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**CODE OF CONDUCT
ON ZOOLOGICAL GARDENS AND AQUARIA
AND INVASIVE ALIEN SPECIES IN EUROPE**

DRAFT VERSION

April 2011 – Working Draft

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1. INTRODUCTION

As highlighted also in the *Millennium Ecosystem Assessment*¹, invasive alien species (IAS) are one of the most important direct drivers of biodiversity loss and ecosystem service changes. Indeed they are widely recognised as a major threat to biodiversity on a global scale, second only to habitat destruction, and the greatest threat to fragile ecosystems such as islands. Biological invasions not only constitute one of the most pervasive global threat to biodiversity: apart from the cost in terms of biodiversity loss, IAS can also have an adverse impact on human life and health, affect our well-being and cause serious economic damage, endangering the ecosystem services we rely on and affecting negatively many socio-economic interests, among which agriculture, forestry and fisheries. Past introductions have usually occurred with little awareness of the potential negative consequences, but in recent times the true extent of the threat posed by IAS in both ecological terms and socio-economic terms has become much better understood. For example, of the 174 European species listed as critically endangered by the IUCN Red List, 65 are in danger because of IAS (Shine et al. 2010). In terms of economic impact, at the European level it has been estimated that damage caused by IAS exceed 12 billions Euro a year (Kettunen et al. 2009).

Today several strategies are developed and implemented to deal with IAS (e.g. eradication, control, containment, etc.) yet prevention is unanimously acknowledged as the best available management option, when feasible. In this context controlling the key entry routes is considered the most effective way of tackling the threats from IAS. Since zoological gardens and aquaria are recognised among the main pathways for IAS in Europe, measures to avoid the escape (and intentional releases in some cases) of potential IAS from such facilities should be undertaken as appropriate. Although most accounts of escapes/releases from zoological gardens and aquaria have been only anecdotal, recent studies have shown the potential role of such institutions in both accidental or deliberate introductions of IAS across the globe should not be underestimated (Fábregas et al. 2010). However it is remarkable that the same study has evidenced that zoos belonging to a professional association (i.e. AIZA in the case of Spain) were found to have less non-secure enclosures than non-members.

On the other hand, zoological gardens and aquaria are increasingly recognized as key players in global conservation programmes thanks to the living collections of endangered species they host, and public outreach. Besides, many zoological gardens and aquaria are organised in associations (such as EAZA and WAZA) and as such have demonstrated a desire to work together in a structured manner, by sharing the same conservation priorities and policies, thus forming a powerful ally to conservation agencies and institutions (in which case it is extremely important to differentiate between professional association zoos and those that do not join such associations). For this reason zoological gardens and aquaria might play an important role in raising awareness to prevent the introduction of new IAS (e.g. through specific information campaigns targeting the general public) and supporting conservation related activities, i.e. from research projects to eradication/control and restoration/reintroduction initiatives. Finally, the presence of IAS in their living collections, might offer such institutions unique opportunities for dedicated environmental education programmes.

1.1 Why a code of conduct?

In 2003 a specific strategy to deal with Invasive Alien Species at the European level (Genovesi and Shine 2004) has been adopted by the Council of Europe. The *European Strategy on IAS* – as it will be called hereafter - is aimed at providing guidance to help Bern Convention Parties in their efforts to increase awareness and information on IAS, strengthen national and regional capacity and co-operation to deal with IAS, prevent the introduction of new IAS into and within Europe, support rapid response to detected incursions, reduce the adverse impact of existing IAS, recover species and restore natural habitats

¹ Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.

and ecosystems adversely affected by biological invasions, and identify and prioritise key actions to be implemented at the national and regional level.

As a follow up of the *European Strategy on IAS*, some European countries have developed national strategies and related legal and technical tools for implementation. For how concerns EU Member States only, also the EC is developing a specific strategy, which is meant to be finalised by 2012. However, with the notable exception of a few EC legal tools (among which the Council Directive 1999/22/EC hereafter referred to as EC Zoo Directive, see § 5.2) and a few national legislations for the implementation of the *European Strategy on IAS*, there are no specific rules set up to prevent the spread of IAS from zoological garden and aquaria, or to recognise the educational role of such institutions with respect to the spread of IAS. Besides, until a comprehensive EU strategy on IAS will be available, the European capacity to respond to such threat will be limited (see Genovesi et al. 2010). For this reason, a code of conduct dedicated specifically to zoological gardens and aquaria, fully compatible with the principles of the future EU strategy on IAS, is needed to involve actively such important stakeholders in the framework of actions aimed at preventing or mitigating the threats posed by biological invasions at the global, regional and national level.

Such need is also stressed by the *European Strategy on IAS* which in relation to the role of zoos and aquaria as a potential pathway for future biological invasions, calls for the establishment of effective systems to prevent further introductions, e.g. by implementing dedicated codes of conduct or adapting existing licensing rules for containment facilities holding potential IAS (Genovesi and Shine 2004). On the other hand, a dedicated study carried out in Spain has shown that although IAS are acknowledged as a threat to biodiversity by the mission statements and codes of practice of the zoo community (EAZA, WAZA, AIZA, etc.) the potential environmental risk posed by IAS is not fully reflected in the security of their enclosures (Fábregas et al. 2010). The same measures are indicated as appropriate for strengthening national policy, legal and institutional frameworks. Furthermore, the *European Strategy on IAS* underlines the need of building awareness and support, e.g. by working with key stakeholders – among which zoological parks and aquaria - to produce and disseminate information and guidance on best practices.

Voluntary codes of conduct and best practices are considered as fundamental flexible “implementation” tools which could be scaled up with support from public bodies, industry federations, user groups and/or NGOs as appropriate with the aim to ensure responsible, proactive policies, and apply these in a coherent manner across Europe (Shine et al. 2010). On the other hand, the principle of self-regulation is believed to be more likely successful and effective than any other legally binding scheme. A voluntary code of conduct to address the risks associated with the use of IAS in zoological gardens and aquaria, e.g. in public exhibitions, can clearly play a multiple role: awareness-raising, stimulating stakeholder involvement, leverage/dissemination of best practices, supplementing existing regulations or filling a regulatory gap. Moreover, in the case of zoological gardens and aquaria the voluntary adoption of a code of conduct focusing on measures to prevent the establishment or spread of IAS would represent a valid incentive to pilot innovative approaches, supported by governments, to contribute to their overarching biodiversity conservation goals. In addition, in contrast with other management options, preventing new introductions of IAS would fit the goals and values of both animal rights groups and conservation biologists, thus overcoming a number of potential “ethically” and “emotionally” based critiques and conflicts from different stakeholders, and particularly from animal rights advocates (see Perry and Perry 2008).

For all the reasons above, and in the light of the conservation focused institutional role that characterises modern zoological gardens and aquaria, a specifically dedicated code of conduct might have a high likelihood of being well received and correctly implemented by such institutions and the relevant associations. In order to stimulate zoological gardens and aquaria to start implementing an effective framework of action in relation to the IAS issue, such a code of conduct is developed under the form of a voluntary regulatory mechanism aimed at setting standard for professionals and voluntary rules of behaviour that all concerned groups of people agree to observe. Such a voluntary tool - needed to demonstrate compliance with a defined standard of reasonable conduct to tackle specific pathway risks -

might also encourage further collaboration opportunities between the governments and the addressed institutions.

In fact, in the specific case of the EU Member States, this code of conduct would also provide guidance for a sound enforcement of the IAS related provision of Article 3 of the EC Zoo Directive (see § 5.2) which otherwise could be open to interpretation. In fact in relation to escapes from facilities, the implementation of this provision is dependent upon the will, knowledge, experience and available resources of each Member State, and as such seems affected by inconsistencies and weaknesses resulting in major variations in the standards applied in the addressed facilities. In any case such legislation applies only to EU Member States, and not to all 47 countries that are parties to the Bern Convention and to which this code of conduct is addressed.

Finally, it is remarkable that the *European strategy on IAS* points out that the development of technical codes of practice to reduce IAS impacts on European biodiversity is to be considered one of the possible roles of the Bern Convention, possibly in collaboration with other relevant sectors and organisations. Thus, the present code of conduct could provide opportunities for promoting new partnerships, e.g. with single institutions and their associations (such as EAZA, WAZA, etc.) and consolidating old ones, e.g. with ISSG of the IUCN/SSC.

2. SCOPE AND AIM

This code of conduct is addressed to all zoological gardens and aquaria in all 47 Member States of the Council of Europe. The objective is to provide guidance on voluntary measures to be adopted to strengthen the role of zoological gardens and aquariums in the conservation of biodiversity - and particularly in the protection of wild fauna and flora in Europe – by contributing to mitigate the problems related to the spread of IAS through the following measures:

- Preventing the introduction and spread of IAS and related pathogens and diseases;
- Promoting the need to raise awareness on biological invasions;
- Supporting IAS related research projects and other relevant conservation initiatives.

The framework of actions to implement this code of conduct is voluntary and depends on there being a high level of self-regulation by the targeted institutions, which is considered a feasible task, being the key strategic objectives of most zoological gardens and aquaria already highly conservation-oriented.

This code of conduct takes into account the enormous variation in animal collections and names of zoos. Because of such great variation among the institutions that are known as “zoos”, there is no concise definition for this word. However, in order to agree to a clear terminology, it is important to consider that according to *The World Zoo Conservation Strategy* (IUDZG/CBSG 1993) there are two key characteristics that all such institutions have in common:

- Zoos possess and manage collections that primarily consist of wild (non-domesticated) animals, of one or more species, that are housed so that they are easier to see and study than in nature;
- Zoos display at least a portion of this collection to the public for at least a significant part of the year, if not throughout the year.

This definition also complies with EC Zoo Directive according to which “zoos mean all permanent establishments where animals of wild species are kept for exhibition to the public for 7 or more days a year, with the exception of circuses, pet shops and establishments which Member States exempt from the requirements of this Directive on the grounds that they do not exhibit a significant number of animals or species to the public and that the exemption will not jeopardise the objectives of this Directive”.

According to *The World Zoo Conservation Strategy* the great diversity of facilities and specialized institutions characterised by analogous roles and as such collectively designated as “zoos” greatly vary with respect to the types of animals collection they exhibit. Indeed zoos can range from general to

specialised collections, in which case they might be named after the relevant specialities, e.g. primate zoos, desert zoos, safari parks, birdparks, waterfowl parks, wild fowl reserves, parrot gardens, reptile zoos, insect zoos, butterfly houses, insectaria, vivaria, aquaria, dolphinaria, oceanaria, marine zoos, sea mammal parks, etc. The number of such zoos and aquaria in Europe is estimated in 3500-5000². In the EU only, according to the *EU Zoo Inquiry 2011* (see § 5.2.1) the total number of licensed zoos is estimated to be at least 3500 however, there might be hundreds of unlicensed and unregulated zoological collections that have not been identified and licensed yet by the competent authorities in accordance with the EC Zoo Directive. In addition, currently there are 34 facilities holding cetaceans in captivity for display to the public in the EU, and a total of at least 60 in Europe³.

In order to avoid ambiguities and ensure the greatest impact in terms of conservation benefit, this code of conduct also addresses rescue centres and other facilities where wild animals are kept in captivity for purposes of scientific research, conservation, display and education. It is clear that in case such facilities would not be open to the public, their primary task in relation to the IAS issue should mostly focus on preventative best practices, while the educational function would be relatively limited.

In the rest of this document all above mentioned institutions are targeted by the code of conduct and will be generically indicated as “zoological gardens (or zoos) and aquaria (or aquariums)”. Thus, in addition to the single institutions, the present code is addressed also to the main zoo associations (such as EAZA, WAZA and all the national based ones) and the relevant national authorities.

3. BACKGROUND

3.1 The history of zoological gardens and aquaria

Collections of wild animals confined within enclosures, displayed to the public, and in which they may also be bred, have a long history. Indeed zoos have evolved from the simple collections and menageries of the ancient times, to the highly complex, professionally managed, zoological gardens of modern times. The first idea of zoological gardens likely raised in concert with the origins and development of agriculture, urbanism, and imperialism in the ancient Near East, i.e. in Mesopotamia and Egypt, where exotic fauna played vital roles in the world's earliest transformations of the natural environment, and where the creation of exotic gardens and zoos was a traditional royal pastime (Foster 1998). The oldest known menagerie of ca. 3500 B.C. was in fact recently discovered at Hierakonpolis, on the Nile south of Luxor (Rose 2010). Later on, the first zoo appeared also in Europe, particularly in Greek city states and in the Roman empire where they were known as “paradises” (Hughes 2003).

The history of modern zoological gardens, established primarily for scientific interest, started some 200 years ago with the creation of the first public zoos in London, Paris and Vienna, as remarked in *The World Zoo Conservation Strategy* (1993). Since then, large numbers of zoos have been established globally, with conservation being seen as a central task for such institutions. This also reflects the great changes which have taken place in the world, in terms of both human society and progress in science and education, besides of course the changes occurred in the overall conservation status of species, habitats, and ecosystems worldwide.

3.2 Zoological gardens and aquaria as pathways for IAS

Reducing the threat of biological invasions requires a focus on the ways humans facilitate the transport and establishment of species in new areas. While analysis of pattern of spread of specific single species remains important, targeting prevention efforts by focusing on specific pathways allow prediction of the spread of multiple species and enables management of multiple species simultaneously. In fact it is considered to yield increased benefits in terms of prevention compared to analyses of single species, because it allows to identify areas that act as sources for new invasions, to identify how multiple species are dispersed through the same vectors, to focus our management efforts and to reduce the probability of

² EAZA Lobbying Strategy 2009-2012

³ <http://www.endcaptivity.org/dolphinaria.php>

invasion or the rate of spread. Thus the analysis of actual and potential pathways is critical to effectively manage the problems related to biological invasion.

As shown from the examples reported below, zoological gardens and aquaria are known to play a significant role as potential sources of IAS for both animals and plants which once introduced in the wild can invade and take over native habitats. Over the centuries, such pathways have contributed to the introduction of several IAS because of either unintentional escapes from captivity or intentional releases, for example further to the closure of a facility or the dumping of unwanted organisms.

In the case of zoological gardens and aquaria, the term “escape” refers to a variety of circumstances ranging from unforeseen events, such as animals (including their larvae and eggs) gaining freedom because of damages to the fence of their enclosures, and through waterways - e.g. from an aquarium into rivers, lakes and sea – for example in clearing operations through the drainage of water, sewage lines, filtration systems and any opening in general (see also Hulme et al. 2008, Padilla and Williams 2003, Fábregas et al. 2010). Other typical circumstances are related to the fact that some animals might be not confined or even allowed to move freely, either intentionally or because of some accidental events (such as storms and floods). The possibility for the public to release the animals directly (i.e. capturing the animal and removing it from the enclosure) or indirectly (i.e. opening doors or windows not properly locked or supervised by the staff) is another factor that has been put in relation with the releases of IAS from zoos due to the lack of “security” of the relevant facilities (Fábregas et al. 2010).

Specific and comprehensive analysis regarding IAS originated by escapes/releases from zoological gardens and aquaria in Europe are still lacking. Current knowledge on such pathways of introduction is often sparse, but some relevant figures and anecdotes are available for the main groups of species. For example, for mammals it is known that escapes from zoos account to 6% of all known causes of introductions in Europe (Genovesi et al. 2009). Although other pathways might have a higher frequency (e.g. fur farming has been at the origin of 15% of all recorded cases, hunting 21%, release or escape of pets 10%) a good management of the animals hosted in zoological gardens and aquaria (e.g. stricter regulation of containment facilities) would have contributed to prevent some of the most impacting invasions in Europe. The same applies to amphibians and reptiles, for which two of the major pathways forming the primary means by which alien herpetofauna has been introduced – the pet trade and “intentional” pathways – actually include exhibit and zoo releases (Kraus 2009). For this group, a preliminary study focusing mostly on US data shows that intentional release of animals by zoo personnel or accidental escape from a zoo facility accounts to 7 introduction events involving 7 species, 4 of which were successfully established (14% frogs and 86% lizards, Kraus 2003). In any case, Kraus (2009) demonstrated that the pet-trade and aesthetically related pathways (that promote the keeping of animals and their frequent escape, release, or intentional introduction, also via exhibitors or zoo personnel) are of overwhelming importance in creating the modern explosion of alien herpetofaunal invasions. On the other hand, for birds the impact of zoos is even more evident, because out of a total of 140 alien bird species present in Europe, seventy-seven species escaped to the wild “non-deliberately” and of these 27 species originated from zoos or bird parks (Kark et al. 2009). According to a more general overview of introductions in the UK (Fitter 1959) the accidental escape of zoo animals (including pets) is a comparatively unimportant factor behind the introduction of IAS in the country, for animals rarely escape in sufficient number to establish self-sustaining populations, yet some twenty one mammals, nineteen birds one reptile and one amphibians (not to consider the many species of fish) escaped from captivity in sufficient number to make naturalisation a possibility.

The assessment of the actual contribution of zoological gardens and aquaria to the IAS problem in Europe is affected by the fact that the major pathways that account for this source of new propagules (either released or escaped) have often been associated to multiple pathways (e.g. linked to other sectors, such as the pet and aquarium trade, fur farms, hunting, fishing, etc.) so that zoos escapes are mixed up with introductions from other captive establishments and private holders. The obvious difficulties to distinguish the actual role/impact of zoological gardens and aquaria reflect on the lack of precise information on the available literature.

Even though the broader aim of zoological gardens and aquaria for nature conservation might have changed positively over recent decades, such an increasing body of evidence highlighting the role of such pathway in facilitating invasions of alien species worldwide, conflicts with the high conservation profile claimed by a number of institutions and demonstrates that the potential threat that their living collections pose as sources of IAS appears disregarded. The current knowledge available on the role of the various pathways must now be used to start modelling explicit management strategies such as optimal detection and inspection strategies and assessments of the effectiveness of different management measures (see Hulme 2009).

3.2.1 IAS originating from zoological gardens and aquaria

Despite the lack of comprehensive and exhaustive studies, there is a wide array of anecdotes showing the role of zoological gardens and aquaria as pathway for IAS of major concern. For example, among mammals there is the case of a feral population of Siberian chipmunk (*Tamias sibiricus*) in the Netherlands, in an urban park in the province of Noord-Brabant, originated in 1972 from a group left behind after the removal of a small zoo (Thissen and Hollander 1996). Also the presence of the grey squirrel (*Sciurus carolinensis*) in Edinburgh and of the red-necked wallaby (*Macropus rufogriseus*) in Derbyshire seem due to the deliberate release of a few animals from a nearby zoo in the beginning of twentieth century (Fitter 1959). The case of the Himalayan porcupine (*Hystrix indica*) established in the wild in Devon in the late 1970s is particularly interesting because the relevant population originated from a pair escaped in 1972 from a zoological park and so far concerns the only species which no longer exists anywhere in Europe as a result of an active eradication programme (Genovesi 2005). However, luckily enough not all introductions have been successful. For example, the Canadian beavers (*Castor canadensis*) is not present in Austria anymore, although in the 1980s some animals were present in the wild for some years, after being escaped from a zoo in Styria (reinforced by other intentional releases carried out since 1953 in Lower Austria and along the floodplains of the Danube, see Nummi 2010).

Surprisingly there are also several records of marine mammals introduced from coastal dolphinarium and oceanaria where animals are kept in nearshore open-air pens which do not adequately prevent escapes of captive animals into the sea. According to Birkun (2002) such cases of escape/release have been known since the early 1980s in the Black Sea in the former USSR, and during the last decade in the Russian Federation and Ukraine. The list of such spontaneously released cetaceans and pinnipeds includes the beluga whale (*Delphinapterus leucas*), the northern fur seal (*Callorhinus ursinus*), the Steller sea lion (*Eumetopias jubatus*), the harbour seal (*Phoca vitulina*), the Caspian seal (*Phoca caspica*) and, possibly, one or two other pinniped species. The exact number of irrevocably escaped alien marine mammals is unknown, but it probably comes to a few tens including two beluga whales which were observed many times in the wild near the Turkish, Romanian, Bulgarian and Ukrainian coasts in the early 1990s (Reeves and Notarbartolo di Sciara 2006). The fate of most accidentally released marine mammals and their possible influence on indigenous Black Sea cetaceans including bottlenose dolphins remain uncertain. Presumably, they can be a source of infections circulating in dolphinarium. Dolphins escaped from their sea pens during a storm are also known in other countries in the world (Money 2008).

Records of animals escaped from zoological gardens and similar institutions are also known for species deliberately shown to the public in areas not confined by adequate fencing systems, and basically free to move throughout the zoo facilities. It is the case of many bird species that are frequently left free to fly in those zoological parks from which they can escape and sometime establish wild populations. An example regarding a species of major concern in Europe is the recently introduced African sacred ibis (*Threskiornis aethiopicus*). This species has escaped from zoological parks in many countries and is now established at least in Italy, Spain and France (Clergeau and Yésou 2006). Unfortunately, not always it is easy to identify the exact origin of an introduced species, besides the true origin of a particular individual will never be an easy task (particularly for highly vagrant species), unless captured and ringed in wild populations, and would be mainly probabilistic, based on the analysis of global pattern and climatic conditions whenever relevant. The case of the pink-backed pelican (*Pelecanus rufescens*) is probably a nice illustration of the potential “noise” created by escapes, in fact although in this case most of European

records are due to escapes from the French free-flying colony, there are clues of natural dispersal to Europe of a few African wild pink-backed pelicans (Jiguet et al. 2008).

One of the best candidate as “the most famous escape” from a zoological facility is actually relative to an alga, namely the killer alga (*Caulerpa taxifolia*). In 1984 this macroalga was unintentionally introduced into the Mediterranean Sea with aquaria outflow by the renowned Musée Océanographique de Monaco. Further to secondary spread facilitated by shipping and currents the killer alga is now dominating large patches along the Mediterranean coastline where it outcompetes the indigenous seagrasses *Cymodocea nodosa* and *Posidonia oceanica*. Besides, the killer alga has endotoxins meant to provide protection against epiphytes and herbivores, which in fact are toxic also to molluscs, sea urchins, and herbivorous fish (Galil 2006) and all this is clearly contributing to the irreversible spread of the species in the Mediterranean.

The escape/release of animals from zoological gardens and aquaria can carry also an associated risk of introducing exotic and potentially unknown diseases and parasites into naive settings. The transmission of such pathogens can be very complex, as show by the case of the Australian tick *Amblyomma moreliae* found on a European snake, the Balkan whip snake (*Coluber gemonensis*) in a zoo in India (BurrIDGE and Simmons 2003). In this context, also captive breeding and re-introduction programmes - although are invaluable conservation practices that are helping several threatened species to recover from the risk of local or global extinction – can contribute to the spreads of diseases. For example, it is recognised that in captive populations of amphibians the occurrence of *Batrachochytrium dendrobatidis* (a pathogenic fungus responsible of a disease called chytridiomycosis, also known as Bd for short and responsible of massive die-offs worldwide) may interfere with the success of relevant reintroduction programmes. For this reason, captive individuals should never be released unless they can be shown to be disease-free through the implementation of sound diagnostic screening procedures⁴. Nevertheless, in the case of a reintroduction programme for the endangered Mallorcan midwife toad (*Alytes muletensis*) this principle was overlooked, because the animals bred in captivity in a zoological facility were released without checking that the individuals were free of Bd (see Walker et al. 2008). As a consequence, Bd was apparently transmitted to the native island populations of the Mallorcan midwife toad – thus jeopardising the survival of the entire stock of this very localised species.

In conclusion, it is worth considering that these are historic escapes, and that more may have happened since then, because it takes decades for IAS to establish themselves. In fact current patterns of alien species richness may better reflect historical rather than contemporary human activities, a phenomenon which has been called “invasion debt” (Essl et al. 2011). This means that many of the most problematic IAS are not recent arrivals, but were relative to introductions occurred several decades ago. Consequences of the current high levels of socio-economic activities will probably not be completely realized until decades into the future. Thus adequate management of IAS should be expanded also to species that are likely to pose the greatest future threat.

3.3 The multifaceted role of zoological gardens and aquaria in conservation

Zoological gardens and aquaria have an enormous potential for action in conservation, education and research. Such potential – already expressed by a number of institutions, particularly those organised in professional associations - is a combination of the added value offered by the way that living collections are managed today, with a growing focus on global to local conservation and research initiatives, together with the particular power of attraction that such living collection have on the general public. In fact, collectively, as estimated by *The World Zoo Conservation Strategy* in 1993, the over 300 zoos organised (or potentially organisable) in national or regional associations in Europe, are visited annually by 130-140 million people according to the 2010 EAZA Conservation Education Strategy 2010-2012, approximately 15% of the current European population. This number of visitors results in great potential for global conservation, education and research through zoos and aquaria and their networks. Indeed, as emphasised

⁴ See the IUCN/SSC Guidelines for Re-Introductions <http://www.iucnssc.org/download/English.pdf>

by the “pigeon paradox” (Dunn et al. 2006) conservation may increasingly depend on the ability of people in cities to maintain a connection with nature. The paradox lies in the dependence of conservation action worldwide on peoples’ direct interactions with urban ecosystems and the organisms, including non-native species such as feral pigeons (e.g. *Columba livia*). In this regard, by making a direct connection between people (mostly from cities) and wildlife, the community of zoological gardens and aquaria have a unique potential to attract, inspire and mobilise mass public engagement and support for conservation initiatives.

As stressed by the EAZA Strategy 2009-2012, an increasing number of zoos are involved in both *in situ* conservation and sustainable development efforts, and *ex situ* programmes (EEPs, Collection Planning, Sustainable Zoo/Aquarium Collections) including all relevant research and educational activities. Among the others, a few projects have been carried out by zoos and aquaria also in relation to the IAS issue, e.g. by providing temporary relief to endangered species from competition or predation by alien taxa, and from hybridisation between different subspecies, domestic forms or introduced similar species as well (see also Gippoliti 2004).

A major example is the reintroduction project of the European mink (*Mustela lutreola*) into its former range in Estonia. This critically endangered species, whose disappearance was partly caused by the impact of the alien American mink (*Mustela vison*) through competition for resources and direct aggression, was the object of a conservation programme initiated in 1991. The goal of this programme – carried out by the WAZA⁵ in partnership with many zoological institutions, with financial support from the EC through the LIFE instrument - was a combination of *ex-situ* and *in-situ* conservation activities to guarantee the survival of the European mink planned in parallel to an eradication programme targeting the America mink. In fact, in the frame of the EEP programme, one of the objectives was to establish free ranging populations in two Estonian islands from where the alien American mink population was meant to be removed, a task that was successfully accomplished in 1998-2000 (Scalera and Zaghi 2004).

Similarly, in 1986 the European Durrell Wildlife Conservation Trust and Mauritian Wildlife Foundation carried out a successful eradication programme in Round Island, a small island north-east of Mauritius. This eradication programme was aimed at removing the rabbit and goat populations introduced in the island 150 years earlier in order to help recovering the last remnants of a palm savannah that once was characteristic of the northern plain of Mauritius.

Zoological gardens and aquaria might be also good partners of universities and other institutions for research activities. At the Rome Bioparco, a study was carried out in collaboration with the University of “Roma Tre” to analyse the reproductive behaviour in a semi-natural habitat of the red-eared slider (*Trachemys scripta elegans*), as well as the competition of this harmful exotic toward the native European pond turtle (*Emys orbicularis*).

3.4 Main associations of zoological gardens and aquaria

3.4.1 The European Association of Zoos and Aquaria (EAZA)

As of September 2010⁶ over 300 zoological gardens and aquaria from 36 countries were represented and linked together by the European Association of Zoos and Aquaria (EAZA), making it the largest professional zoo and aquarium association in the world. More than 280 institutions of the total EAZA membership were located within the EU (and as such obliged to comply with Council Directive 1999/22/EC relating to the keeping of wild animals in zoos). The EAZA was formed in 1992 with the aims of facilitating cooperation within the European zoo and aquarium community towards the goals of education, research and conservation and of representing the interests of its members. Indeed according to the EAZA constitution and the Strategy 2009-2012, the objectives are to promote and facilitate cooperation within the European zoo and aquarium community with the aim of furthering its professional quality in keeping animals and presenting them for the education of the public, and of contributing to scientific research and to the conservation of global biodiversity (e.g. through internationally coordinated

⁵ <http://www.waza.org/en/site/conservation/waza-conservation-projects/overview/european-mink-reintroduction>

⁶ See the EAZA Position Statement on the developing EU Strategy for Invasive Alien Species (IAS) in ANNEX I

breeding programmes of wild animals and *in situ* conservation). The EAZA expects to achieve these aims through stimulation, facilitation and co-ordination of the community's efforts in education, conservation and scientific research, through the enhancement of co-operation with all relevant organisations and through influencing relevant legislation within the EU.

The EAZA also aims at empowering European citizens to learn about and contribute to global biodiversity conservation goals by ensuring that its member zoos and aquaria achieve and maintain the highest standards of care and breeding for the species they keep. The EAZA should not be regarded as a representative of zoos in the EC because its member institutions account to no more than 8% of the total number of zoos in Europe⁷. Nevertheless this association might have a significant social role in educating European citizens about animals, their conservation, and overarching threat processes such as climate change, habitat loss and how consumer behaviour interacts with these global challenges. In fact it is estimated that more than 140 million people visit EAZA members each year, equivalent to approximately one in five European citizens. To this regard, zoos and aquaria have been demonstrated to host a far more representative and inclusive visitor social spectrum than any other museum or science centre. Besides, EAZA member institutions employ 20.000 staff members, 5.000 of which are seasonal, and house more than 250.000 animals, excluding fish and invertebrates. Therefore EAZA members are often important economic drivers and cultural centres in their local communities, and are often important "opinion formers" on environmental issues, including that of IAS as also reported in the recent *EAZA Position Statement on the developing EU Strategy for Invasive Alien Species* (see Annex I).

3.4.2 The World Association of Zoos and Aquariums (WAZA)

Another major organisation for the zoo and aquarium community is the World Association of Zoos and Aquariums, United for Conservation (WAZA). Currently, more than 300 institutions - including leading zoos and aquariums, regional and national associations of zoos and aquariums, as well as some affiliate organisations from around the world - are institutional members of WAZA, and about 1300 zoos and aquariums are somehow linked to WAZA through their membership in a regional or national association member of WAZA (among which the EAZA). The WAZA promotes cooperation between zoological gardens and aquariums with regard to the conservation, management and breeding of animals in captivity and encourages the highest standards of animal welfare and husbandry. In addition, WAZA promotes environmental education, wildlife conservation and environmental research, promotes and coordinate cooperation between national and regional associations and their constituents, and assists in representing zoological gardens and aquariums in other international organisations or assemblies. A recent survey showed that annually more than 700 million visitors pass through the gates of the zoos and aquariums united in the WAZA network each year, and are thus potentially exposed to environmental education. Furthermore, the world zoo and aquarium community reportedly spends about US\$ 350 million on wildlife conservation each year. Therefore, the world zoo and aquarium community has the potential to play an important role in both environmental education and wildlife conservation. Indeed by working together, the global zoo and aquarium community can have a cumulative conservation impact that builds significantly on the achievements of individual zoos and aquariums but which overall has a greater synergy and impact.

With regard to the present code of conduct, it is important to underline that among the other things, by working through its membership and external partners, WAZA is particularly well placed to promote the implementation of best practice standards globally and to help ensure that resources are directed to the areas of greatest need. Besides, as readily recognised by WAZA itself, the world's zoos and aquariums,

⁷ This figure is reported here <http://www.bornfree.org.uk/campaigns/zoo-check/zoos/eu-zoo-inquiry/introduction> but should be considered only indicative because the number of zoos in the EU is very unclear. In any case, EAZA does include nearly all significant zoos in the EU and likely accounts for a far greater proportion of the zoo visiting public attendance and the numbers of animals kept.

through a global network, also constitute a unique “early warning” system with regard to the transmission, spread, treatment and control of known and emerging zoonotic diseases (diseases that can be transmitted between animals and humans) which is clearly connected with the IAS issue.

In 1993, The World Zoo Organisation (IUDZG) and the Captive Breeding Specialist Group of the IUCN published *The World Zoo Conservation Strategy*. This strategy identified, for the first time in a single document, the areas in which zoos and aquaria can make a contribution to be fully involved in nature conservation. As a follow up, in 2005 the WAZA, in collaboration with its partners, prepared the *World Zoo and Aquarium Conservation Strategy*⁸ (WZACS), a revised, second strategy that reinforces and expands the overall themes of the first document and presents a vision of the roles that all zoos and aquariums can and must play in the conservation of wildlife and their ecosystems. It is a document that articulates the modern role of zoos and aquariums and their commitment to conservation, and is adopted by the EAZA too. This strategy provides a common philosophy for zoos and aquariums across the globe and defines the standards and policies with which to achieve the conservation goals. With regard to the IAS issues, the section “Ethics and Animal Welfare” points out that “zoos and aquariums should always be aware that invasive exotic animal and plant species are a potential threat to the indigenous fauna and flora. They should ensure that exotic animals in their care do not escape and pose a risk to indigenous species. They should also be careful in the selection of plant species for landscaping, and aquariums should ensure that no water plants, or parts or seeds thereof, can get into natural waters”. Another important aspect of the strategy is the claimed flexibility between registered zoos and aquariums for how concern the compliance with national and international legislation with respect to animal transfers, and particularly with regard to national legislation aimed at preventing the introduction of alien species that have invasive potential (as the processes required for the implementation of such legislation can unfortunately be time-consuming and complicated, and interfere with conservation programmes). Finally, as part of the final recommendations, the WZACS requires that zoos and aquariums undertake every effort to prevent the escape of animals and plants of IAS.

To detail carefully the implementation of WZACS by public aquariums a dedicated publication was prepared by the WAZA Aquarium Community (Penning et al. 2009). It included also explicit references to the IAS issue. For example, in relation to “Ethics and Animal Welfare, it requires zoos and aquariums to undertake every effort to prevent the escape of animals and plants of invasive species. To this regard, the WZACS response is that “aquariums agree that appropriate measures must be taken to prevent the escape or accidental discharge of non-indigenous, invasive or potentially harmful animals and plants, parasites, pathogens and other living organisms.”. To this purpose, the following actions are foreseen for public aquariums, national and regional aquarium/zoo associations and partners:

- Ensure that aquarium exhibits are designed to prevent the escape of exhibit specimens, parasites, pathogens and other organisms with potentially deleterious impacts in the wider environment, e.g. viruses, fungi, bacteria, zooplankton and phytoplankton and genetically modified organisms (GMOs);
- Ensure that discharge water is appropriately screened or sterilised before leaving the premises;
- Ensure that aquarium personnel understand the possible ramifications of escape or accidental discharge of alien species, including in the context of zoonoses (aquatic diseases communicated between animals, sometimes including humans);
- Liaise with the Amphibian Ark on biosecurity protocols and laboratory facilities designed to prevent the spread of the potentially lethal aquatic fungal amphibian disease chytridiomycosis;
- Liaise with the IUCN-SSC Invasive Species Specialist Group and contribute to their databank;
- Contribute to the development of national, regional and international policy and best practice guidelines on biosecurity and the prevention of release of invasive aquatic species of plant, animals,

⁸ WAZA (2005) Building a Future for Wildlife - The World Zoo and Aquarium Conservation Strategy. <http://www.waza.org/files/webcontent/documents/cug/docs/WAZA%20CS.pdf>

parasites, pathogens etc. and on measures for remedial action or control should such a release take place accidentally.

Besides, in the context of “Partnerships and Politics” the WZACS urges national and regional associations to persuade their respective governments to improve or create zoo and aquarium legislation that will help zoos and aquariums to carry out their conservation purpose. In this regard, public aquariums, national and regional aquarium/zoo associations and partners should inform, encourage and collaborate with government agencies and legislators in formulating or modifying legislation, policy and edicts concerning biodiversity conservation, migratory species, IAS, harvesting of natural resources, the control of aquatic pollution and other environmental issues.

3.5 Key stakeholders

A key stakeholder in relation to the implementation of the present code of conduct is the Invasive Species Specialist Group (ISSG). The ISSG is a global network of scientific and policy experts on IAS, organized under the auspices of the Species Survival Commission (SSC) of the International Union for Conservation of Nature (IUCN). The ISSG promotes and facilitates the exchange of IAS information and knowledge across the globe and ensures the linkage between knowledge, practice and policy so that decision making is informed. Indeed, the three core activity areas of the ISSG are information exchange, networking and provide policy and technical advice, particularly to European institutions (i.e. EC) in the context of *European Strategy on IAS* development. The ISSG was established in 1994. It currently has 196 core members from over 40 countries and a wide informal global network of over 2000 conservation practitioners and experts who contribute to its work.

The ISSG is currently contributing to the development of a global Early Warning and Rapid Response (EWRR) framework for biological invasions, by supporting the improvement, harmonisation and integration of related information systems (e.g. to develop alarm listing systems, diagnosis of invaders, a web-based global register of invasive species, access to updated and detailed management information, etc.). The group has been participating in several relevant international conferences and workshops, both to provide advice and to contribute to the development of regional and national EWRR systems, particularly in Europe. Networking activities with countries and regions where early warning systems are already being implemented, are ongoing. In 2009, a major ISSG achievement at the European level was the publication of the technical report *Towards an early warning and information system for invasive alien species (IAS) threatening biodiversity in Europe* produced under contract with the European Environment Agency (Genovesi et al. 2010). The report was prepared by a team of experts, led by the Institute for Environmental Research and Protection (ISPRA Italy), in collaboration with the ISSG. It contributes to the ongoing development of an EU Strategy on IAS (see § 4.1) which the EC committed to complete in 2012, and which the ISSG contributed to develop in collaboration with other companies and experts, e.g. in the framework of a comprehensive study recently finalised by the IEEP (Shine et al. 2010).

4. LEGAL FRAMEWORK

At the global level, a number of international agreements are in place that include provisions to prevent the introduction of, control or eradicate IAS that threaten species, habitats or ecosystems (for a review see Miller et al. 2006). In Europe, a dedicated strategy has been adopted by the Council of Europe to provide guidance to all 47 parties for the development of further domestic legislative measures (see § 1). Nevertheless, with the notable exception of a few national initiatives, an effective strategy to combat IAS on either a voluntary or a regulatory basis at the regional level is not yet duly implemented. At the EU level, coordinated frameworks dealing at least in part with the issue of IAS already exist in some sectors (Miller et al. 2006).

For instance the Council Directive 92/43/EEC *on the conservation of natural habitats and of wild fauna and flora* requires Member states to “ensure that the deliberate introduction into the wild of any species which is not native to their territory is regulated so as not to prejudice natural habitats within their

natural range or the wild native fauna and flora and, if they consider it necessary, prohibit such introduction” (Art.22b).

More importantly, among the existing EU legislation and policies, the EC Zoo Directive already provides part of the solution to the problem of IAS. This directive, which entered into force in 2002, includes requirements to prevent the introduction of IAS. In addition, there are a number of EU legal tools addressing zoo such as the Commission Decision 2007/598/EC of 28 August 2007 *concerning measures to prevent the spread of highly pathogenic avian influenza to other captive birds kept in zoos and approved bodies, institutes or centres in the Member States*.

Besides, the EC is finalising its proposal for an EU strategy, which intends to bring forward in 2012.

4.1 The Council Directive 1999/22/EC

The Council Directive 1999/22/EC of 29 March 1999 relating to the keeping of wild animals in zoos was adopted with the objective to provide a framework for Member States legislation aimed at promoting the protection and conservation of wild animal species and strengthening the role of zoos in the conservation of biodiversity, public education, scientific research and the exchange of information. In particular, in relation to the IAS issues, according to article 3 (Requirements applicable to zoos) Member States shall take measures to ensure all zoos implement the following conservation measures: “preventing the escape of animals in order to avoid possible ecological threats to indigenous species and preventing intrusion of outside pests and vermin”.

Other relevant measures of the EC Zoo Directive, which come into force in April 2002, include ensuring adequate accommodation facilities for zoo animals with species-specific enrichment of enclosures that aims to satisfy their biological and behavioural needs, high standards of animal husbandry including a programme of preventative and curative veterinary care and nutrition, contributions to research or conservation activities, education of the visiting public and training of staff. This is to be achieved by Member States through the implementation of article 4 and 5, according to which Member States shall adopt measures for licensing and inspection of existing and new zoos in order to ensure that the requirements of Article 3 are met. Another important provision in relation to the IAS issue is found in article 6 (Closure of zoos), according to which “In the event of a zoo or part thereof being closed, the competent authority shall ensure that the animals concerned are treated or disposed of under conditions which the Member State deems appropriate and consistent with the purposes and provisions of this Directive”. Besides, according to article 7, for the purposes of this Directive Member States shall designate competent authorities.

All EU Members States have been obliged to transpose the requirements of the Directive into national legislation in order to fully implement and enforce its requirements. Although the EC has the responsibility to ensure the effective implementation of the Directive by Member States (and take legal action in case of non-compliance) no reporting obligations are foreseen, therefore there is no report from Member States to the EC on the actual implementation of its provisions at the national level⁹.

4.1.1 ...and its implementation

In relation to the IAS issue, recent studies have indicated that the EC Zoo Directive has not been implemented or enforced effectively or consistently in some Member States, where facilities might be still in conditions that do not fully guarantee the prevention of escapes of animals.

A recent report on the implementation of the EC Zoo Directive was made in 2008 by Eurogroup in collaboration with EWLA (Eurogroup for Wildlife and Laboratory Animals), thanks to support from the EC Directorate General for the Environment, under the LIFE+ Programme for funding of European environmental NGOs. According to the main findings, adequate tools still need to be put in place to assist the authorities in better implementing the EC Zoo Directive. These include guidelines or codes, and a

⁹ A service contract on *Study on the effectiveness of the Zoo Directive (1999/22/EC) — evaluation of the implementation and enforcement in Member States* was foreseen to be tendered in April 2010, but it did not proceed.

strategy for animals at zoos which are closing and the identification of some rescue/reception centres for such animals.

Another recent initiative aimed at monitoring and analysing the level of implementation and enforcement of the EC Zoo Directive, its transposition into national law, national enforcement of that law and the status and performance of selected zoos in each Member State in compliance with the legal requirements of the EC Zoo Directive, is the *EU Zoo Inquiry 2011*¹⁰. This study is an independent initiative, not supported from the EC, which is funded and executed by the Born Free Foundation, in association with the European coalition ENDCAP. The overall objective of the inquiry is to assess the current situation in the Member States, identify issues requiring attention and provide recommendations with regards how enforcement measures can be improved. This extensive ambitious EU-wide project involves 21 EU countries and a total of 200 zoos, but so far national reports are available only for Bulgaria, Cyprus, Greece, Ireland, Romania. The result of the surveys pointed out that the impact of zoological gardens in relation to the IAS issue can be significant, as most facilities failed “to take appropriate measures to prevent the escape of non-indigenous species into the natural environment” (with the partial exception of Ireland and Romania for which measures were better, but not fully, enforced). In fact many zoos have absent or inadequate perimeter fencing, or unsecure enclosure fencing, while others host free-roaming animals (including feral cats and dogs) deliberately introduced to the zoo and free to move in and out of the zoo facilities at will. For example, in Cyprus this included species such as rose-ringed parakeets, in Greece rabbits, common slider (*Trachemys scripta*) and various bird species, including the rose-ringed parakeet, in Ireland domestic guinea pigs, waterfowl, red-necked wallaby, birds of prey escaping from falconry, in Romania mute swan (*Cygnus olor*), red deer, horse and emu. Furthermore, contacts between non-native and native species can facilitate the transmission of disease, also to humans, as in the Greek case of *Trachemys scripta*, a dangerous carriers of salmonella. However, the overall reliability of such results is limited by the fact that the executors are animal rights organisations characterised by the stated aim of phasing-out the keeping of wild animals in captivity, and this carries the inherent risks of their assessment being biased.

A former *Study of Conformity of EU Member States national laws with the EU Zoo Directive*¹¹ made by Eurogroup/EWLA in 2007, confirmed that in general all checked national laws (Austria, Belgium, Bulgaria, Czech Republic, France, Germany, Hungary, Italy, Poland, Romania, Spain) included the basic requirements stated in Article 3 of the EC Zoo Directive regarding “Pests control/escape prevention”.

In addition, a pilot study¹² carried out in 2006 by InfoZoos in Spain to assess the degree of compliance by zoos with the EC Zoo Directive (and the related Spanish Act 31/2003) revealed that many facilities were not complying with the law, which led to the closing down of four zoos. In particular, in relation to IAS, visual evidences recorded during the visits showed that the physical boundary of many of the enclosures in all zoos visited were inadequate (100%), potentially allowing animal escapes and unauthorised public access. This was due to several reasons, but the most common was insufficient height in relation to the animal(s) contained and their apparent poor maintenance. More recently, a study aimed at assessing the security of animal enclosures, and at identifying which factors could be affecting such security (Fábregas et al., 2010) found that out of a sample of 63 zoological parks in Spain, 75% had enclosures that were considered “non-secure” (free-flying birds or any other species which were not housed in an enclosure but wandered freely in the zoo were not considered in the study). In the Spanish investigation, 80% of these enclosures housed non-indigenous species, including 21 species listed by the European Inventory of Invasive Species.

4.2 The EU strategy on IAS

At the EU scale, the Commission’s Communication *Halting the loss of biodiversity by 2010 and beyond: sustaining ecosystem services for human well-being* (COM(2006) 216 final) stressed the need for

¹⁰ www.euzooenquiry.eu

¹¹ http://www.eurogroupforanimals.org/policy/pdf/zoo_study_dec_07.pdf

¹² http://www.bornfree.org.uk/fileadmin/user_upload/files/zoo_check/VersionTransl.pdf

coordinated action to reduce substantially the impact of IAS on EU biodiversity. More recently, the Commission's Communication *Towards an EU Strategy on Invasive Species* (COM(2008) 789 final), recognised that halting the loss of biodiversity in the EU will not be possible without tackling IAS in a comprehensive manner. As a result, four options were proposed for establishing an harmonised system able to guarantee a consistent approach between neighbouring countries to monitor and control IAS and their effects on European biodiversity.

Such options are characterised by different levels of ambition. In particular, in order of increasing intensity, Option A "Business as usual" foresees the simple continuation with the ongoing implementation of existing instruments (but clearly, if no action is taken, IAS will continue to become established in the EU with increased associated ecological, economic and social consequences and related costs). Option B "Maximise use of existing approaches" is based on the promotion of best use of existing legislation. In practice, formal legal requirements would remain as they are today but there would be a conscious decision to proactively address IAS problems under existing legislation, e.g. by developing and implementing voluntary codes of conduct to encourage responsible behaviours, developing a EWRR system, maintaining an European inventory on IAS, increasing awareness, exchanging best practice, implementing eradication and control measures at national level. The main shortcoming of this option lies on the fact that a system which is built on voluntary undertakings by Member States and voluntary codes of conduct would only be as effective as the weakest link in a chain. Option B+ "Adapt existing legislation" implies amending existing legislation to widen the scope to formally take IAS issues into account, e.g. by extending the list of "ecological threat species" for which import and internal movement are prohibited under the EU Wildlife Trade Regulations. Option C "Comprehensive, dedicated EU legal instrument" includes the basic tools described in option B, but in addition includes the rapid introduction of new legislation, which will make it possible to tackle IAS in a comprehensive manner. In addition a set of horizontal measures that are common and relevant to all options is also considered; these include communication, education and awareness-raising, development of the knowledge base, and financing. Finally it is proposed that the technical aspects of the implementation could be centralized by a dedicated agency or similar structure.

According to a recent study (Shine et al. 2010) Option A is not considered a viable option for the EU as environmental, social and economic costs associated with biological invasions would continue to escalate without any gains for issue visibility or policy coherence. On the other hand, also Option B is not considered viable in isolation, as many suggested components would require a legislative basis (with the notable exception of the voluntary codes, best practices and communication campaigns which are foreseen to play a key role in delivery through a partnership-based approach, possibly supported by governments). Indeed, Option B+ provides opportunities to address IAS by seeking synergies with existing legislation and as such could be the start of a more integrated approach to EU environmental biosecurity, to the extent supported by relevant mandates. The favourite option is therefore Option C according to which a new legislation would provide a flexible framework by establishing a continuum of prevention and management measures with clearly allocated roles and duties of care.

The same study also presents a detailed analysis of the international, EU and Member State baseline and proposed priorities for action. It provides an interesting discussion of the major voluntary measures to address risks associated with the introduction or use of alien species. According to this study, voluntary measures can play a multiple role: awareness-raising, stakeholder innovation, leverage/dissemination of best practices, supplementing existing regulations or filling a regulatory gap. So far, some pathway codes have already been developed for sectors not covered by international or EU regulatory frameworks. Examples are, only to mention those already developed by the Council of Europe in consultation with relevant stakeholders:

- *Code of Conduct on Horticulture and Invasive Alien Plants*, developed jointly with EPPO (Heywood and Brunel 2009);

- *Code of Conduct on Companion Animal and Invasive Alien Species*, developed in collaboration with the Ornamental Aquatic Trade Association and pet trade associations (Davenport and Collins 2009);
- *European Charter on Recreational Fishing and Biodiversity* (Brainerd 2010).

Experience suggests that high-level “soft law” instruments can contribute positively to raising the baseline. For example, the horticulture code is non-binding but was formally approved by the respective member countries of EPPA/Council of Europe (including EU-27 MS). Governments of UK and Belgium are the first ones who responded positively to the invitation to endorse the code at national level by drafting harmonised national codes of conduct and implementing dedicated information campaigns (in the case of Belgium with a dedicated information campaign supported with funds from the EC, e.g. through the LIFE+ instrument).

5. RECOMMENDATIONS

Zoological gardens and aquaria are definitely aware of the importance of their role in conservation, research and education for contributing to mitigate the threat of biological invasions. This is sufficiently highlighted by the activities related to invasive alien species (IAS) carried out in the last years (see examples in § 3.3). However the overall commitment and engagement of zoological gardens and aquaria to prevent that their living collections might represent a source for the introduction of IAS has not yet been adequately addressed.

To ensure that successful measures are undertaken by zoological gardens and aquaria to achieve their conservation objectives and minimize the drawback of certain activities, a set of recommendations has been developed for the following three relevant sectors:

1. Single institutions of zoological gardens and aquariums (including institutions that are not involved in professional networks as EAZA and WAZA)
2. Associations of zoological gardens and aquariums (EAZA, WAZA and relevant national associations)
3. National authorities

The guidelines and recommendations below are to be considered as a fundamental first step needed to encourage voluntary initiatives for zoological gardens and aquariums fully consistent with the principles of the *European Strategy on IAS*.

5.1 Guidelines for zoological gardens and aquaria

5.1.1 Adopt good preventative measures to avoid unintentional introduction and spread of IAS

The variety of episodes of unintentional introductions of IAS from zoological gardens and aquaria shows that many institutions might face significant challenges in managing their facilities in order to effectively prevent the escape of animals (and related diseases) in the wild. For this reason, it is fundamental that each single institution implements appropriate methods to prevent the risk of escapes, paying particular attention to the following measures:

- a) Ensure a regular maintenance of all containment infrastructures e.g. cages, aviaries, fences, barriers, etc.
- b) Remove potentially invasive alien species from exhibits or open air displays, unless all possible measures to prevent the escape/release of animals have been undertaken.
- c) Adopt techniques that reduce the invasive potential of the species kept in exhibits or open air displays e.g. by restricting permanently or temporarily the ability of birds to fly through wing clipping, pinioning, etc. whenever feasible and appropriate.
- d) Ensure that the water from enclosures and aquaria (or any other water body included in the zoo) is not released into natural environment without being adequately monitored and/or treated as necessary.

- e) Establish an assessment procedure involving responsible and regular monitoring of the facilities, to assess the risks of escapes of potential IAS (e.g. due to damages to fences, etc.).

A decision can be made to retain a species free to move throughout the zoo facilities provided that specific risk assessments are undertaken (e.g. in order to evaluate whether such species might represent a threat to native species, habitats and ecosystems) and that contingency plans are in place to control and contain such species in case of escapes in the wild.

In addition, given the growing role of plant collections in many zoos, including those used either for food (e.g. birds seeds) or for environmental enrichment, it is important to ensure that the use of plants which may spread to adjacent natural areas is avoided. As an alternative, non-invasive, possibly native, plants that are aesthetically and horticulturally suitable in the region should be identified and used as replacement of known or potential IAS taxa.

To prevent the accidental introduction of potentially invasive alien species in the environment, the same should apply also to such plants used in zoos and aquaria infrastructures by garden designers and landscape architects, or to algae and other organisms used in aquaria and other similar facilities for ornamental purposes.

5.1.2 Take into account the risks of IAS introductions in wildlife management projects

Captive breeding and re-introduction are invaluable conservation practices that are helping several threatened species to recover from the risk of local or global extinction, yet such management measures carry an associated risk of introducing (potentially) invasive alien species and possibly unknown pathogens into naive settings. In some cases the release of such species and their pathogens may interfere with the success of the conservation measures themselves (see captive breeding and reintroduction programmes of endangered amphibians in relation to the spread of chytridiomycosis). To prevent the risk of release in the wild of IAS (and related diseases and pathogens) further to the implementation of *ex situ* and *in situ* wildlife management programmes, it is fundamental to develop adequate protocols focusing on the *IUCN Guidelines for Re-introductions*, and particularly on the following key principles:

- a) Captive individuals should never be released in the wild outside their historically known natural range, e.g. for breed stock exchanges and similar initiatives, except under exceptional *bona fide* research and conservation related circumstances. In such cases the release of a target species should be allowed only further to specific risk analysis aimed at evaluating the possible impact on native species, habitats and ecosystems, and only in a strictly controlled environment (e.g. fenced areas).
- b) Captive individuals should never be released in the wild outside their historically known natural range, for purposes that could be defined as “fauna improvement” linked to tourist, ornamental or hunting purposes, even when hidden behind the higher need of research and conservation initiatives (e.g. in the case of species actually belonging to endangered taxa).
- c) Captive individuals should never be released in the wild unless they can be shown to be disease-free through the implementation of sound and dedicated diagnostic screening procedures.
- d) Stringent screening and quarantine procedures should be envisaged to avoid disease transmission between animals kept in captivities and between captive and wild animals, such as regular checks to control the occurrence of diseases and pathogens in captivity, routine procedures for the treatment of infected animals and use of biosecure facilities where it is possible to keep individuals/species duly separated.
- e) Contingency response plans in case of spread of diseases and pathogens to species currently threatened with extinction should always be readily available.

5.1.3 Engage in information campaigns awareness raising and outreach activities focusing on IAS

A major contribution of zoological gardens and aquaria in relation to the IAS issue is to be envisaged in the high potentialities of the educational role which characterises such institutions. Education,

information and awareness-raising campaigns are needed to influence the behaviour of the target audience and facilitate choices to reduce IAS risks related to intentional and unintentional introductions of animals and plants in the wild. Besides, considering that many IAS are quite frequently hosted in zoos, such institutions might provide an excellent opportunity to raise awareness among the visiting public about the ecological harm associated with the release of such IAS into the wild (Fábregas et al. 2010). On this regard the key activities could be the following:

- a) Promote information campaigns to inform visitors on which of the hosted species are native to an area and which are not, e.g. through temporary or permanent exhibitions and dedicated panels, guides, etc.
- b) Provide detailed information on IAS, e.g. origin, main pathways, and ecological and socio-economic impacts, both to warn zoo personnel about the potential risk of IAS within their animal collection as well as raising awareness amongst the public about the risk of releasing them into the wild.
- c) Ensure that strong interpretation is provided to the public explaining the risk associated with the IAS hosted in the facility and their function in the facility.
- d) Promote the circulation of information about the invasiveness in other biogeographic regions of native species hosted within the relevant facility.
- e) Support awareness raising activities (e.g. seminars, dedicated campaigns, etc.) to inform visitors on the general issue of IAS.
- f) Encourage preventative measures against the escape and release of IAS in the wild.
- g) Circulate information on legislation and best practices by explaining it in the simplest context specific way to enable compliance
- h) In the case of activities concerning breed stock exchanges or any other movement of species known to be actually or potentially invasive consider attaching a statement of caution as a precautionary “warning”.

5.1.4 Adopt best practices aimed at supporting early warning and rapid response system

The effective implementation of measures against the ecological and socio-economic threat from IAS needs to be supported by all main societal sectors involved in activities directly or indirectly involved in the movement, release, detection and management of IAS. In this context zoological gardens and aquaria play a pivotal role as key stakeholders, and as such a major contribution would be offered by the following activities:

- a) Establish dedicated IAS management programs encompassing research, education and management initiatives to help prevent and control the spread of IAS.
- b) Develop contingency plans to prevent the spread in the wild of IAS of hosted animals which might eventually escape from the facilities.
- c) Remove or control self sustaining populations of IAS already present and free to move throughout the zoo facilities in natural or semi-natural conditions.
- d) Promote reporting and rapid response to animals escaped in the wild, and participate in developing, implementing or supporting regional, national or local early warning systems for immediate reporting and control.
- e) Support initiatives aimed at providing temporary or permanent facilities to prevent the spread of IAS e.g. by establishing rescue centres to host otherwise unwanted/abandoned animals (particularly pets) or for animals removed from the wild whenever suppression is not feasible option in eradication/control programmes.
- f) Promote activities aimed at keeping native species of animals that are threatened by the presence of introduced IAS in their natural habitat, in the light of future reintroduction programmes.

5.1.5 Promote research activities focusing on issues related to impact and management of IAS

Promote research activities on IAS and their impact (e.g. considering all ecological and socio-economic affected aspects) useful for the design of management programmes for the species and possibly in the light of future reintroduction programmes of the affected native species and relevant habitat restoration activities.

5.1.6 Be aware of regulations concerning zoological gardens and aquaria and IAS

- a) Enforce and implement correctly all existing laws relating to the management of animals in zoological gardens and aquaria (e.g. the legislation enforced by the EU Member States for the implementation of the EC Zoo Directive) and particularly ensure that all animals owned by, managed by and kept by European zoological gardens and aquaria are housed in conditions that prevent introductions of IAS.
- b) Consider all laws on importation, exportation, quarantine and distribution of animals across political boundaries.
- c) Be sensitive to multilateral conventions and treaties that deal with this issue and encourage affiliated organizations to do the same.

5.2 Guidelines for associations of zoological gardens and aquaria

5.2.1 Launch conservation campaigns focusing on IAS

One of the most desirable way to tackle IAS threats is to build awareness, foster responsible practices and support voluntary compliance. To this regard, European and global associations of zoological gardens and aquaria are a vital part of the solution, because they may play a key role in increasing public awareness, responsibility and education, and ensuring public participation and involvement within the activities carried out by the member institutions and the relative public.

A fundamental contribution from associations such as EAZA and http://www.eaza.net/campaigns/Pages/European_Carnivore_Campaign.aspx WAZA could come from organising at least one annual conservation campaign focusing on IAS. Also other campaigns (e.g. on international wildlife trade, biodiversity threats, endangered species, etc.) could at least in part be focusing on the IAS issue. By addressing the key recommendations listed in this code of conduct, plus a variety of related issues affecting the species hosted by each single involved institution, these campaigns would increase the cooperation between the zoos associations, their members and other conservation organisations.

Besides promoting awareness and providing the impetus for key regulatory changes based on the present code of conduct, such conservation campaigns might also help raising funds to make a significant and lasting contribution to support all major IAS related activities (management and maintenance of facilities to prevent escapes, information campaigns, research activities, grants for eradication projects, etc.).

5.2.2 Develop best practice manual and guidelines on methods to prevent the introduction of IAS

The wider adoption of this voluntary code of conduct would be strongly facilitated if embraced by international bodies with oversight of the activities of the targeted institutions. For this reason both the EAZA and the WAZA can yield great influence on the zoological gardens and aquaria to adopt best practices. This objective could be achieved by promoting and/or contributing to the development of manuals and guidelines to raise awareness among member institutions on use of appropriate methods to prevent the introduction of IAS (e.g. particularly by providing guidance on recommendations listed in § 5.1.1). As a result, zoological gardens and aquaria could further consolidate their position as leading actors in global conservation programmes by playing a key role in the management of IAS at either the local, regional or global level, for example considering the establishment of a more demanding accreditation processes (see Fábregas et al. 2010).

Key elements for consideration (see also Shine et al. 2010) may include the following measures:

- a) Promote specific and comprehensive analysis regarding IAS originated by escapes/releases from zoological gardens and aquaria in Europe.
- b) Incorporate information on biosecurity and prevention into educational materials.
- c) Involve the public and relevant interest groups in monitoring activities, with appropriate training and information materials.
- d) Implement targeted awareness-raising activities to increase the chances of early detection of new IAS and build understanding of why eradication may be necessary.
- e) Actively encourage the scientific and research community to support these efforts by ensuring prompt circulation of information on new arrivals.
- f) Use an eradication or control programme to communicate information on what different stakeholders can do to reduce the chance of future incursions.
- g) Involve interest groups and appropriate media channels in the design and dissemination of public awareness materials for both terrestrial and aquatic systems, including information on success stories and practical ways to reduce risks.

5.2.3 Strengthen partnership with other organizations for the sound management of IAS

One of the key strategic directions of both the EAZA and the WAZA is the development of strategic relationships with multilateral environmental agreements and global conservation treaties, as well as with other intergovernmental organisations and international nongovernmental organisations. On the other hand, a stronger global networking of zoological gardens and aquaria to tackle biological invasions involving public outreach, information sharing and capacity building is a priority to prevent the problems of the past which are expected to occur with increasing frequency and impact (not necessarily because of zoological gardens and aquaria) also in the future, as shown by historical trends (see Hulme et al. 2008). The effectiveness of such networking would be clearly facilitated by establishing strong partnerships with other recognised network of experts.

As a first step to demonstrate a more clear commitment to the conservation of European wildlife in relation to the threat from IAS, both the EAZA and WAZA might consider the following actions:

- a) Develop partnerships, on behalf of the relevant communities of zoological gardens and aquaria, with international organisations such as the IUCN/SSC Invasive Species Specialist Group (ISSG) e.g. under the form of a Memorandum of Understanding. Similarly to other campaigns such partnership could be supported by the Council of Europe (an example is the European Carnivore Campaign ran by the EAZA).
- b) Coordinate and facilitate collaborations with all relevant regional and national groups of experts in databases, early warning systems, monitoring, and other means of preventing IAS problems.

These activities would benefit both the EAZA and WAZA in terms of visibility, and would help such associations in achieving the strategic objective related to lobbying activities. In fact, in partnership with other networks, the community of zoological gardens and aquaria could contribute to the development of the IAS strategy at both the national and regional level by providing support on its key elements, such as the early warning and rapid response system and related decision support tools.

5.3 Guidelines for national authorities

5.3.1 Guarantee implementation of relevant legislation and related

- a) Acknowledge that the issue of IAS is a major threat for species, habitats and ecosystems, and undertake measures to ensure that all European legislation established to prevent introductions of IAS

from zoological gardens and aquaria (i.e. EC Zoo Directive) is fully understood, and effectively transposed, implemented and enforced.

- b) Establish financial instruments and incentive programs to guarantee enforcement of relevant legislation.
- c) Ensure that all zoological gardens and aquaria – and similar facilities with captive wild animals - are licensed and regularly inspected to ensure they comply with the licensing requirements (accurately address enclosure security in official inspections and authorization processes).
- d) Ensure animal confiscations, rescue and zoo closure (see also Article 6 of the EC Zoo Directive) should the preventative measures mentioned in this code of conduct (see section dedicated to single institutions in § 5.1) fail to be implemented in licensed facilities.
- e) Implement sound strategies for animals from closing facilities to avoid the release of species which might be potentially invasive.

5.3.2 Support IAS related activities of zoos and aquaria and relevant associations

In compliance to the present code of conduct:

- a) Promote specific and comprehensive analysis regarding IAS originated by escapes/releases from zoological gardens and aquaria in Europe.
- b) Ensure that all zoological gardens and aquaria address the threat of biological invasions through the correct implementation of voluntary regulatory instruments like the present code of conduct, upholding the highest of standards.
- c) Establish financial instruments and incentive programs to guarantee that captive animals in licensed facilities are kept in conditions that meet the criteria listed in this code of conduct e.g. no free-roaming species in the zoo, existence of a secure perimeter fence, etc. (see section dedicated to single institutions in § 5.1).
- d) Facilitate accession to external funding instruments (e.g. at EU level, the EC may support national and/or regional initiatives through the LIFE+ programme, for example in relation to information and communication campaigns).
- e) Provide guidance and establish relevant enforcement tools such as guidelines and educational courses to ensure adequate capacity building and staff training for zoological gardens and aquaria and their associations in relation to the IAS issue and related preventative measures, e.g. on how to responsibly keep animals in order to prevent escapes in the wild.
- f) Require risk assessment for all government (financially) supported *ex situ* or *in situ* conservation programmes to ensure that no harmful species (or relevant diseases and pathogens) are introduced, intentionally or unintentionally, from the living collections hosted in zoological gardens and aquaria in the country.
- g) Bond requirements for zoological gardens and aquaria to commit themselves to develop contingency plans for non-authorized releases or accidental escapes of IAS in the wild.

6. IMPLEMENTING, MONITORING AND EVALUATING THE CODE

In this code of conduct some fundamental elements for a sustainable strategy at the regional level that balances the risk posed by invasive alien species against the educational, commercial and aesthetic benefits of the living collections hosted in zoological gardens and aquaria are suggested. The application of this voluntary based approach in this field is novel and innovative, its strength being the ambitious aim to facilitate the expression of the collective potential of the global zoo and aquarium community in relation to the mitigation of one of the greatest threat to biodiversity.

To guarantee an effective and successful implementation of such a code is necessary to build on the experience from similar initiatives. For example, it is known that this approach has been used successfully to ameliorate similar problems in the framework of activities of botanical gardens. In particular, in the USA the potential risks posed by living collections of plants led to the launch in 1999 of a voluntary code of ethics for botanic gardens and arboreta known as the *Chapel Hill Challenge* followed in 2002 by the *St Louis Declaration*, a similar set of voluntary guidelines which, besides botanic gardens, targeted the entire horticultural industry. The effectiveness of these voluntary codes of practice did not appear particularly strong (Hulme 2011) basically because of lack of a proper strategy to guarantee a stronger global networking of the targeted institutions to tackle biological invasions involving public outreach, information sharing and capacity building. In any case, some positive example of proactive behaviour regarding IAS occurred in Florida where growers agreed to voluntarily stop growing 45 potentially invasive plants (Niemiera and VonHolle 2009). In Europe, a major example of best practice refers to the implementation of a *Code of Conduct on Horticulture and Invasive Alien Plants* recently developed by the Council of Europe (in collaboration with EPPO). In this case, as a follow up a national programme has been financed in Belgium through the LIFE+ Communication and Information funds to stimulate endorsement of the voluntary code and raise awareness of the environmental risks of invasive alien plants along the ornamental horticulture supply chain.

The national experiences and lessons learnt regarding voluntary codes as those mentioned above have emphasised that to be fully effective and to increase the likelihood of long-term behaviour change this code should be widely disseminated. This clearly stresses the importance of supporting stronger global networking of zoological gardens and aquaria combined with information campaigns aimed at preventing lack of knowledge, possibly coordinated by the key organisations (like EAZA and WAZA) and with the full support of the national authorities.

In any case, the effectiveness of voluntary codes is difficult to evaluate with precision: without an underpinning regulatory framework, there are identified risks of “free-riding” and regulatory capture. As suggested by Shine et al. (2010) the future EU Strategy on IAS could proactively support integrated voluntary programmes that combine development of sectoral codes with targeted media campaigns and training. Such actions could be supported through existing EU funding instruments. At a higher level of ambition, it could also require Member States to consider developing statutory codes of conduct along the lines of the present one that clarify responsible practices and establish a baseline for a duty of care.

A pivotal role in this context could be played by the EAZA and the WAZA, that given their conservation focused objective should guarantee a sound IAS policy, for example by actively encouraging the implementation of the recommendations of this document, in combination with monitoring and reporting rates of endorsement across their membership. Such systematic reviews would provide verifications for proactive actions by all concerned institutions against IAS and would provide further evidence for the effectiveness of zoos and aquariums as centres of education and conservation.

Also, collaboration between the ISSG, an organization with a history of producing IAS management guidelines, and both EAZA and WAZA could prove beneficial in the development of standard protocols and joint training materials targeting IAS preventative approaches. Besides, such partnership would create the right conditions for suggestions for future improvements of this code of practice. In fact, the present code of conduct, although specifically developed for the European region, could be extended and adapted for adoption also in other regions and at global level.

7. REFERENCES

- Birkun A (2002) The current status of bottlenose dolphins (*Tursiops truncatus*) in the Black Sea. AC18 Inf.2 ACCOBAMS, Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area. First Meeting of the Parties Monaco, 28/02/2002 - 2/03/2002. 43 pp.
- Burridge MJ, Simmons LA (2003) Exotic ticks introduced into the United States on imported reptiles from 1962 to 2001 and their potential roles in international dissemination of diseases. *Veterinary Parasitology* 113:289–320
- Clergeau P, Yésou P (2006) Behavioural flexibility and numerous potential sources of introduction for the sacred ibis: causes of concern in western Europe? *Biological Invasions*, 8:1381–1388
- Dunn RR, Gavin MC, Sanchez M, Solomon JN (2006) Pigeon paradox: the dependence of global conservation on urban nature. *Conservation Biology* 20(6): 1814-1816.
- Essl F, Dullinger S, Rabitsch W, Hulme PE, Hülber K, Jarošík V, Kleinbauer I, Krausmann F, Kühn I, Nentwig W, Vilà M, Genovesi P, Gherardi F, Desprez-Loustau ML, Roques A, Pyšek P (2011) Socioeconomic legacy yields an invasion debt. *Proceedings of the National Academy of Sciences*. 108:203-207.
- Fàbregas M, Guillén-Salazar F, Garcés-Narro C (2010) The risk of zoological parks as potential pathways for the introduction of non-indigenous species *Biol Invasions* 12:3627–3636
- Fitter RSR (1959) *The Ark in our Midst. The Story of the Introduced Animals of Britain: Birds, Beasts, reptiles, Amphibians, Fishes.* London, Collins.
- Foster KP (1998) Gardens of Eden: exotic flora and fauna in the Ancient Near East, in: Albert, J., Bernhardsson, M. & Kenna, R. (Eds) *Transformations of Middle Eastern Environments: legacies and lessons.* New Haven, CT, Yale University School of Forestry and Environmental Studies no. 103.
- Galil B (2006) *Caulerpa taxifolia*. In: DAISIE (ed) *Handbook of Alien Species in Europe. Invading Nature: Springer Series in Invasion Ecology*, Springer, Dordrecht, The Netherlands
- Genovesi P (2005) Eradications of invasive alien species in Europe: a review. *Biol Invasions* 7:127–133
- Genovesi P, Shine C (2004) European strategy on invasive alien species. *Nature and environment*, Council of Europe, 137: 1–66.
- Genovesi P, Bacher S, Kobelt M, Pascal M, Scalera R (2009) Alien mammals of Europe. In: DAISIE (ed) *Handbook of Alien Species in Europe. Invading Nature: Springer Series in Invasion Ecology*, Springer, Dordrecht, The Netherlands, Pp. 119-129
- Genovesi P, Scalera R, Brunel S, Solarz W, Roy D (2010) Towards an early warning and information system for invasive alien species (IAS) threatening biodiversity in Europe. *European Environment Agency*, Tech. report 5/2010. 52 pp.
- Gippoliti S (2004) Captive-breeding and conservation of the European mammal diversity. *Hystrix It. J. Mamm. (n.s.)* 15(1): 35-53
- Hughes JD (2003) Europe as Consumer of Exotic Biodiversity: Greek and Roman times. *Landscape Research*, 28:1,21-31
- Hulme PE (2009) Trade, transport and trouble: managing invasive species pathways in an era of globalization. *Journal of Applied Ecology* 46:1, 10-18
- Hulme PE (2011) Addressing the threat to biodiversity from botanic gardens. *Trends in Ecology and Evolution*, in press

- Hulme PE, Bacher S, Kenis M, Klotz, S, Kühn I, Minchin D, Nentwig W, Olenin S, Panov V, Pergl J, Pyšek P, Roques A, Sol D, Solarz W, Vilà M (2008) Grasping at the routes of biological invasions: a framework for integrating pathways into policy. *Journal of Applied Ecology*. 45: 403–414.
- IUDZG/CBSG (1993) *The World Zoo Conservation Strategy: the Role of the Zoos and Aquaria of the World in Global Conservation*. Chicago, IL: Chicago Zoological Society.
- Jiguet F, Doxa A Robert A (2008) The origin of out-of-range pelicans in Europe: wild bird dispersal or zoo escapes? *Ibis* 150(3) : 606-618.
- Kark S, Solarz W, Chiron F, Clergeau P, Shirley S (2009) Alien birds, amphibians and reptiles of Europe. In: DAISIE (ed) *Handbook of Alien Species in Europe. Invading Nature: Springer Series in Invasion Ecology*, Springer, Dordrecht, The Netherlands, pp. 105–118.
- Kettunen, M., Genovesi, P., Gollasch, S., Pagad, S., Starfinger, U., ten Brink, P. & Shine, C. 2009. Technical support to EU strategy on invasive species (IAS) - Assessment of the impacts of IAS in Europe and the EU (Final draft report for the European Commission). Institute for European Environmental Policy (IEEP), Brussels, Belgium)
- Kraus F (2003) Invasion pathways for terrestrial vertebrates. Pages 68–92 in J. Carlton, G. Ruiz, and R. Mack, eds. *Invasive species: Vectors and management strategies*. Island Press, Washington, DC.
- Kraus F (2009) *Alien reptiles and amphibians: a scientific compendium and analysis*. New York: Springer.
- Miller C, Kettunen M, Shine C (2006) *Scope Options for EU Action on Invasive Alien Species (IAS)*. Final report for the European Commission. Institute for European Environmental Policy (IEEP), Brussels, Belgium.
- Money J (1998) *Captive cetaceans: a handbook for campaigners*. Document by the Whale and Dolphin Conservation Society, Bath, U.K.
- Niemiera AX, Von Holle B (2009) Invasive Plant Species and the Ornamental Horticulture Industry. In *Management of Invasive Weeds*, Inderjit (ed.) Springer, New York, NY. pp. 167-187.
- Nummi P (2010) NOBANIS – Invasive Alien Species Fact Sheet – *Castor canadensis*. – From: Online Database of the North European and Baltic Network on Invasive Alien Species – NOBANIS www.nobanis.org, Date of access 10/4/2011.
- Padilla DK, Williams SL (2004) Beyond ballast water: aquarium and ornamental trades as sources of invasive species in aquatic ecosystems. *Frontiers in Ecology and the Environment* 2: 131–138.
- Penning M, Reid GMcG, Koldewey H, Dick G, Andrews B, Arai K, Garratt P, Gendron S, Lange J, Tanner K, Tonge S, Van den Sande P, Warmolts D, Gibson C (Eds) (2009) *Turning the Tide: A Global Aquarium Strategy for Conservation and Sustainability*. World Association of Zoos and Aquariums, Bern, Switzerland
- Perry D, Perry G (2008) Improving interactions between animal rights groups and conservation biologist. *Conservation Biology* 22:27–35.
- Reeves R, Notarbartolo di Sciara G (eds) (2006) *The status and distribution of cetaceans in the Black Sea and Mediterranean Sea*. IUCN Centre for Mediterranean Cooperation, Malaga, Spain. 137 pp.
- Rose M (2010) World's First Zoo - Hierakonpolis, Egypt. *Archaeology*. A publication of the Archaeological Institute of America 63(1)2010. www.archaeology.org/1001/topten/egypt.html
- Scalera R, Zaghi D (2004) Alien species and nature conservation in the EU. The role of the LIFE program. *LIFE Focus*. European Commission, Bruxelles. Pp.60.
- Shine C, Kettunen M, Genovesi P, Essl F, Gollasch S, Rabitsch W, Scalera R, Starfinger U, ten Brink P (2010) Assessment to support continued development of the EU Strategy to combat invasive alien

species. Draft Final Report for the European Commission. Institute for European Environmental Policy (IEEP), Brussels, Belgium.

Thissen JBM, Hollander H (1996) Status and distribution of mammals in The Netherlands since 1800. *Hystrix*. (N.S.) 8 (1-2): 97-105.

Walker SF, Bosch J, James TY, Litvintseva AP, Valls JAO, Piña S, Garcia G, Rosa GA Cunningham AA, Hole S, Griffiths R, Fisher MC (2008) Invasive pathogens threaten species recovery programs. *Current Biology*, 18, R853-R854.

ANNEX I - EAZA Position Statement on the developing EU Strategy for Invasive Alien Species (IAS)

September 2010

Introduction

This statement presents the position of the European Association of Zoos and Aquaria (EAZA) on the developing EU Strategy for Invasive Alien Species (IAS). While EAZA recognises that IAS, particularly botanical species, remain a concern in relation to native species sustainability in Europe it does not believe that the introduction of an additional Directive, or other additional regulatory measures, is the best approach to tackling this issue. EAZA understands that some parties to this discussion have proposed a 'white list' approach to IAS, whereby only a small number of species that have already undergone a risk assessment would be approved. We strongly disagree with such an approach, which would almost certainly lead to a significant number of animal species currently responsibly managed in human care in EU Member States, and which clearly pose no threat to native species, being banned as they have not been risk assessed. This would be an unrealistic and onerous approach to the control of species that potentially threaten European native species. A more pragmatic and sensible approach should be taken. We are particularly concerned as to what impact a 'white list' approach would have on zoos and aquariums, who are already legislated for via a number of other regulations and directives, notably the Zoo Directive (1999/22/EC), in respect of careful control of animals and their containment. The remainder of this statement will provide further detail on EAZA's position. EAZA's current status and general position;

- As laid down in EAZA's constitution the objects of the association are: a. to promote cooperation for the furtherance of wildlife conservation, through internationally coordinated breeding programmes of wild animals and in situ conservation; b. to promote education, in particular environmental education; c. to promote scientific study; d. to represent the interests of its members;
- EAZA represents 325 members from 36 countries, 300 of which maintain public collections of animals. More than 280 institutions of the total EAZA membership are located within the European Union.
- EAZA member institutions receive approximately 140 million visitors a year and house more than 250,000 animals, excluding fish and invertebrates. EAZA member institutions employ 20,000 staff members, 5,000 of which are seasonal;
- EAZA members are often important economic drivers and cultural centres in their local communities;
- In the context of local areas EAZA members are often important 'opinion formers' on environmental issues, including that of invasive species;
- EAZA has a significant social role in educating European citizens about animals, their conservation, and overarching threat processes such as climate change, habitat loss and how consumer behaviour interacts with these global challenges. Zoos and aquariums have been demonstrated to host a far more representative and inclusive visitor social spectrum than either museums or science centres;
- EAZA has adopted the World Zoo and Aquarium Conservation Strategy (2005) which articulates the modern role of zoos and aquariums and their commitment to conservation;
- EAZA institutions in the European Union comply with Council Directive 1999/22/EC relating to the keeping of wild animals in zoos;
- From 2008 to 2010 EAZA ran the European Carnivore Campaign (www.carnivorecampaign.eu), a campaign supported by the Council for Europe that demonstrates our commitment to the conservation of European animal species;
- In 2003 EAZA issued a statement on IAS to all its member institutions (see additional document).

We believe;

- The current EU focus on the potential risk of invasive species in Europe is welcome in that it recognises that invasive species are a threat to our native biodiversity;

- That there is sufficient legislation in place that can be enacted to control threats from invasive species;
- That banning non-risk assessed species from human care throughout Europe would be a retrograde step;
- That a ‘one size fits all’ policy is inappropriate for an environmentally diverse area such as the Member States of the EU;
- That a ‘white list’ approach, where only a small number of species are approved and that all other species alien to EU Member States would be banned from being held in human care in zoos and aquariums, until full risk assessments have been undertaken, is an unacceptable option;
- Zoos and aquariums in EAZA comply with all EU member legislation as it applies to their collections and are rigorous in their efforts to prevent escapes from such facilities. EAZA has rigorous ‘Animal Care Standards’ to which its member institutions comply and an additional statement on IAS with which members must comply;
- Zoos and aquariums in EAZA do not pose a significant risk in reference to IAS. A Directive requiring all non-native species to undergo a full risk assessment to see if they could, potentially, pose a risk (species such as elephants, tigers, wombats, hornbills etc.) would be inappropriate, take many years, be nonsensical, and would be prohibitively costly;
- The vast majority of non-native species held by zoos and aquariums do not pose any risk at all and should therefore be excluded from this otherwise well-intentioned strategy;
- A ‘white list’ approach would be costly and likely lead to extensive non-compliance across Member States.

What we would like to see;

- Improved enactment of existing legislation to tackle issues associated with threats from IAS;
- That any moves to designate species as potentially invasive are proportionate and based on risk assessments of the highest scientific standing;
- That a ‘black list’ approach, wherein species known or thought to be a significant risk are assessed and that any provision for them to be held in human care, for example in zoos and aquariums, would be controlled using existing legislation and viewed in the context of the overarching conservation benefits of management and breeding in such a setting;
- That such a ‘black list’ approach should be country by country to take into account different climatic conditions and environments, which affect the potential for an alien species to become invasive;
- Such a ‘black list’ approach should be based on rigorous risk assessments with full stakeholder participation;
- That the full costs of such risk-assessments must be borne in mind;
- That the EU, in any future deliberations on IAS, pays close attention to the role of responsible zoos and aquariums in education, conservation and research;
- That the EU recognises the unique position and professionalism of EAZA members in maintaining non-native species for the purposes noted above and that this responsible approach should not be penalised or indeed hampered by legislative conditions that make human care of such species difficult if not impossible. This would impact not only on conservation of many species, but on the environmental education opportunities for EU citizens who visit EAZA members and on the economic input of zoos and aquariums into their local economies.