to develop and so find ways of invasive management that would not be possible through the traditional pathways of government and established research.

- EXPERTISE in control and monitoring of invasives in wetlands and their effects on people and biodiversity which has been developed as a livelihood or as a commercial enterprise.
- SUPPORT TO GOVERNMENTS in their efforts to manage invasions and prevent their occurrence.

18. **Role of the Ramsar Convention in wetland invasive management**

- COOPERATION with other agencies and organizations involved in global, regional and national efforts to understand and manage invasive species in wetlands. In particular IUCN's Global Initiative on Invasive Species, The Global Invasive Species programme of SCOPE, IUCN, CAB International and UNEP and the Regional Invasive Species Programme of SPREP in 24 countries of the South Pacific region.
- AWARENESS and the preparation of TOOLS for recognition and management of wetland invasives and the use of the Ramsar networks and those of their technical partners for their distribution.
- DOCUMENTATION of case studies and development of INTERNATIONAL PERSPECTIVES on the sources and spread of wetland invasives - with dispersal of the information through the Contracting Parties and other Ramsar networks and those of their technical partners.
- POLICY and LEGISLATION development to implement management of invasives both nationally and internationally.
- RALLYING OF SUPPORT to member states to manage wetland invasions and prevent new infestations - and the relationship of invasives to international trade, transport and tourism.

Recommendations

19. Refer to draft decision Ramsar COP DOC 15.14 on *Invasive species and aliens*.