World Association of Zoos and Aquariums
WAZA | *United for Conservation*

TURNING THE TIDE

A Global Aquarium Strategy for Conservation and Sustainability

IUCN

SSC Species Survival Commission

Ramsar

Wetlands International

Conservation International

WWF

TURNING THE TIDE

A Global Aquarium Strategy for Conservation and Sustainability

Implementation of the World Zoo and Aquarium Conservation Strategy by the WAZA Aquarium Community and Partners

Compiled and edited by

M. Penning, G. McG. Reid, H. Koldewey, G. Dick, B. Andrews, K. Arai, P. Garratt, S. Gendron, J. Lange, K. Tanner, S. Tonge, P. Van den Sande, D. Warmolts and C. Gibson

Citation

Penning, M., Reid, G. McG., Koldewey, H., Dick, G., Andrews, B., Arai, K., Garratt, P., Gendron, S., Lange, J., Tanner, K., Tonge, S., Van den Sande, P., Warmolts, D. and Gibson, C. (Eds) 2009. *Turning the Tide: A Global Aquarium Strategy for Conservation and Sustainability*. World Association of Zoos and Aquariums, Bern, Switzerland.

ISBN 978-3-033-02140-2

WAZA Executive Office
Lindenrain 3
3012 Bern
Switzerland
www.waza.org

Design
www.naturebureau.co.uk

Print
Information Press, Oxford, UK

Cover
Open ocean exhibit at Monterey Bay Aquarium, USA, with great white shark. Back cover: Hairy hermit crab, *Anomura* sp. © Dennis King, South Africa. High School Lake Ecology Class, Shedd Aquarium, USA.

The World Association of Zoos and Aquariums (WAZA) is a global organisation which harmonises the principles, policies, practices and strategy of over 1300 leading zoos and aquariums. WAZA is the unifying representative of the global zoo and aquarium community and works in partnership with IUCN, national governments and non-government organisations to ensure high standards of animal welfare and to achieve conservation in zoos and aquariums (*ex situ*) and in nature (*in situ*). (www.waza.org)

Contents

Foreword

"There has long been a belief that the sea, at least, was inviolate, beyond man's ability to change and to despoil. But this belief, unfortunately, has proved to be naïve"

Rachel Carson, ***The Sea Around Us*** 1951

The World Association of Zoos and Aquariums (WAZA) is a global organisation which acts to harmonise the principles, practices, policies and strategy of over 1300 zoos and aquariums. Its strap-line is 'United for Conservation'. WAZA evolved from the International Union of Directors of Zoological Gardens (IUDZG), founded in 1935 in Basle, Switzerland but which ceased to exist during World War II. A reconstituted IUDZG was founded in Rotterdam in 1946 eventually to become the World Zoo Organisation (WZO). In 2000, the WZO was re-named and re-branded as 'WAZA' to reflect a more modern and inclusive organisation, where public aquariums are fully represented and where cooperative action is greatly valued and promoted. Today, WAZA is the unifying representative and 'voice' for the global zoo and aquarium community. From its base in Switzerland, it works in partnership with IUCN, national governments and non-government organisations to ensure high standards of animal welfare and to achieve conservation and sustainability both in zoos and aquariums (*ex situ*) and in nature (*in situ*).

WAZA's vision is to be a trusted and leading partner in the conservation of biodiversity, with a particular focus on species cared for by zoos and aquariums. Its mission is to provide leadership and support for zoos, aquariums and partner organisations of the world in animal care and welfare, conservation of biodiversity, environmental education and global sustainability. In the pursuit of the vision and towards the fulfilment of the mission it was realised, almost 20 years ago, that a strategic conservation 'blueprint' was required to guide the organisation and its members. From this, in 1993, the *World Zoo Conservation Strategy* was published by the WZO-IUDZG in partnership with the IUCN Species Survival Commission's Conservation Breeding Specialist Group (CBSG). This document defined for the first time the overall responsibilities and opportunities that the international zoo and aquarium community needed to act on in order to be fully engaged in the collective global conservation movement. In 2002, several senior representatives of the world zoo and aquarium community met to discuss a proposed new strategy document: Dr Bert de Boer (Chairman of the European Association of Zoos and Aquaria, EAZA, and principal author and editor of the original 1993 strategy); Dr Ulysses Seal (then Chairman of the CBSG); Dr William Conway (then Director of the Wildlife Conservation Society, New York, USA) and Professor Günther Nogge, (then Director of the Cologne Zoo, Germany and a past President of the WZO). The new strategy would build on the success of the original, begin to raise the profile of aquariums and also demonstrate more ways in which zoos and aquariums could successfully support conservation initiatives. From these initial excellent endeavours, a new strategy was developed under the aegis of a Steering Committee, led by Dr Jonathan Gipps (Director of Bristol Zoological Gardens, UK, and Chair of the WAZA Conservation and Sustainability Committee).

The new and current *World Zoo and Aquarium Conservation Strategy* (WZACS) was launched on the 2 May, 2005 in Melbourne, Australia. Headed '*Building a Future for Wildlife',* it is the result of the collective efforts of over 350 zoo and aquarium professionals and many other conservation and sustainability partners worldwide. The strategy is aimed at all zoos and aquariums, associations and partner organisations, however large or small, however rich or poor, and not just those who are members of WAZA. The strategy provides a shared philosophy and high-level aspiration for zoos and aquariums across the globe. It also defines the standards, policies and practices that are necessary to achieve their goals in conservation. This landmark document can be downloaded free-of-charge from the WAZA website at www.waza.org in English, German, Russian, Swedish, Spanish, Portuguese, Polish, Czech and Chinese.

Many internationally-respected individuals from public aquariums made significant contributions to the original WZACS (2005) document. However, it has long been recognised that alongside many aspects in common, there are differences between aquariums and zoos: in their nature, character, typical constitution, operational requirements, in their stakeholder community; and in the challenges faced in conservation and environmental sustainability for the aquatic or wetlands environment. Hence, it was decided that a dedicated publication – prepared for and by aquarium professionals and partners – was required to detail carefully the implementation of WZACS by public aquariums. This new strategy document plots the course for public aquariums in a world where marine, coastal and freshwater resources are being ruthlessly exploited, where water-associated biodiversity is steadily declining and where the careful management of all aquatic ecosystems is now crucial for the well-being of the planet. In short, this present document '*Turning the Tide*' is the full response of the WAZA Aquarium Community to the WZACS.

The implementation of this new strategy will be supported and monitored by WAZA through its Aquarium Committee, with key inputs from the Conservation and Sustainability Committee, Ethics and Welfare Committee, Science and Veterinary Committee, Marketing and Public Relations Committee and its Education Committee (which is managed in close conjunction with the International Zoo Educators, IZE). Through a cooperative, strategic approach, the aquariums of the world will unite among themselves and with many other partners to make a meaningful contribution to global efforts in aquatic conservation and sustainability.

Prof Gordon McGregor Reid
WAZA President

Dr Mark Penning
WAZA President Elect
Chair: Aquarium Committee

Dr Jonathan Gipps OBE
Chair: WAZA
Conservation and
Sustainability Committee

International Endorsement

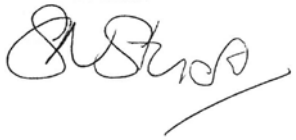
In preparing this document, we would like to warmly thank all of the WAZA institutional and regional association members together with numerous individual colleagues, including from the International Aquarium Forum (IAF), International Aquarium Congress (IAC) and European Union of Aquarium Curators (EUAC). A full list of individual acknowledgements is given (p. 50). WAZA is also most grateful for formal endorsement of this document by the IUCN Species Survival Commission, The Ramsar Convention on Wetlands, Conservation International, Wetlands International and the World Wildlife Fund-US.

For their contributing reviews we thank: colleagues in the IUCN-Species Survival Commission – Dr Simon Stuart (Chair, IUCN-SSC) and Dr Will Darwall (Manager, IUCN-SSC Freshwater Biodiversity Unit); colleagues from the Ramsar Convention on Wetlands – Dr Anada Tiega (Secretary General) and his team; colleagues in Conservation International – Dr Russell Mittermeier (President), Dr Claude Gascon (Executive Vice-President, Programs and Science), Dr Tom Brooks (Vice-President, Conservation Priorities and Outreach, Center for Applied Biodiversity Science), Neil Cox (Programme Officer, IUCN SSC/CABS Biodiversity Assessment Unit) and Dr Ian Harrison (Freshwater Species Assessment and Program Fundraising Manager and Research Associate of the American Museum of Natural History, New York); colleagues in World Wildlife Fund-US – Dr Bill Fox (Head of Fisheries) and Dr Michele Thieme (Freshwater Fish Biologist); and colleagues in Wetlands International – Dr Jane Madgwick (CEO) and her team.

WAZA also greatly appreciates the following statements of endorsement:

International Union for Conservation of Nature

One of the most exciting developments in conservation in recent years is the enormous growth in conservation activities, both *in situ* and *ex situ*, by the world's zoos. In many senses this is a direct result of the *World Zoo and Aquarium Conservation Strategy*, which was spearheaded by the World Association of Zoos and Aquariums (WAZA) in 2005. I am now delighted to see, and endorse, the *WAZA Global Aquarium Strategy for Conservation and Sustainability*, and I am convinced that this will have an enormous impact in galvanizing the world's aquariums for conservation. This strategy could hardly come at a better time. The world's oceans are suffering from unprecedented impacts from humans, and conservation efforts need to be greatly strengthened. The potential loss of an entire ecosystem, coral reefs, as a result of increasing ocean surface temperatures and ocean acidification is now a very real possibility. Ensuring the survival of coral reefs is perhaps the greatest conservation challenge of our times. Failure will have very severe implications in terms of potential species' extinctions, loss of livelihoods for those human communities dependent on reef-associated fisheries, and decreased coastline protection with the risk of catastrophic floods. The *WAZA Global Aquarium Strategy for Conservation and Sustainability* is an important part of the global response to this challenge, and I congratulate WAZA on showing the vision and leadership to bring this about.



Simon N. Stuart, PhD
Chair, Species Survival Commission
International Union for Conservation of Nature

Conservation International

The World Association of Zoos and Aquariums has developed an important strategy describing the essential role that aquariums can play in furthering the conservation of aquatic species. The strategy identifies the direct contributions that can be made through the implementation of *in situ* and *ex situ* conservation programmes. The strategy also highlights the contribution that aquariums can play in professional capacity development and public education, to ensure a better understanding of aquatic ecosystems, their conservation and the services that these ecosystems provide to human well-being. Through the implementation of this strategy, aquariums can inspire and help societies to manage aquatic assets sustainably for the equitable benefit of current and future generations.

Conservation International believes that the conservation of aquatic biodiversity is closely linked to safeguarding the livelihoods of the billions of people who rely on the services provided by these ecosystems. These include the provision of clean freshwater, the food resources from the Earth's seas, lakes, rivers and other wetlands, and the myriad of other environmental, cultural, and aesthetic services provided by these aquatic ecosystems. CI is working with many other partners, including IUCN's Species Programme and Species Survival Commission, Wetlands International and NatureServe, to create global priorities that integrate aquatic biodiversity, ecosystem services and human well-being. These include the Global Marine Species Assessment and Global Amphibian Assessment programmes that provide much of the global data on threats to aquatic species and their conservation status. These data, recorded in IUCN's Red List of Threatened Species™, underpin many of the programmatic activities recommended in this *WAZA Global Aquarium Strategy for Conservation and Sustainability*.

This *WAZA Aquarium Strategy* also identifies several opportunities for collaboration with research institutions, national and international non-governmental organisations, and local organisations, all of which share the goals of conserved and sustainable aquatic ecosystems.

Therefore, Conservation International congratulates the World Association of Zoos and Aquariums on the development of this very important document and looks forward to the opportunities to contribute to the success of the Strategy.

Russell. A. Mittermeier, PhD
President, Conservation International

Wetlands International

Our congratulations to the World Association of Zoos and Aquariums for issuing *A Global Aquarium Strategy for Conservation and Sustainability*. Wetlands International has been working worldwide for almost two decades towards the sustainable use of wetlands, including the full range of their services benefiting biodiversity and human well-being.

Representing 6% of the land surface, 30% of all freshwater, 40% of all species and with over one billion people directly depending on them, wetlands remain a priority for conservation and development. Furthermore, the close links between IUCN SSC / WI Specialist Groups and the WAZA community – particularly through the Freshwater Fish Specialist Group – illustrates our shared objectives.

We therefore greatly appreciate WAZA targeting its strategy towards conservation and sustainability and hope to further increase our collaboration in the future for the sustainable use of wetlands. This publication will certainly catalyse and strengthen ties between zoos, aquariums and the International Conservation Community.

I would like to thank you for this opportunity,

Jane Madgwick, PhD
CEO, Wetlands International

Ramsar Convention on Wetlands

The Ramsar Convention on Wetlands congratulates the world's aquarium community for having elaborated the *WAZA Global Aquarium Strategy for Conservation and Sustainability*. This strategy clearly recognises and defines the substantial and concrete roles that aquariums can and should play to contribute to the global challenge of achieving a significant reduction of the current rate of biodiversity loss, including in regard to wetland ecosystems such as freshwater rivers, swamps, ponds and lakes, coastal lagoons, deltas, estuaries and mangroves, seagrass beds and coral reefs. Aquariums are particularly well suited to make the wider public aware of ongoing wetland loss, species decline and the need to counteract this through conservation and restoration of these ecosystems. Aquariums also have a great educational potential. Threatened wetland species are excellent communication tools to create a better understanding of complex ecological processes and to obtain public participation and engagement in conservation projects. The Ramsar Convention looks forward to working together with WAZA and the world's public aquariums to this end.

Anada Tiega, PhD
Secretary General, Ramsar Convention on Wetlands

Executive Summary

There are well in excess of 300 substantial public aquariums in the world and more than 100 have been opened since 1990. Collectively, including those operated within zoos, they may attract as many as 450 million visitors each year; and so have a very large educational and economic impact. This rapidly growing 'Aquarium Industry' (ranging from commercial businesses through to, municipal institutions, research establishments and charitable trusts) is often associated with economic regeneration projects to revive socially impoverished, run down docklands and industrial areas.

Public aquariums are also actively engaged in a large, diverse and ever-expanding programme of conservation and sustainability initiatives from conservation breeding through to the restoration and re-stocking of natural marine and freshwater habitats. Their agenda covers everything from mountain streams, swamps, peatlands and coastal wetlands to the ocean depths; coral reefs to cave fishes and otters; crabs and clams to crocodiles and hippos; jellyfish to penguins, snakes, sea lions and dolphins; and sharks to seahorses, salamanders, frogs and turtles. Public aquariums in partnership with other organisations have a massive potential to tackle global issues in conserving aquatic biodiversity and water resources, alongside issues in fisheries, environmental management, aquatic animal welfare, human development and poverty alleviation.

Turning the Tide: A Global Aquarium Strategy for Conservation and Sustainability (WAZA, 2009) is the detailed response of the international aquarium community to the, more general, *World Zoo and Aquarium Conservation Strategy* published by the World Association of Zoos and Aquariums (WAZA, 2005). The structure of *Turning the Tide* follows chapter sequence and headline statements made in the original WZACS. Topics covered are: Integrating Conservation; Conservation of Wild Populations; Science and Research; Population Management; Education and Training; Communication, Marketing and Public Relations; Partnerships and Politics; Sustainability; Ethics and Animal Welfare.

The world's aquarium community have provided detailed responses to the original statements, emphasising the close, intricate, sophisticated and vital relationship between conservation work conducted off-site (*ex situ*) with that implemented in nature (*in situ*). There follows, per chapter section, action lists that could or should be adopted at different levels ranging from individual public aquariums through to national and regional aquarium/zoo associations.

Public aquariums, national and regional associations and partners are encouraged to maximise the conservation, sustainability, educational and scientific value of their activities, carefully taking into account the recommended responses and action lists in *Turning the Tide*. In doing so, they should develop their own customised, written aquarium action plans, incorporating 'SMART' objectives. This means setting conservation, sustainability and other targets that are Specific, Measurable, Achievable, Realistic and Time-bound.

Introduction

The aquarium 'industry'

It is difficult to make absolute distinctions as to what constitutes a 'zoo' versus a 'public aquarium', as most will include terrestrial, aquatic, amphibious and highly water-dependent species in their collections, albeit usually in different taxonomic proportions (Figure 1). The free-standing public aquariums of the world and zoo-aquariums may be charities, municipal facilities, university research institutions or commercial enterprises. However constituted, they are uniquely placed to communicate with a large proportion of the global population and to foster in their visitors an appreciation of the aquatic environment. At least 650 million people visit zoos and aquariums each year worldwide, making this a bigger mass public participation activity than football (soccer)!

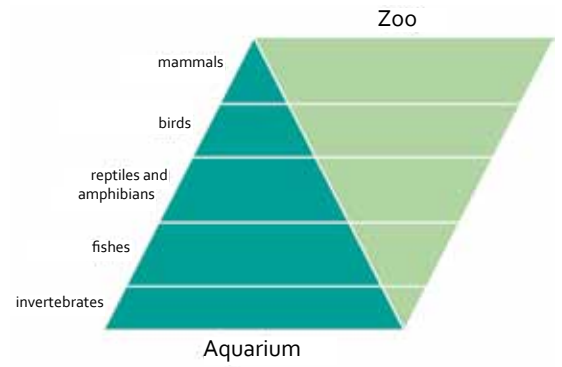


Figure 1. Typical differences between zoos and aquariums in taxonomic representation. Reid, G. McG., 2004.

The total number of substantial public aquariums in the world is estimated to be well in excess of 315 (Appendix III) with the number (WAZA affiliated and non-affiliated) increasing each year. Since the early 1990s more than 100 public aquariums have been opened around the world, notably including 22 in China (Appendix III). This contrasts with the far slower rate of establishment of entirely new terrestrial zoos. This remarkable contemporary expansion of the 'aquarium leisure industry' reflects public enthusiasms and demands and is also often associated with the multi-million dollar regeneration of cities, docklands and other run-down, previously industrial areas. Such large-scale investments bring about highly beneficial economic, employment and social impacts.


Chester Zoo's conservation-themed aquarium. © Steve Rawlins.

The existence and rapid spread of aquariums in all regions of the world also creates new educational opportunities across a diverse and multi-cultural audience representing all socio-economic categories. Through innovative and informative educational displays, these institutions work to inspire people to care about the state of our aquatic environment, and to empower them to make lifestyle choices that are environment-friendly. The potential is enormous. At least 250 million people visit an aquarium each year (Appendix III). If China is included then (on current approximate data) the figure could be as high as 450 million. Individual large public aquariums in China, Japan, and the USA achieve in excess of 3, 4, 5 or 6 million visits each year (Appendix III).

As well as having a strong economic, visitor and education base, public aquariums have numerous other strengths (Appendix IV) and are now rising to the many substantial challenges in conserving the natural aquatic environment and demonstrating 'sustainable credentials'. Often still dependent on wild-caught stock for exhibits (in a way that modern terrestrial zoos generally are not) public aquariums are responding by becoming increasingly engaged in collaborative, international conservation breeding programmes (e.g. Species Survival Plans and Taxon Advisory Groups). These involve many threatened aquatic species of mammals, birds, reptiles, amphibians, fishes, invertebrates and plants (Appendix VIII). Aquarium-bred populations serve as an 'insurance policy' providing conservation options for re-introduction in the event of threatened taxa becoming extinct in the wild (EW) under IUCN Red List criteria. Increasingly, aquariums also fund and engage in conservation and sustainability projects in the field at home and abroad, and often in partnership with other conservation organisations (Appendix VII).

Planet 'Water'


Oceania. © Wetlands International.

Perhaps all of us at times underestimate the extraordinary power and importance of water and the value of life that lives in and around it. Our planet that we know as 'Earth' could just as easily be named 'Water', with over 1.36 billion cubic kilometres of fluid taking up some 70.8% of the planet's surface. Of this water, 97.2% exists in the oceans, 1.8% in glaciers, ice caps and ice sheets, 0.9% in groundwater and 0.02% in freshwater in lakes, inland seas, and rivers. One thousandth of a percent is atmospheric water vapour at any given time, including from the air that humans and other terrestrial animals breathe out. Water flows in our veins and is, literally and metaphorically, our 'life blood' and few fully recognise the crucial wider role that water plays in making our planet suitable for human and all other life. Life on Earth is only possible because of the oceans, rivers and water bodies inland. Approximately 70% of the oxygen we breathe is generated by floating 'algae' (phytoplankton) in the world's oceans and lakes, with just 30% being produced by the forests and other plant biomes on land.

The Earth's climate is driven by the ocean currents, which carry heat around the planet, and dictate the weather and basic environmental conditions for life. Recent research indicates that the little understood but fundamental phenomenon of electro-magnetism may relate, at least in part, to global water movements. Scientific studies on global warming indicate that we could have a virtually ice-free Arctic within 30 years, with consequent continental floods that would negatively affect up to one-quarter of the world's population and countless species of animals and plants (http://www.agu.org/pubs/crossref/2009/2009GL037820.shtml).

Aquatic biodiversity and water resources

Water bodies support an astonishing diversity of natural organisms with, for example, some 70,000 mollusc, 40,000 crustacean, 29,300 fish and 5,743 amphibian species listed (http://www.iucnredlist.org/static/stats), alongside a multitude of mammals, birds, reptiles, insects and aquatic species of plants, both microscopic and macroscopic. With the discovery of species new to science, the taxonomic list grows substantially each year. For freshwater, estuarine and marine fishes alone, more than 300 new species have been described each year from 2006–2008 and close to 500 were described in 2009 (IUCN SSC/WI Freshwater Fish Specialist Group database). It is estimated that some 50–80% of the world's biodiversity is found in the oceans (http://www.panda.org/about_our_earth/teacher_resources/webfieldtrips/oceans_threat/; http://www.waza.org/marketing/


Indian River, Dominica. © Richard Gibson, Chester Zoo, UK.

downloads/18%20Judy%20Mann%20-%20UsHAKA.pps). Nonetheless, humans spend far more money contemplating other planets than in studying oceans and other still poorly understood aquatic ecosystems!

All animals and plants rely heavily on water, with agriculture for crops being a notably big consumer, accounting for as much as 70% of all freshwater use. In addition to daily freshwater intake needs, water provides valuable opportunities for human hygiene, energy generation, recreation and for the creation of economic livelihoods. Around 60% of the world's population live within 60km of the sea, but we fail to care as we should for such a valuable resource. More than 450 cubic kilometres of waste are dumped into the sea each year, some of it highly toxic and not biodegradable.

Global fisheries and environmental issues

The majority of the world's fisheries are food fisheries that provide roughly 40% of the protein consumed by nearly two-thirds of the world's population. Some 38 million people make all or a major part of their living from fishing worldwide, landing about 90 million tonnes of fish per year. This is transformed into numerous economic products both consumable and non-consumable, including fresh fish meat, canned fish, dried fish, roe, caviar, oils, skins and ground meal. There is a smaller allied trade in shells, dried corals, curios and traditional medicines derived from aquatic species. Very many aquatic taxa 'shellfish' (invertebrate) 'finfish' (vertebrate) are involved in mainstream fisheries (refer, for example, to *FishBase* http://www.fishbase.org/). In addition, recreational fishing accounts for at least 4% of the world's catch and has an overall value of around US$ 16 billion per year.

Regrettably, these same world's fisheries are in a state of crisis. The Food and Agriculture Organization (FAO, http://www.fao.org/) currently estimates that 70% of commercial fisheries have already collapsed or are over-fished and likely to collapse. Populations of many of the 'top' predatory fishes, such as certain species of tuna, swordfish and sharks have been reduced to 10% of the original levels. Charismatic invertebrates such as octopus and cuttlefish are suffering too. Each year some 30 million tonnes of sea life (including rare sharks, dolphins, turtles, seabirds, seahorses and water snakes) are discarded as accidental 'by-catch'. Aquatic species of animals and plants at particular risk through trading are increasingly being listed under CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora, see Appendix I). The threats to wildlife and sustainable global fisheries are many indeed, from over-fishing, by-catch, destructive fishing techniques, global warming and climate change, pollution (including shipping, land-based, industrial, agricultural and pharmaceutical); and the relentless degradation of the aquatic and coastal environment, notably including mangroves and coral reefs.


Seal tangled in fishing net. © Salkode Wolf – Ecomare.

Logging in Borneo. © Roland Seitre.

Living coral reefs and reef-associated species are, in particular, under threat from ocean acidification, resulting from the steady global increase in dissolved carbon dioxide from the atmosphere. The acidification threshold limit for corals corresponds to atmospheric carbon dioxide concentrations in excess of 350ppm. A persistent reduction in pH from 8.1 to below 7.3 is predicted between now and the year 2300. At pH 7.7 we have a lethal limit for shell-forming molluscs and reef-building corals, which taxa are predicted to disappear entirely by 2065, if current acidification trends continue. In the interim, there will be major disruption to ecological food webs and many species of fish will struggle physiologically and many will be unable to breed below critical threshold limits. This grave situation has led 155 senior marine scientists from 26 countries to recently sign the Monaco Declaration, highlighting the double-threat of global warming and ocean acidification (http://www.ocean-acidification.net/; http://www.us-ocb.org/MonacoDeclaration.pdf; the WAZA endorsed statement of the Coral Reef Working Group Meeting, The Royal Society, 6 July 2009).


Crab fishing, UK. © P. Richardson.

Many of the largest rivers of the planet (Amazon, Mekong and Congo) flow through ancient tropical rainforests which have for millennia stabilised environmental conditions allowing high levels of fish and other freshwater biodiversity to evolve and prosper. Unfortunately, today, rainforests are being lost at an alarming rate (http://www.nature.org/rainforests/explore/facts.html, http://www.rainforestsos.org/pages/nonprofits/) and environmental protection is being stripped away as a consequence; resulting in warmer, chemically degraded and more turbid systems with a loss of breeding habitats. Hence, these rivers are less suitable or entirely unsuitable for particular aquatic and amphibious species. The deleterious impact of deforestation can be seen anywhere in many freshwater rivers from headwaters to estuaries; with some negative effects such as increased sedimentation causing problems beyond river mouths and extending to smother coral reefs offshore.

River basins, particularly in industrialised parts of the world, are dammed, culverted and over-abstracted, with many major rivers on all continents no longer flowing freely to the sea. Freshwaters – although representing less that 0.02% of available global water – contain extraordinarily high levels of fish diversity (12,000 or more species, or at least 40% of the total – IUCN SSC / WI FFSG data).


Many forms of waste, including non-bridgeable plastic, are found in aquatic habitats. © Steve Trewhella.


Freshwater fisheries in Southeast Asia. © E. Parker.


Seal amongst beach litter, UK. © Skomer MNR.

They support important, highly commercial fisheries such as for sturgeon, salmon, eels and prawns and for freshwater molluscs yielding pearls. Aside from major commercial fisheries there are artisanal subsistence fisheries which are especially important in developing countries providing vital local protein, dried or smoked food reserves and products to trade. These artisanal fisheries often engage women in areas where other female employment is scarce but, increasingly, children are pulled out of school to fish. Over 68% of freshwater fisheries are in developing countries. Overall, freshwater fishes constitute some 87% of all global inland fisheries (fin-fish and shellfish) production – and produce more than 20 million tonnes, approaching one-quarter of the entire world's food fish. Some 12 million people are employed directly in freshwater fishing and this depends on maintaining or securing a healthy, sustainable aquatic environment.

Aquatic ecosystems are, nonetheless, plagued by a thoughtless and continuing over-exploitation and by increasing pollution, habitat modification and the introduction of alien invasive species (such as tilapia, Nile perch, water hyacinth and chytrid fungus in freshwaters). The global dispersal of alien invasive species in marine systems via discharges of ships ballast is another growing problem. Overall, the aquatic sphere contains among the most globally threatened ecosystems, habitats and indigenous species. According to the WWF Living Planet Index, there is a 27% general decline in biodiversity in marine systems and 28% in freshwater (http://www.panda.org/about_our_earth/all_publications/living_planet_report/living_planet_index/).

Aquaculture and the environment

The Food and Agriculture Organization of the United Nations (FAO, http://www.fao.org/) reports that fish farming, or 'aquaculture', has become a multi-billion dollar global industry, and more than 30% of all the marine animals consumed each year are now raised on these farms. Land-based farms worldwide raise commercially valuable algae and higher plants and also billions of crustaceans, molluscs and fishes in freshwater ponds, pools, or concrete tanks. Ocean-based fish farms are situated close to shorelines, and fish in these farms are packed into net or mesh cages, sometimes

Discarded bycatch from a prawn trawl. © Johnny Woodlock, Irish Seal Sanctuary.


Freshwater fishery, Southeast Asia. © Wetlands International.

creating health and welfare problems in terms of disease and parasite transmission, eutrophication and other pollution. Escapes of potentially invasive exotic species to the surrounding environment are another issue, particularly in the case of inland, freshwater aquaculture.

In addition to human food provision, there are now many aquaculture facilities producing ornamental freshwater and marine species in Southeast Asia, Singapore, Sri Lanka and the USA. The marine component of this global ornamental fish trade is featured in a recent report from the United Nations Environment Programme and the World Conservation Monitoring Centre (http://www.unep-wcmc.org/resources/publications/UNEP_WCMC_bio_series/17.htm). This estimates that the number of marine aquarists worldwide is between 1.5 and 2 million, with the export trade in aquarium fish between US$ 200–330 million per year. The total value of the ornamental fish retail trade is valued at around US$ 7.2 billion and (including tanks, filtration and other products) the entire industry is valued at some US$ 15–30 billion, worldwide. This massive 'hobbyist fishery' provides countless jobs and livelihoods in wholesale and retail; and also in rural low-income coastal areas in the tropics that otherwise have limited resources and economic options.

Some aquarium trade farms operate to a highly regarded international standard (see, for example, *FAO Technical Guidelines for Responsible Fisheries*, Volumes 1–5) and are reliable and trusted suppliers of animals, aquatic plants and frozen fish food to hobbyists and public aquariums (in the latter case, for example, the 'water flea' *Daphnia* and 'mosquito' larvae, *Chironomus*). Clearly, the mainstay of any public aquarium is its collection of living aquatic organisms, and all responsible aquariums must be committed to sustainable means of acquisition, through reputable suppliers, accredited and certificated wherever possible. The food used to feed aquarium livestock must also be from sustainable, disease-free sources.

Public aquariums, the aquarium industry and sustainable practices

Public aquarium livestock acquisition operates largely in the context of a very large international hobbyist trade involving reptiles, amphibians, fishes, invertebrates and other taxa (see above). There are responsible trade associations such as the Ornamental Fish Industry (OFI, www.ornamentalfish.org) and the Marine Aquarium Council (MAC, www.aquariumcouncil.org) who set increasingly more demanding welfare and sustainability benchmarks in the acquisition, care, management and transportation of livestock (from source, through wholesalers to retail outlets). Domestic aquarium and vivarium hobbyists themselves are organised into federations and societies (some national, some international) and many of which specialise in thematic areas (tropical marine, tropical freshwater, African lakes, etc.); or specialise in closely circumscribed taxonomic groups such as seahorses, cyprinodont fishes, cichlid fishes, corals, crustaceans, aquatic plants and so forth. Indeed hobbyist associations and individual hobbyists (including amateurs specialising in reptiles, amphibians, molluscs, crustaceans and dragonflies) have contributed hugely to the creation and sharing of expert knowledge on, say, water-quality management, husbandry, life history, parasites, disease treatment and breeding. Such specialists and communities are increasingly concerned to support conservation, welfare and sustainability initiatives. Public aquariums have much to gain by fostering relationships with these groups, drawing on their expertise and engaging in partnership initiatives.

Artificially selected/genetically modified livestock versus conserving natural biodiversity

Fishes, invertebrates and plants in many public aquarium collections often originate from the ornamental trade. The majority of freshwater fishes in the trade are derived from captive breeding

or aquaculture, but this presents scientific, conservational and management problems for public aquariums. This is in terms of the lack of a breeding history, possible hybridisation, the modification of natural behaviours and the absence of a natural geographical provenance for the livestock. Artificial selection and genetic engineering in ornamental and scientific laboratory facilities to produce 'attractive' or 'useful' traits (actually sometimes 'monstrous' or 'transgenic' forms which would barely survive in the wild) poses further problems. Some transgenic aquarium fishes such as 'medakas' (*Oryzias latipes*) and zebrafish (*Danio rerio*) incorporate jellyfish genes that cause the fish to glow in the dark; and there is a real prospect of such genetically modified (GM) fishes being released to the wild with uncertain consequences. There is also the bigger issue of 'genetically improved' GIFT or G8 tilapia (*Oreochromis niloticus niloticus* – the so-called 'Frankenstein fishes') which are engineered to survive in a wide range of environments and which can often ecologically out-compete indigenous fishes leading to decline or the extirpation of populations (http://www.fao.org/docrep/009/a0113e/A0113E04.htm; http://www.idrc.ca/en/ev-67662-201-1-DO_TOPIC.html). There are overall concerns in terms of animal welfare and also the *ex situ* maintenance of representative natural aquatic biodiversity and natural genomes, with the longer-term prospect of re-introduction back to the wild where necessary and appropriate. The widespread aquacultural practice of die-injection to add 'day-glo' artificial colours to the fishes more subdued natural pattern is an associated welfare problem.

Coral reefs and the ornamental fish and invertebrate trade

Nearly all the tropical marine aquarium fish and invertebrates are taken on or around coral reefs, including sea anemones, shrimps, molluscs, sponges, crabs and decorative corals themselves (both hard and soft, but subject to regulations). Although about 25 tropical marine fish species are cultured on a commercial basis alongside a fair number of crustacean and coelenterate species, the vast majority are taken from the wild. This raises obvious conservation issues, and there has been a long-running debate about the positive and negative aspects of the marine ornamental trade. It stands to reason that the most conservation-friendly source of fish, crustaceans and coelenterates for public aquariums would be home-bred specimens, but in reality the situation is not so simple. For some species where breeding requirements are well known, there would appear to be little if any need to collect further individuals from the wild. However,

Lake Malawi cichlid fishes, Chester Zoo aquarium. © Steve Rawlins.

Clownfish, *Amphiprion ocellaris,* and anemone in symbiotic relationship. © Steve Rawlins.

while producing the specimens at home may, indeed, reduce direct collection pressure on the wild stocks, it may also remove any incentive or reason for indigenous people to conserve the wild stocks and their habitats at the local level. Coral reefs are, for example, increasingly being destroyed to form road building materials, reducing coastline protection. Respect for and utilisation of the traditional knowledge of indigenous fishing peoples – protecting their rights to a livelihood and the need for fair trade and benefit sharing – is an important part of contemporary conservation and sustainability initiatives and is also an obligation under the Convention of Biological Diversity (CBD, http://www.cbd.int/) which WAZA subscribes to.

Conservation and ecological restoration

For most marine species, our biological understanding is in its infancy regarding, for example, life histories, reproductive behaviour and the complicated nutritional and other ecological needs of, say, marine pelagic larvae. In the short to medium-term these conditions may never be economically and efficiently duplicated under aquarium conditions. However, in the longer term, for conservation and restoration purposes, it will be vital to scientifically understand and routinely replicate these processes *ex situ*. Corals in nature are subject to major and increasing threats to survival from bleaching, disease and acidification related to global warming. Coral propagation including sexual reproduction in aquariums (see www.secore.org) is now possible by way of rescue and in providing an 'insurance policy' should particular species be lost from the wild (EAZA Research Strategy, 2008). Indeed, several public aquariums are already active in reef restoration through coral gardening. Many other reef-associated species are highly fecund with broad distributions that lend themselves to allow sustainable take, as long as the coral survives and the related fishery is managed properly. In the end, there is a moral and practical obligation to enable people to benefit from the well-managed and sustainable use of marine, coastal and freshwater resources. Human development and poverty alleviation must necessarily become a part of a holistic and integrated conservation agenda for public aquariums.


Beluga and aquarium-bred calf, *Delphinapterus leucas*. © Shedd Aquarium, USA.

For freshwaters, the IUCN-SSC (via four of its specialist groups and 12 other organisational partners, including the European Union *Life* project and Aquazoo Düsseldorf) co-organised the first International Workshop on the Restoration of Fish Populations, 1–5 September, 2009, Düsseldorf Germany (publication pending, http://www.lanuv.nrw.de/alosa-alosa/int/tagung_2009/index.html). This workshop focused on the restoration of river, lake and estuarine habitats and the genetic management, re-introduction or supplementation of populations of indigenous fish species lost or in severe decline. These losses or declines are mainly due to gross pollution and large scale

habitat modification taking place in industrialised nations from the late 18th and early 19th centuries onwards. The importance of freely-flowing, well-connected, naturally dynamic systems was emphasised in relation to diadromous migratory taxa such as salmon, sturgeon, shad, eels and carp-like fishes (cyprinids) – see 'Diadrom' website http://diadrom.tripod.com/. In restoration, the importance of organisational partnerships is emphasised, covering both *in situ* and *ex situ* aspects, with substantial opportunities for fish hatcheries and public aquariums. For example the Aquazoo, Düsseldorf was the first to have an educational public display of IUCN Red-Listed living allis shad, *Alosa alosa*, and to provide a base and resources for the international Allis Shad-EU *Life* Project team (2007 onwards, http://www.lanuv.nrw.de/alosa-alosa/en/index.html). As a result, the first mass-production fish hatchery for this species has opened and some 2.25 million fry were stocked to the (pollution-reduced, spawning habitat improved) Rhine River in 2008 and 2009 (Beeck *et al.*, 2009). This creates the uplifting prospect that mature shad will once again thrive and breed in the Rhine and other European systems and become as economically important as they were 150 years ago.

In general, the fecund nature of many fish and invertebrate species means that, once their breeding biology is understood, *ex situ* production can, as necessary, be in the hundreds, thousands or even millions. This contrasts with the often more limited reproductive capabilities of terrestrial vertebrates.

In the case of the economically important and IUCN Red-Listed European eel, *Anguilla anguilla,* it is noted that an improved understanding of their migratory biology (Acou *et al.*, 2009 in press) has led to collaboration with authorities managing hydroelectric dams who would shut down their turbines at predicted peak periods of eel migration (some of which stocks had been raised *ex situ*). Hitherto, the passage of juvenile 'silver' eels downstream through 13 consecutive power plants to begin their life in the sea has been associated with 37–82% mortality. If disseminated and adopted, this fresh collaborative approach between conservationists, biologists and water engineers has a major global conservation potential for migratory fishes. The general principle is that some sort of worthwhile mitigation in favour of indigenous species in the wild is often possible, even in the face of apparently overwhelming industrial, agricultural, scientific and social challenges. Many public aquariums in Europe display the European eel and so there is also a key potential here for publicising this important initiative. Individual aquariums can support or adopt IUCN SSC volunteer Specialist Groups. For example, the North of England Zoological Society accommodates and supports the IUCN SSC / WI Freshwater Fish Specialist Group.

Action on destructive fisheries and improving welfare standards

Over the past decade, a growing awareness of destructive fishing practices has developed, and efforts have been made by WAZA and partners to address this issue. Funded programmes have been initiated to ensure better trade data collection and analysis. 'No-take' areas and protected reserves (marine and freshwater) are being established, often with aquarium support. Local fishers are being trained to hand-collect using nets rather than hazardous chemicals or explosives, and a trade in species with high mortality in transit or in aquariums is deliberately proscribed. Comprehensive programmes have been developed that certify that animals are collected using environmentally appropriate and welfare compliant methods and accord with the regulations of the Convention on International Trade in Endangered Species (CITES, see Appendix I).

Action has been taken by WAZA and its member associations over high profile welfare and conservation concerns, including over the inappropriate practice of acquiring wild dolphins through the process of a slaughter fishery. Today in at least one zoo association region there are sustainable programmes where 75% of dolphins are aquarium bred and no wild dolphin has been acquired in more than 15 years (Association of Zoos and Aquariums – AZA 2009 data). These inspected and accredited holding institutions have become leaders in marine mammal rescue, veterinary care, rehabilitation and release. Sadly, such hard-won skills came too late to save the now extinct Yangtze River dolphin, *Lipotes vexillifer,* but may well be applied to other comparable near-extinction crises in the future.

Model international aquatic conservation projects

Numerous good examples across a wide range of taxa are listed (Appendix VII). Project Seahorse is one excellent, positive example of an initially community-based conservation initiative in the Philippines that has spread internationally, and has strong public aquarium links. Seahorses are harvested globally for the ornamental, curio, and especially the traditional medicine trades. The numbers taken reach an unsustainable 20 million individuals per annum. Locally and regionally, the harvesting of specimens over the years has had serious impact, resulting in the listing of all seahorses under CITES Appendix II (see Appendix I), and the first internationally managed programme for a marine fish within the public aquarium community. Project Seahorse has been working with local communities in the Philippines and elsewhere to set up voluntary marine protected areas, and to bring the management of the harvest and low-technology aquaculture of seahorses for the ornamental and medicinal trades onto a sustainable footing. The public aquarium community (institutions, associations and taxon advisory groups) has strongly supported these efforts which are now having an appreciable, worthwhile impact in nature. These same aquariums have worked to establish best practices for their care in our collections and developed educationally effective interpretation for the public and other stakeholders.

Seahorse taxonomy training in Hong Kong market. © Amanda Vincent, Project Seahorse.

The establishment of an Amphibian Ark (AARK) by WAZA and the IUCN SSC Amphibian and Conservation Breeding Specialist Groups is another example of a worldwide zoo, aquarium, botanical garden, nature museum and other partners initiative to address an extinction crisis (see www.amphibianark.org). Responsible public aquariums within the WAZA community now play a crucial role in advancing conservation and sustainability initiatives. WAZA, itself, is active in international policy development and promotion for conservation and sustainability and was represented at the IUCN World Conservation Congress in Barcelona. Here, WAZA successfully co-sponsored the following motions of relevance to aquatic life: CGR4.MOTO21 – Stopping the amphibian crisis; CGR4.MOTO23 – The World Species Congress; CGR4.MOTO33 – An effective European Plan of Action for Sharks; CGR4.MOTO34 – Conserving migratory and oceanic sharks; CGR4.MOTO54 – Cross-Commission collaboration on sustainable use of biological resources.

Structure, content and purpose of 'Turning the Tide'

The nine chapters below follow the sequence and statements made in the original WZACS (2005) and also reflect much of the detailed Introduction above. The topics covered are: Integrating Conservation; Conservation of Wild Populations; Science and Research; Population Management; Education and Training; Communication, Marketing and Public Relations; Partnerships and Politics; Sustainability; Ethics and Animal Welfare. The world's aquarium community has provided overall responses to these statements per chapter, emphasising the close and vital relationship between conservation work conducted off-site (*ex situ*) with that implemented in the field (*in situ*).

There follow, per chapter section, action lists (by no means exhaustive) that could or should be adopted at different levels of generality ranging from individual public aquariums through to national and regional aquarium/zoo associations. In short, public aquariums, national and regional associations and partners should maximise the conservation and sustainability value of their activities, carefully taking into account the WZACS vision statements and recommendations and the aquarium community responses and action lists. In doing so they should develop their own customised, written aquarium action plans, incorporating 'SMART' objectives. This means setting targets that are Specific, Measurable, Achievable, Realistic and Time-bound.

In responding to the profound implications of *Turning the Tide: A Global Aquarium Strategy for Conservation and Sustainability*, WAZA members and partners will continue to find and improve ways to protect and support the aquatic environment and the wonderful creatures contained within.

The Strategy

Long-snouted seahorse, *Hippocampus guttulatus*. Taxonomic and conservation research on this species has been supported by a consortium of 14 public aquariums. © Tashin Ceylan 'Guylian Seahorses of the World' photo competition.

Chapter 1

Integrating Conservation

Vision

"The major goal of zoos and aquariums will be to integrate all aspects of their work with conservation activities. The fundamental elements of each organisation's culture will be the values of sustainability and conservation, and social and environmental responsibility. These values will permeate all areas of their work and will be understood and promoted by all those working within the WAZA network."

The World Zoo and Aquarium Conservation Strategy, 2005

Beach clean-up on the Great Lakes. Shedd Aquarium, USA.

Recommendation


Caribbean manatee, *Trichechus manatus*. © Nuremberg Zoo, Germany.

1.1 That the World Zoo and Aquarium Conservation Strategy (WZACS) calls on institutions to pursue a strategy of integrated conservation and strive to allocate all their financial and human resources carefully and intelligently, with maximum cohesive and strategic thinking within their own organisation, and maximum collaboration with others. This will achieve the greatest sustainable conservation benefit for threatened species, their habitats and their human neighbours.

Response

All public aquariums, national and regional associations and partners should maximise the conservation and sustainability value of their activities, carefully taking into account the WZACS vision statements (above and below) and the recommendations. In doing so they should develop their own customised, written aquarium action plans, incorporating 'SMART' objectives. This means setting targets that are Specific, Measurable, Achievable, Realistic and Time-bound.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- consider the use of flagship species to improve public awareness of aquatic conservation issues;
- emphasise the importance of 'green' sustainable resource use in commercial, recreational and subsistence fisheries and in all aquarium operations including education, retail and catering;
- develop and link exhibits to aquatic field conservation and sustainability projects through, for example, appropriate interpretation;
- emphasise the close relationship between aquatic and terrestrial habitats (and conservation actions for each of these), i.e. marine, brackish and freshwater conservation must be closely linked with terrestrial conservation to be fully effective;
- provide expertise and support for appropriate and relevant field programmes;
- integrate aquarium and field programmes, and materially support worthwhile global aquarium-related projects such as Project Seahorse, Amphibian Ark and the SECORE / Coral Zoo project;
- materially support the conservation work of other international voluntary aquatic conservation groups or agencies, such as the several taxonomic and thematic Specialist Groups of IUCN SSC;
- engage aquariums in relevant spheres of activity where there are 'biodiversity versus water resource' issues, as in the case of certain local, national and international programmes for environmental impact assessment, river basin or coastal zone management, pollution control, urban regeneration and sustainable seafood use;
- collaborate with local management agencies and local communities to monitor and conserve a local aquatic ecosystem;
- directly conserve the local aquatic environment, and develop a practical programme committing to at least one beach, river or pond clean-up each year, enlisting the help of volunteers and gaining media publicity for the positive results.

Chapter 2

Conservation of Wild Populations

Vision

"Zoos and aquariums will make further contributions to conservation in the wild by providing knowledge, skills and resources through initiatives in zoo breeding, translocations and re-introduction, wildlife health, research, training, education and by funding field activities. Zoos and aquariums will be an important force for worldwide conservation by their employment or support of field workers active in the conservation of wild animals and their habitat."

The World Zoo and Aquarium Conservation Strategy, 2005

Fishers and Project Seahorse biologists prepare to survey Handumon Marine Protected Area, Philippines. © Amanda Vincent, Project Seahorse.

Recommendations


Brian Zimmerman (Assistant Curator, Aquarium, ZSL) sampling for conservation purposes in the Amazon. © ZSL, UK.

2.1 The World Zoo and Aquarium Conservation Strategy (WZACS) calls on all zoos and aquariums to increase their work in support of conservation in the wild.

Response

All public aquariums, national and regional associations and partners should collaborate to play a meaningful role in field conservation efforts, adapting their strategic priorities, financial budget, human resources and stakeholder relationships to suit.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- liaise closely with and support the *in situ* conservation strategies and plans of other international organisations (such as CI, FFI, WI, and WWF) and conventions (such as CBD and RAMSAR), and engage directly with aquatic conservation groups or agencies and the several taxonomic and thematic Specialist Groups of IUCN SSC;
- adopt a policy of formally supporting at least one substantial *in situ* project through, for example, providing or developing expertise, training, interpretation, education, campaigns or fundraising;
- consider ways in which *ex situ* aquarium expertise can be appropriately and effectively applied to aquatic field conservation issues including species survival, e.g. by providing scientific research data or technical assistance in species' maintenance, documentation, transport, re-introduction or translocation, assisted reproduction, genetic resource banking and cryobiology; or by organising expeditionary fieldwork (subject to standard risk assessments).

2.2 The WZACS takes the view that zoos and aquariums, encouraged by WAZA and its regional and national associations, should focus their conservation proposals and actions within local, national, or regional Species Survival Plans (e.g. SSPs, EEPs) or Biodiversity Action Plans (BAPs); and/or similar species and habitat recovery programmes. In a situation where these have not been set up, or are not effective, their formation (or reformation) should be initiated, supported and strengthened.

Response

Aquariums and their associations understand that – while major conservation agencies (governmental and non-governmental) have made substantial progress – global, regional, national and local BAPs of various kinds (with *ex situ* and *in situ* components) are not generally well-developed and co-ordinated for 'higher' marine vertebrate taxa, marine fishes, freshwater fishes and aquatic invertebrates. It is proposed that partnership assistance in developing and co-ordinating such action plans should be offered by aquariums and their associations as appropriate, at a global, regional, national and local level.


Male Potosi pupfish, *Cyprinodon alvarezi*. This species is Extinct in the Wild. © Heiko Kaerst.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- demonstrate a responsible, environmentally conscious attitude to aquarium management such that it does not impact

on species survival in the wild, e.g. manage waste water disposal in such a way as to eliminate the accidental introduction of exotic (potentially invasive) species or pathogens to waterways external to the aquarium;


Re-introduction of the agile frog, *Rana dalmatina,* into the wild, Jersey. © Richard Gibson, Chester Zoo, UK.

- make appropriate liaisons in order to facilitate development and implementation of aquatic BAPs in their various forms and in appropriate contexts;
- engage national and regional aquarium/zoo Taxon Advisory Groups (TAGs) to help develop a co-ordinated strategy (Regional Collection Plan) for breeding endangered species, with specific recommendations on species, numbers, target population size and participating aquariums;
- refer to *Wildlife in a changing world: an analysis of the 2008 IUCN Red List of Threatened Species* (http://www.iucn.org/about/work/programmes/species/red_list/review/);
- engage with the various IUCN SSC Specialist Groups to help establish the Red List status of a target proportion of the 645 fish species currently listed as Data Deficient (IUCN Red List, 2009.1);
- review all fishes assessed as Threatened or Near-Threatened on the IUCN Red List (13 species EW, 289 species CR, 269 species EN, 717 species VU, 255 species NT [IUCN Red List, 2009.1]), to determine which would benefit from *ex situ* management;
- utilise the expert skills of the IUCN Conservation Breeding Specialist Group in the genetic management of small animal populations, in conservation planning (e.g. population and habitat viability analyses or PHVAs);
- consult with EAZA's EPMAG (European Population Management Group), which is developing a new initiative for fish populations;
- breed threatened or 'model' species in aquariums (but only when appropriate and in strict compliance with legal requirements, acquisition and welfare codes) to support the conservation of the species in the wild;
- play an active role in the recovery of species that are Extinct in the Wild by maintaining these as genetically and demographically viable populations in aquariums, and by actively engaging in national government approved re-introduction or translocation efforts;
- involve the local aquarium and the national or regional association in associated field projects that are worthwhile, officially endorsed and efficiently managed.

2.3 The WZACS emphasises that zoos and aquariums must not work independently in re-introduction or translocation programmes but must work with other institutions, and always with the appropriate government authorities, the relevant IUCN SSC Specialist Groups, and other governmental and non-governmental conservation agencies, particularly those in the host country, and with the relevant national or regional zoo and aquarium associations.

Response:

Aquariums fully recognise that re-introduction or translocation programmes must be conducted in accordance with IUCN and national government guidelines.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- follow guidance from the IUCN Re-introduction Specialist Group well in advance of any proposed re-introductions, translocations and releases;

- liaise closely with relevant government departments, NGOs and regional associations when conducting re-introduction programmes;
- consider Key Biodiversity Areas ('hotspots') and other recognised priority conservation areas, in conservation and re-introduction programmes;
- develop and regularly review an institutional policy for the disposal of surplus stock, with a presumption against release to the wild save in appropriate and fully authorised circumstances;
- plan and assess the suitability of at least one officially endorsed re-introduction project for conservation purposes per aquarium association.

2.4 The WZACS strongly recommends that, where possible, zoos and aquariums recruit, train and support conservation staff for work in the wild; the WZACS also applauds those zoos, aquariums and partner institutions that have set up training courses for conservation professionals, and encourages other institutions to consider setting up their own courses or offer assistance to those courses already operating.

Response

Aquariums and their associations should provide training or other support for their own staff and, where possible and appropriate, other conservation professionals.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- plan or provide support for at least one training course per aquarium association for resource management personnel in, for example, basic species identification, sampling techniques or other subjects relevant to conservation and sustainability;
- encourage management, scientific, curatorial and keeping staff to get involved in field conservation activities, so gaining 'on the job' experience which is of immediate practical benefit and which can, in turn, be communicated to other colleagues.

2.5 The WZACS calls on national and regional associations and all zoos and aquariums, however small or large, to be actively involved in raising funds for field conservation.

Response

Aquariums should actively raise funds for field conservation and apply these funds to their own worthwhile, high priority programmes and targeted projects, or apply them to equally valuable projects operated by partners.

Ragged-tooth shark, *Carcharias taurus*, prepared for release, Two Oceans Aquarium, South Africa. © G. Spiby.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- adopt and sponsor at least one aquatic field conservation or sustainability project and actively raise funds for that particular project;
- liaise closely with other conservation organisations (at a national, regional or global level, as appropriate) in order to have a balanced representation of aquatic field conservation and sustainability projects across priority areas;
- consider developing fundraising and awareness-raising campaigns in partnership or in liaison with others;
- consider adopting, hosting and funding an aquatic specialist group of the IUCN SSC.

2.6 The WZACS suggests that zoos and aquariums enhance their sites with a view to providing habitats for threatened native species.

Response

Aquariums recognise that the development of their own site of operation should take into account naturally-occurring indigenous species and that they should manage the external, natural aquatic or wetland environment in a sensitive, responsible and sustainable way. This may involve the creation of habitats to be colonised by indigenous species of aquatic or amphibious animal and plants (submerged and emergent). Where possible and appropriate, natural habitats should be accessible to and demonstrated for the public; or, alternatively, interpreted for the public in an aquarium exhibit, including species native to the region.

Action

For public aquariums and partners to:

- ensure that the habitats of native aquatic and coastal species are routinely protected and that land development is integrated into the site and landscape planning policies for the aquarium;
- liaise with local conservation organisations for good representation and inclusion of Key Biodiversity Areas and other priority conservation regions in the aquarium's site and landscape use planning policy.

Second National Training Course on Freshwater Fish Identification and Conservation, Philippines. This was supported by Chester Zoo / FFSG. © Claudine Gibson Chester Zoo, UK.

2.7 The WZACS recommends that regional and national zoo associations devote time and money to devising and implementing methods of assessment of the conservation contributions being made by their members.

Response

Aquariums recognise that assessing the impact of conservation programmes is critical to the advancement of long-term conservation outcomes.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- utilise and contribute to international conservation databases such as ISIS-ZIMS, held electronically and operated by institutions and the regional associations (e.g. AZA, EAZA);
- encourage collation and pooling of institutional data and routinely assess and benchmark the relative and collective contributions made to conservation and sustainability both practically and financially;
- disseminate data so derived to responsible conservation organisations and authorities, so as to make the best use of synergies and opportunities for collaboration;
- develop tools to assess the impact respective institutions make on the visiting public and the extent to which positive lifestyle and behavioural changes are brought about.

Chapter 3

Science and Research

Vision

"Zoos and aquariums are fully and actively integrated into the research community and into public consciousness and understanding of science as serious, respected scientific institutions that make significant contributions and sound scientific decisions for wildlife worldwide."

The World Zoo and Aquarium Conservation Strategy, 2005

Researchers tagging a yellowfin tuna. Monterey Bay Aquarium, USA and Stanford University, USA. © Scott Taylor.

Recommendations

3.1 The World Zoo and Aquarium Conservation Strategy (WZACS) urges all associations, regional and national, to continue to record and collate the research that their members undertake, to make that information accessible, and to monitor the emergence of new areas of science for their potential application to conservation.

Response

Aquariums should conduct or support relevant research, make it accessible to the aquarium and wider community through, say, web links, publication and other means of dissemination; and they should register research projects and reports with regional associations.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- promote the establishment of research project registers at a regional level;
- utilise the International Aquarium Forum, International Aquarium Congress and the WAZA and other existing networks (WON, WOP, IAF) to link and co-ordinate research projects;
- incorporate research sessions and technical papers into regional aquarium conference programmes;
- promote links with local universities and other training institutions;
- routinely produce and distribute scientific reports; and wherever possible publish research results in peer-reviewed publications;
- swiftly and effectively record and communicate relevant (perhaps critical) information on general biology, husbandry, diseases, health care and breeding for Threatened (IUCN Red List) or 'model' species managed *ex situ* by the aquarium community. This should be done, for example, through utilising the International Species Information System (ISIS) and through electronic websites, published articles and guidelines;
- consider becoming engaged in expeditionary research, possibly in partnership with other organisations (subject to the necessary risk assessments and safety precautions).

3.2 The WZACS recommends that, for zoo and aquarium-directed research, institutions both individually and collectively identify, prioritise and pursue their own research needs.

Response

Individual aquariums have great capacity for relevant *ex situ* research because they can comfortably hold statistically significant numbers of many species of animals and plants in ecological or community conditions broadly similar to the wild and which can, where appropriate, be experimentally controlled. They also have a growing capacity to develop *in situ* aquatic research projects at home and abroad in partnership with other organisations. Research education and training can be delivered through aquarium education programmes and student projects. Aquarium/zoo associations need to further develop their already demonstrated capacity to promote and co-ordinate funded research initiatives, especially in partnership with other organisations. In particular, the European Association of Zoos and Aquariums has, in direct response to the WZACS (WAZA, 2005), published *Developing the Research Potential of Zoos and Aquariums: The EAZA Research Strategy* (EAZA, 2008). This detailed strategy document contains a generalised Research Action Plan which could easily be customised in various contexts for specific aquatic research identification and prioritisation purposes (http://www.eaza.net/).

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- prepare an institutional or regional research strategy drawing on published aquarium and zoo sources and referring in particular to *Developing the Research Potential of Zoos and Aquariums: The EAZA Research Strategy* (EAZA, 2008);
- identify research priorities, including through the WAZA network, and communicate these to the members;
- monitor research outputs through the WAZA network to ensure that priority issues are addressed;
- develop institutional research capacity and programmes that will address priority issues.

3.3 The WZACS calls upon the international zoo and aquarium community to promote the establishment and widespread use of databases and resource banks to assist zoo conservation efforts. In particular, it calls upon the WAZA network and the International Species Information System (ISIS) to ensure that, in its final form, the Zoological Information Management System (ZIMS) is valuable, accessible and affordable for all WAZA members and for members of WAZA regional and national associations. Furthermore, it calls on all regional associations to promote universal participation in ISIS' ZIMS project.

Response

Aquariums endorse the use of ZIMS as a comprehensive, internationally standardised record keeping system, with components customised for aquarium use and the convenient management of comparatively large numbers of individuals in single populations.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- promote, support, join ISIS and subscribe to ZIMS as soon as possible.

3.4 The WZACS urges all zoos and aquariums to review their resources and contribute to the greatest extent and in as many ways as possible to research initiatives, especially those directed towards conservation. In addition, they should work both independently and co-operatively to obtain external research funding. To assist this effort, WAZA and regional associations should maintain information on available funding sources and the conditions for access.

Response

Aquariums should support both *in situ* and *ex situ* research programmes that are in the best interests of conservation.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- use aquarium collections to develop techniques for particularly useful application in *in situ* species conservation programmes, e.g. tracking, and benign fin clipping methods (ensuring ethical, welfare and legal compliance);
- consider developing/supporting at least one *in situ* and one *ex situ* research project per aquarium. This should be co-ordinated with on-going work of conservation organisations or academic / research institutions to minimise any prospect of unnecessary duplication of effort or a conflicted, unproductive situation – and to maximise the opportunities of levering additional funds through joint applications and pooled contributions.

3.5 The WZACS encourages zoos and aquariums and associated research organisations to analyse and publish their research results in peer-reviewed scientific journals, and to promote their results through the compilation and circulation of bibliographies and through short reports and reviews in relevant journals, newsletters and websites.

Response

Aquariums should encourage structured and relevant research, and make the products thereof available to the aquarium community and beyond.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- publish the products of formal academic research in peer-reviewed journals;
- at least publish valuable information on aquarium husbandry, management and breeding in the 'grey' literature and popular magazines;
- publish articles by aquarium veterinary and aquarist staff on, for example, the breeding of rare species or the treatment of aquatic diseases in appropriate specialist journals, newsletters or websites;


Threatened aquarium-bred red-lined torpedo barb, *Puntius denisonii*. © Colin Grist, Chester Zoo, UK.

- support field conservation projects which have veterinary requirements by encouraging and supporting veterinary staff to participate in them;
- collect basic life history data and longevity data on all species that are relevant to co-ordinated programmes both *ex situ* and *in situ*;
- submit an annual census of species held/activities to international databases, e.g. ZIMS, FishBase, Census of Marine Life;
- publish and publicise both successes and failures in conservation interventions in order to promote learning among the conservation community.

3.6 **The WZACS calls for regular discipline-related reviews of zoo research to be undertaken at institutional, regional and/or global level. These reviews should assess and document progress with their identified research priorities and evaluate and redirect those priorities as needed.**

Response

Aquariums are strongly placed to lead the process and set research priorities for the global aquarium community.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- create an institutional research policy as soon as possible;
- develop an institutional audit process that will assess research conducted in the context of the prevailing institutional research policy; establish regional systems of research appraisal and review.

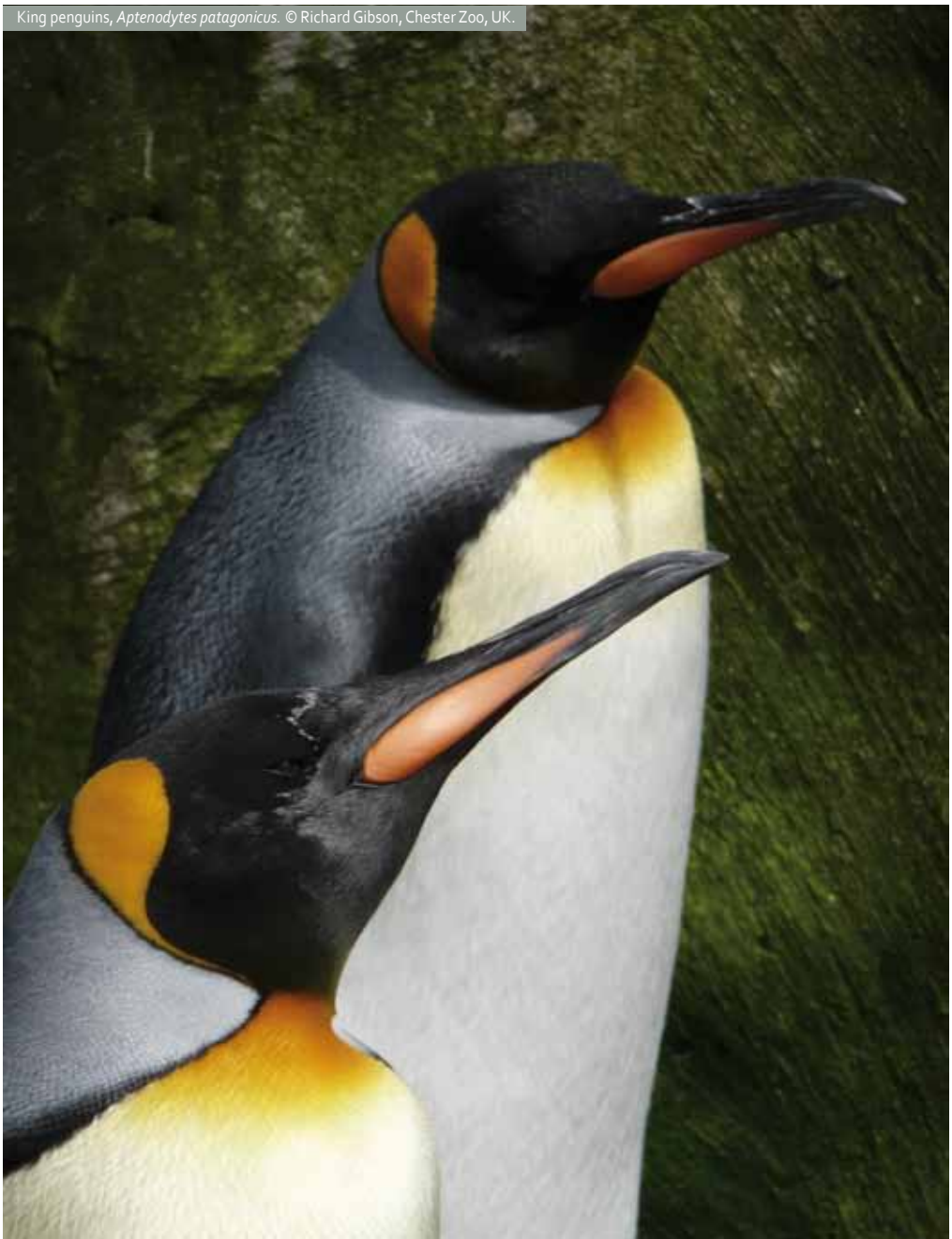
Chapter 4

Population Management

Vision

"All zoos and aquariums will be primary centres of expertise in small animal population management and will be involved in global or regional co-operative breeding programmes. All such programmes will be based on sound knowledge using the latest available data on population management, reproductive biology, genetics, behaviour, physiology, nutrition, veterinary care and husbandry."

The World Zoo and Aquarium Conservation Strategy, 2005



King penguins, *Aptenodytes patagonicus.* © Richard Gibson, Chester Zoo, UK.

Recommendations

4.1 The World Zoo and Aquarium Conservation Strategy (WZACS) recommends that all breeding programmes for threatened species in zoos and aquariums be managed as global or regional co-operative programmes with participating zoos and aquariums sharing a set of specific programme objectives. Regional programmes should link together to address global conservation strategies. Global or regional studbooks or equivalent databases need to be maintained for these species. Where resources allow, breeding programmes for non-threatened species should also be monitored and managed.

Response

Aquariums recognise the value of managed breeding programmes and need to see these developed to the high level of achievement often seen in terrestrial zoos.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- encourage all public aquariums to be members of WAZA and/or a regional/national zoo and aquarium association;
- ensure that all aquariums holding 'programme animals' participate in existing regional or global programmes and work within regional and international studbook agreements;
- ensure that local, national, regional or global appraisals of threatened species are carried out where appropriate and conservation breeding programmes implemented;
- consider the opportunities to support aquatic plant as well as animal conservation programmes utilising the latest advances in hydroponics.

4.2 The WZACS recommends that all breeding programmes in which zoos or aquariums are involved should be quantitatively and objectively evaluated in terms of their objectives, status and viability.

Response

Aquariums agree that regular critical review of all breeding programmes is required and that progressively higher benchmarks should be established for this.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- ensure regional/national associations and special interest groups conduct regular, critical reviews of all breeding programmes and relate this to the demographic situation in the wild, engaging in 'meta-population' management where possible and appropriate;
- encourage regional associations to work towards global species management plans and the implementation of international studbooks, where appropriate;
- consider the opportunities of developing/supporting breeding projects on site, in the habitat countries, close to the site of the conservation problem.

4.3 The WZACS strongly recommends that all breeding programmes should be based on sound science and management using the latest available knowledge on population management, reproductive biology, genetics, animal behaviour, nutrition, veterinary care and husbandry standards.

Response

Aquariums agree that expertise from all sectors should be incorporated into breeding programmes to ensure optimum performance. Valuable work can also be conducted with non-threatened species. The propagation of colonial organisms such as rare sponges, corals and jellyfish require special consideration.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- encourage, where relevant and possible, partnership contributions to breeding programmes from scientific institutions, the private aquarium trade (e.g. OFI), aquaculture industry, individual aquarium hobbyists and other appropriate specialists;
- ensure the vetting, quality-control, production and appropriate dissemination of relevant husbandry manuals, studbooks and species/population management protocols;
- share knowledge of published reports, articles and peer-reviewed papers;
- subject to a Safety, Health and Environment (SHE) risk assessment, make tissue material available to research institutions (e.g. museums, universities, cryobanks). This is for, say, the genetic analysis of populations, species and higher-level taxa and their phylogeography (with the presumption that results of these studies are made publicly available via publication in, say, GENBANK);
- contribute to frozen tissue (bio-cryo/genome resource) banks whenever possible, including those operated by the Frozen Ark consortium (www.frozenark.org) and the Amphibian Ark (www.amphibianark.org).

4.4 The WZACS reminds all zoos and aquariums and local, regional and national authorities that they would find it useful to consult the 'WAZA Guidelines on the acceptance of seized or confiscated animals' before accepting confiscated animals.

Response

Aquariums agree to act in an ethical way and in the best interests of conservation to follow the 'WAZA Guidelines on the acceptance of seized or confiscated animals' when contemplating the acceptance of confiscated animals.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- ensure that the 'WAZA Guidelines on the acceptance of seized or confiscated animals' is received and accepted by regional associations and disseminated to their respective member institutions;
- encourage all aquariums to develop relationships with local conservation agencies, customs authorities and other regulatory bodies (e.g. TRAFFIC), to provide said authorities with the guidelines and maintain contact;
- ensure that any proposed acquisition does not contravene the CITES regulations or other relevant conservation or legal codes.

4.5 The WZACS urges all zoos and aquariums to continue to support the scientific development of population management, particularly for taxa held in group situations (e.g. fish, invertebrates and micro-organisms), or species facing specific challenges, such as disease.

Response

Aquariums agree to support the ongoing development of practical, yet sophisticated population management software that is readily accessible and suitable for application in the aquarium situation. They are aware of particular challenges in managing and documenting the successive generations of populations of aquatic species, often containing comparatively large numbers of individuals or which may exist as colonies or colonial organisms, e.g. certain anemones, corals jellyfish, sponges and bryozoans.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- encourage all public aquariums to join and actively support and subscribe to the internationally standardised Zoological Information Management Software system (ISIS-ZIMS) (see below).
- support and contribute to the EAZA/EPMAG management initiative for fishes.

4.6 The WZACS reminds all zoos and aquariums that they are expected to maintain critical animal records on their collections and contribute these data to the ISIS database and studbooks in a timely and comprehensive manner. The WAZA and regional associations must continue to explore economically viable methods for institutions in developing countries to participate fully in this process.

Response

Aquariums acknowledge the value and importance of maintaining accurate databases and of making regular submissions to accepted and recognised studbooks.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- join, support and actively participate in the ZIMS project as soon as possible;
- assist aquariums in developing countries to participate in ZIMS through financial support and/or training programmes.

4.7 The WZACS calls on all zoos and aquariums to link their collection planning with regionally or globally identified conservation priorities working in collaboration with IUCN SSC's thematic and taxonomic Specialist Groups.

Response

Aquariums understand that liaison with regional associations and conservation organisations will allow for collection planning in the context of identified conservation priorities.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- ensure that regional associations have identified key conservation priorities in collaboration with recognised conservation authorities;
- ensure that these key conservation priorities are communicated effectively to the respective membership bases and action groups;
- encourage all aquariums to develop their collections in the context of these identified conservation priorities;

Spotted pond turtle, *Geoclemys hamiltonii*. Despite being scheduled on CITES Appendix I, this attractive turtle, native to India, Nepal, Pakistan and Bangladesh has been widely exploited. It is now listed as Vulnerable on the IUCN Red List of Threatened Species. © Richard Gibson, Chester Zoo, UK.

- monitor how collections respond to conservation priorities and work to address them;
- supply collection and programme data to external conservation organisations for inclusion, where appropriate, in global databases such as the IUCN Red List, ZSL-EDGE database, Alliance for Zero Extinction Biodiversity Hotspot Index, WWF Living Planet Index/Report, the TRAFFIC database and the World Biodiversity database.

4.8 The WZACS calls upon legislators and enforcers to make sure that the processes of implementation involved in the transfer of animals and genetic materials between zoos and between aquariums are completed as speedily as possible.

Response

Aquariums recognise the need for the rapid and sensible application of legislation and protocol in the transfer of animals and genetic material between aquariums. This is for the central purposes of maintaining and improving welfare standards in transit and maximising conservation benefits both *in situ* and *ex situ*.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- abide by existing statutory regulations and internationally accepted transfer protocols such as the Balai directive, CITES and IATA regulations;
- participate in working groups and liaison forums with relevant authorities in developing improved transfer protocols and legislation;
- engage relevant authorities to improve and upgrade transfer protocols and associated legislation where appropriate;
- for transfer of frozen materials, liaise with genome resource banking agencies such as the Frozen Ark and Amphibian Ark Biobanking Advisory Committee;
- build credibility with appropriate authorities by conducting animal and genetic transfers with integrity, honesty and transparency.

Chapter 5

Education and Training

Vision

"Zoos and aquariums with their unique resources of live animals, their expertise, and their links to field conservation will be recognised as leaders and mentors in formal and informal education for conservation. The educational role of zoos and aquariums will be socially, environmentally and culturally relevant, and by influencing people's behaviour and values, education will be seen as an important conservation activity. Zoos and aquariums will expand the training of their own staff and of others engaged in in situ *and* ex situ *work."*

The World Zoo and Aquarium Conservation Strategy, 2005

Touch pool, Shedd Aquarium, USA.

Recommendations


High school lake ecology class, Shedd Aquarium, USA.

5.1 The World Zoo and Aquarium Conservation Strategy (WZACS) urges all zoos and aquariums to ensure that education is a central part of their reason for being and to provide adequate support and resources to enable this role to be fulfilled.

Response

All aquariums should have an active education department or dedicated member of staff (teacher/presenter) to provide effective education to groups of learners and informal interpretation to the visiting public.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- employ at least one trained and qualified education staff member, with a view to establishing an education (discovery and learning) department;
- provide adequate funds for the proper operation of an education service;
- provide a variety of learning experiences for visitors of all ages including basic signage, interactive interpretation and advanced electronic communication systems;
- consider the advantages of co-operative sharing of interpretation between institutions/associations (e.g. signage, audio-visual material, general literature) to minimise expense and maximise benefits;
- consider developing a public enquiry response network in collaboration with other aquariums or other institutions including nature museums, wildlife parks and other organisations;
- link with national and international programmes for training, capacity building and educational outreach e.g. those of UNEP, IUCN and WWF.

5.2 The WZACS recommends that all zoo and aquarium associations, regional and national, should develop an education policy. This should provide a co-ordinated approach to education, both formal and informal, and should provide leadership in the formulation of principles, strategies and minimum education standards.

Response

All aquarium/zoo associations and individual institutions should have a cohesive and co-ordinated education policy and action plan. The International Zoo Educators are available to advise on and support such developments.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- develop education policies under the auspices of regional aquarium/zoo associations;
- communicate the education policies to the respective membership bases and to institutional staff;
- work with the International Zoo Educators and the WAZA Education Committee and regional education committees develop to share the workload and maximise benefits;
- liaise with other external conservation organisations which have educational divisions or departments (e.g. UNEP, IUCN and WWF);
- consider the opportunities for educational outreach in the habitat countries and for educational exchanges;
- note the critical overlap between education, public relations and the media.

5.3 The WZACS recommends that individual zoos and aquariums should develop or adapt their own education policies in line with those of their association and their own needs.

Response

All aquariums should have an institutional education policy that will complement global, regional and national strategies and policies.

Action

For public aquariums and partners to:

- endorse the delivery of education as one of the core values of the aquarium;
- join relevant local groups and national/regional associations and actively participate in their education meetings;
- develop an institutional education policy (what is to be achieved) and strategy (how to achieve it) as soon as possible;
- develop an institutional education policy to be ratified by the aquarium's senior management team;
- communicate the education policies and strategy to institutional staff and wider stakeholders.

5.4 The WZACS recommends that education policy statements, strategies and standards should be readily available and should be reviewed and updated regularly.

Response

Liaison with relevant associations is important to keep abreast of change and to keep strategies updated.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- develop a benchmarked, prioritised system that will allow regular review of education policy in the context of changing regional and international norms and trends;
- consider the advantages of linking up with a university education department or local college of education to obtain an independent assessment of policies and programmes;
- if considering education and training programmes for research, refer to *Developing the Research Potential of Zoos and Aquariums: The EAZA Research Strategy* (EAZA 2008).

Exploris school group © Shark Trust, UK.

Lionfish, *Pterois miles*. This beautiful species is a good model for education programmes about venomous marine creatures and bio-prospecting in the sea. © Camilla Floros.

5.5 The WZACS recommends that zoos and aquariums enhance the effectiveness of conservation education by working closely with other education institutions and organisations, governmental departments and ministries, and by being involved in formal education curriculum activities, and formal educational programmes designed for all ages and abilities.

Zoo-supported education programme launch for coral island restoration project, Mauritius. © Maggie Esson, Chester Zoo, UK.

Response

All aquariums should contribute to formal education by establishing links with relevant government departments, conservation organisations and other environmental education institutions. They should also conduct research into the effectiveness of education programmes focused on the aquatic environment.

Action

For public aquariums and partners to:

- become active members of an appropriate national and regional zoo and aquarium association and promote the aquatic context;
- promote the formation of and participation in Education Specialist Groups within these associations;
- join the International Zoo Educators Association (IZE);
- link with the relevant government education department in the preparation of aquarium education or educational research programmes, based on their education curriculum requirements;
- partner with local schools in the community and provide aquatic environmental education lessons and resource materials;
- develop life-long learning programmes in aquatic topics for adults and senior citizens;
- provide curriculum-based training in aquarium related topics for local teachers;
- link with regional and international education programmes and activities.

5.6 The WZACS recommends that zoos and aquariums should endeavour to develop structured training programmes available to all staff and volunteers.

Response

Training programmes for aquarium personnel are crucial to ensure that a sensible, relevant and appropriate conservation and sustainability message is conveyed to the visiting public and that institutions project an air of professionalism.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- develop a system of ongoing professional development at all levels;
- promote an understanding by personnel of *in situ* and *ex situ* conservation programmes;
- consider providing training courses for people actively engaged in aquatic conservation programmes, perhaps in partnership with others;
- consider providing, say, aquatic animal identification, biology or aquatic ecology courses for interested members of the public;
- consider providing aquatic conservation courses (including welfare-related fish tagging and handling) to interested anglers, where possible;
- gain commitment from at least one aquarium from each regional aquarium association to offer husbandry training to support field conservation efforts;
- gain commitment from at least one aquarium from each regional aquarium association to offer training in identification and handling of CITES listed species for CITES managers;
- liaise with regional aquarium accreditation and licensing authorities when developing written standards;
- consider supporting an IUCN Red List training exercise for assessing the conservation status of aquatic taxa.

5.7 The WZACS strongly encourages all zoos and aquariums to use objective and tested methods of evaluating the effectiveness of their conservation education and training programmes.

Response

All aquariums should regularly evaluate their education and training programmes.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- develop a mechanism by which the content and implementation of formal education to groups of learners, informal interpretation to the visiting public, and staff training programmes can be assessed;
- liaise with regional aquarium accreditation and licensing authorities when developing written standards in these and other aspects.

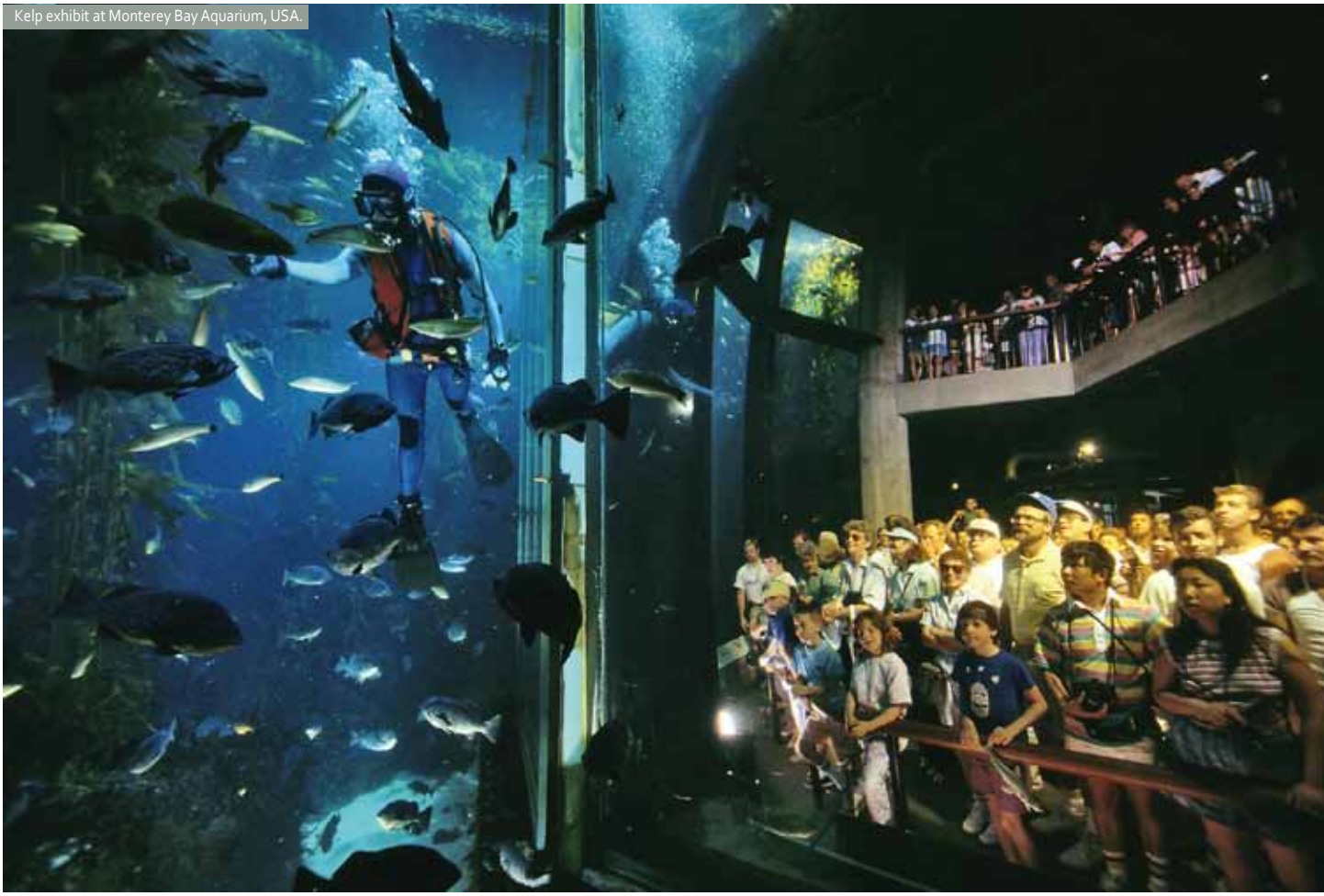
Chapter 6

Communication, Marketing and Public Relations

Vision

"Zoos and aquariums and their national and regional associations will become highly effective in communicating conservation issues and their role in conservation. They will become better recognised as one of the major and most trusted voices speaking on behalf of wildlife and wild places."

The World Zoo and Aquarium Conservation Strategy, 2005



Kelp exhibit at Monterey Bay Aquarium, USA.

Recommendation

6.1 The World Zoo and Aquarium Conservation Strategy (WZACS) strongly recommends that all zoo and aquarium associations, and all zoos and aquariums, however small or large, design and implement a communication strategy. This should include the following basic steps: define the overall communication goals; identify the target audiences; decide key messages; choose tactics and methods; identify resources available and needed; and develop monitoring and evaluation techniques.

Response

Aquariums agree that a strong, clear and cohesive communication strategy is required within the zoo and aquarium industry. Aquariums need to be in tune with the interests and concerns of the wider stakeholder community, notably in the areas of animal welfare, conservation and sustainability. Furthermore, aquariums understand that the aquarium contribution to the global conservation effort requires participation from and the inclusion of all regions of the world.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- request that each regional association develops an appropriate regional communication strategy;
- ensure that the WAZA Marketing and Public Relations Committee collate these regional strategies and develop a global WAZA communication strategy;
- encourage all aquariums to develop a strong, consistent Public Relations and Marketing plan that links well with relevant national and regional communication strategies and WAZA philosophies;
- establish a platform for communicating the importance of zoos and aquariums in conservation through media, educational material and public relations directed at guests, local media, government officials and other NGOs;
- provide staff with media training within individual aquariums and identify charismatic experts and celebrity spokespersons at a regional and national level to carry key messages;
- engage constructively with mainstream animal welfare groups such as the International Fund for Animal Welfare (www.IFAW.org) and the World Society for the Protection of Animals (www.wspa.org/uk) to progress animal welfare communications and practice and develop programmes for continuous improvement;
- recognise the public relations risks posed by extremist animal rights groups and their campaigns, and organise an honest, effective, pro-active programme with zoo and aquarium staff, media and other stakeholders;
- establish a system to openly consult with visitors and the general public, to receive constructive feedback and, where appropriate, act upon it;
- develop a means of identifying and explaining aquatic animal-associated conservation and sustainability issues such as shark finning, over-fishing, destructive fishing methods, drive fisheries, certification of catches, sustainable harvesting and the like, and effectively communicate these to the public and policy makers;
- liaise with other conservation and aquarium trade bodies and act to pool useful data (e.g. Marine Stewardship Council, Marine Aquarium Council);
- communicate conservation and sustainability messages through the aquariums retail and catering services, e.g. fair trade sustainable marine products and the supply of cooked fish and shellfish from a list of non-threatened species;
- develop creative opportunities to disseminate information about successful scientific, research and conservation programmes, both *in situ* and *ex situ*;
- actively engage and help to develop regional zoo-aquarium associations in areas where none exist and bring these under the WAZA umbrella;
- develop a network of media representatives (press, radio, television) through the establishment of personal relationships with individual representatives of these media, and effectively utilise such networks to promote the activities of aquariums;
- use each aquarium's unique institutional profile to influence public opinion and voting habits for conservation outcomes consistent with the WZACS;
- liaise with other conservation organisations to develop timely and appropriate messages, or to join in their campaigns;
- stress the value of species and aquatic ecosystems for people (the 'ecosystem services' approach) and, from this, engender a greater interest in conservation. And a better understanding of the need to support conservation both *in situ* and *ex situ*.

Chapter 7

Partnerships and Politics

Vision

"Through increased co-operation and judicious encouragement, zoos and aquariums will continue to raise standards of animal management, educate the public to act on behalf of conservation issues, and assist in field projects. Partnerships will strengthen global co-operation and help all zoos, aquariums and other conservation organisations to improve and to achieve their conservation goals. Zoos and aquariums will be encouraged to help one another, particularly those that have fewer resources and/or expertise."

The World Zoo and Aquarium Conservation Strategy, 2005

Pacific white-sided dolphin, *Lagenorhynchus obliquidens*, Shedd Aquarium, USA.

Recommendations

7.1 The World Zoo and Aquarium Conservation Strategy (WZACS) strongly recommends that zoo and aquarium partnerships and networks will be established or strengthened at local, national, regional and international levels.

Response

All aquariums should promote and actively participate in relevant partnerships and networks.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- draw up 'stakeholder maps' at local, national and regional level;
- develop an institutional policy actively supporting the relevant aquarium networks;
- support the World Association of Zoos and Aquariums (WAZA) through regular attendance of meetings, workshops and conferences, and the support of programmes;
- make available sufficient institutional resources to allow for the meaningful participation in WAZA meetings and programmes;
- further develop and support the working relationship with the European Union of Aquarium Curators (EUAC), the International Aquarium Congress (IAC) and the International Aquarium Forum (IAF);
- encourage and support the development of aquarium enterprises in regions where they are not widespread or generally well developed, including Africa, the Middle East and India and their participation in regional zoo-aquarium associations;
- encourage aquariums that are so far non-affiliated to become affiliated at a national, regional and global level (see 7.3, below).

7.2 The WZACS reminds all zoos and aquariums that they must comply with the legislation and policy that affects conservation and animal welfare.

Response

Responsible public aquariums agree that compliance with existing conservation, environmental, health and safety and animal welfare legislation at national and international levels is a key component of good aquarium practice. It is also a sound basis for accreditation by governments and professional bodies.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- establish a framework, policy and action plan to ensure statutory compliance and advisory best practice;
- comply with existing legislation and policy and communicate the appropriate and necessary standards to staff and the visiting public;
- establish an internal institutional Ethics and Welfare Committee and an independent ethical review process to routinely verify compliance with existing legislation and to review the operational practices from an ethical and welfare perspective;
- as necessary, refer the ethics and welfare committees of WAZA and of the regional associations;
- develop and institute a national and regional accreditation or other peer review process where such does not already exist.

7.3 The WZACS maintains that all zoos and aquariums should be or should strive to be members of a regional and/or national zoo association.

Response

All aquariums should be, or work to become, members of the World Association of Zoos and Aquariums (WAZA) and the appropriate regional and/or national zoo-aquarium association.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- actively encourage WAZA membership and ensure that all major public aquariums are members of WAZA;
- actively encourage membership of a regional association and ensure that all major public aquariums are members of a regional association;
- actively encourage membership of a national association and ensure that all major public aquariums are members of a national association, where such exists.

7.4 **The WZACS recommends that regional and national associations should make every effort to produce and present a conservation conscience appropriate to their culture within their member institutions, and to bring the activities of all their members into a common ethical and technical framework.**

Response

Aquariums should develop and promote a conservation and welfare ethos or 'conscience' at a regional and institutional level and work in partnership to harmonise regional differences; and to develop conservation and welfare ethics and technical standards that are truly international and continuously improving.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- encourage regional and national aquarium associations to promote a conservation ethos within their respective membership bases and ensure that programmes and projects undertaken by these associations are developed and carried out in this context;
- introduce or develop an institutional aquarium culture of corporate responsibility and charitable giving;
- assist well-intentioned but under-resourced institutions to help them to achieve their potential within the world conservation community through training, technology transfer, staff exchanges, mentoring and exchange of knowledge;
- link and interact with the Specialist Groups of the Species Survival Commission (SSC) of the IUCN, including the Conservation Breeding Specialist group (CBSG) and Re-introduction Specialist Group (RSG) and those specifically concerned with conserving aquatic taxa;
- lead or participate in appropriate conservation campaigns, including partnering with other conservation organisations (and credible animal welfare organisations for, conservation-associated, animal welfare campaigns);
- form a 'sister' or 'twinning' partnership with an institution in a developing nation or region;
- develop co-operative inter-aquarium research projects in conservation, biological, veterinary or social sciences;
- develop a 'Friends of the Aquarium' or other active volunteer association to support conservation activities such as canal and beach 'clean-ups' and to generate funds;
- link with schools for education in caring for the aquatic environment;
- liaise and co-operate with the ornamental fish industry , where appropriate, to improve the sustainability and ethics of the trade;
- collaborate with zoological societies, museums, universities and research institutions to promote conservation and environmental ethics by organising or hosting conferences and seminars, presenting lectures, producing educational displays and developing interpretive and promotional material for sharing;.
- liaise with cultural institutions including museums and libraries to promote an aquatic 'nature link' involving, for example, public art, creative and factual writing, public readings, poetry competitions and similar activities;
- consider engaging painters, sculptors, ceramicists and other visual artists, through an 'artist in residence' programme, to promote the conservation message;
- evaluate educational and conservation campaigns and their impact on modifying or improving human ethics, attitudes and behaviours towards the aquatic environment;

- when progressing conservation outreach projects targeting species or habitats, consider addressing associated issues in human development and poverty alleviation, probably best done in partnership with other development organisations.

7.5 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.

Response

Aquariums agree that communicating with local and national government, and lobbying where appropriate, is essential in developing appropriate legislation to continuously improve general standards of operation and, in particular, promote the conservation activities of public aquariums.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- ensure national/regional associations are aware of and engaged in legislation that is relevant to the operation of aquariums;
- establish each aquarium as a centre of expertise and encourage consultation by legislative bodies in all matters relating to the keeping of wild aquatic animals in human care;
- inform, encourage and collaborate with government agencies and legislators in formulating or modifying legislation, policy and edicts concerning biodiversity conservation, migratory species, alien invasive species, harvesting of natural resources, the control of aquatic pollution and other environmental issues;
- communicate with specific government departments, ministries and wildlife agencies to promote the activities and raise the standards of public aquariums (e.g. those concerned with aquatic environments, fisheries, forestry, agriculture, veterinary health and tourism) – also highlight the large economic and corresponding social benefits of public aquariums;
- engage in any forum that officially deals with the application and enforcement of legislation;
- work towards strengthening the hand of governments that attempt to reform or close aquariums that are unable to achieve desired standards of conservation, education, science, animal management and welfare.

7.6 The WZACS urges those countries that do not have zoo and aquarium legislation to use and adapt the existing relevant legislation of other countries when formulating their own policies and regulations, and to seek the help of those zoo and aquarium associations where legislation already exists.

Response

Aquariums agree that the development of relevant and appropriate legislation in countries where this is inadequate or not fully developed is a vital component of the conservation effort. Monitoring, review, feedback and where, appropriate, revision of laws and regulations concerning animal welfare and ethics should be an integral part of the legislative process.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- identify and assist governments with inappropriate or incomplete zoo and aquarium legislation and refer legislators to the relevant regional association;
- establish and support programmes for technical co-operation and advice with developing institutions and countries.

Chapter 8

Sustainability

Vision

"All zoos and aquariums will work towards sustainability and reduce their 'environmental footprint.' They will use natural resources in a way that does not lead to their decline, thus meeting the needs of the present without compromising future generations. All zoos and aquariums will serve as leaders by example, using green practices in all aspects of their operations and by demonstrating methods by which visitors can adopt sustainable lifestyles."

The World Zoo and Aquarium Conservation Strategy, 2005

Kelp forest, Two Oceans Aquarium, South Africa. © S. Lennert.

Recommendations

8.1 The World Zoo and Aquarium Conservation Strategy (WZACS) strongly recommends that all zoos and aquariums adopt measures and activities that help sustain natural resources.

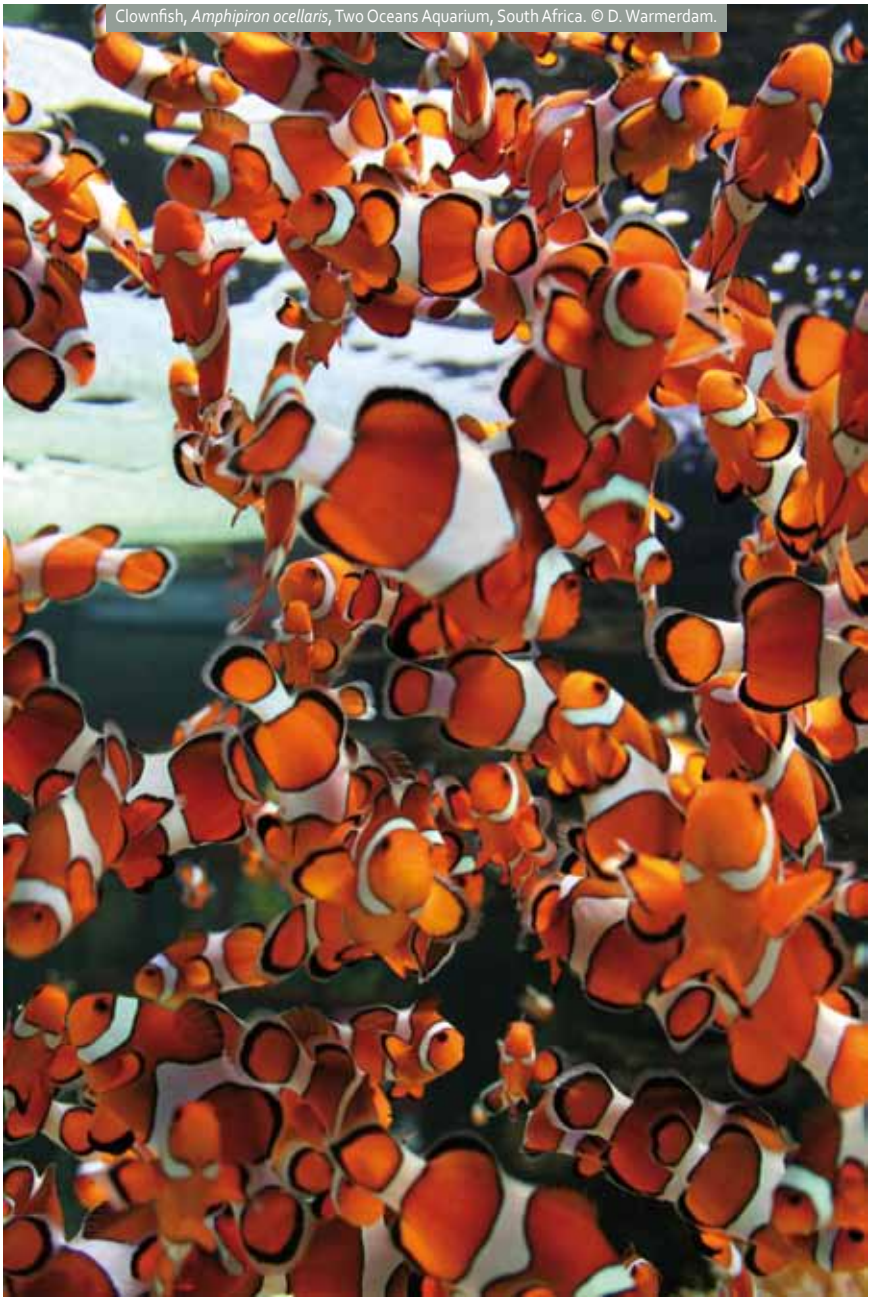
Response

It is recognised that the aquarium community should find ways to reduce and rationalise resource use and to adopt a 'green' or sustainability policy for application across all of their operations and activities.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- liaise with regional associations, WAZA and other aquariums to establish best practice;
- incorporate green measures in the design and construction of new aquariums, and in new exhibits proposed by existing aquariums, particularly with respect to energy consumption;
- consider alternative sources of energy for running the aquarium operation such as geothermal, solar, bio-gas fermentation or hydroelectric and employ heat recovery systems in mechanical engineering services; set targets and timelines for reducing or rationalising resource use, be it related to power or fresh water consumption, or collection of specimens for exhibition or for food;
- ensure that products for sale in aquarium retail outlets and cafeterias accord with sustainability and 'fair trade' guidelines;
- ensure that fish and shellfish for consumption in aquarium restaurants are not on the IUCN Red List and come from well-managed sustainable fisheries (certified where possible).



Clownfish, *Amphipiron ocellaris*, Two Oceans Aquarium, South Africa. © D. Warmerdam.

8.2 The WZACS recommends that all zoos and aquariums have a written environmental policy and undertake environmental audits.

Response

Aquariums should develop environmental policies at an institutional and regional level and integrate these into regular audit programmes.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- work to gain an internationally recognised environmental management award or institutional standard such as ISO 14001 (www.iso14000-iso14001-environmental-management.com/iso14001.htm);
- develop environmental policies at an institutional and regional level that will complement the standards set in internationally recognised management systems such as ISO14001;
- work to ensure that aquarium buildings and operational systems conform with international sustainable building design, construction and management standards such as those of BREEAM (the Building Research Establishment's Environmental Assessment Method, www.breeam.org);

- work to ensure that aquarium associated civil engineering works operate to an internationally recognised standard such as the Civil Engineering Environmental Quality Assessments and Awards Scheme (CEEQUAL, http://www.ceequal.com/)
- develop institutional audits (e.g. EMAS the Eco-Management and Audit Scheme www.iema.net/ems/emas) that assess operations in the context of institutional environment, health and safety policy and aim for continuous improvement;
- ensure that safety, health, environmental (SHE) and sustainability standards are a component of accreditation or other peer-review process at a regional and global level.

8.3 **The WZACS urges all zoos and aquariums to practice environmental sustainability, by showing by example how sustainability can be achieved and how social attitudes and behaviour can be changed. Aquariums and zoos can thus be shown to be contributing to the conservation of entire ecosystems.**

Response

Aquariums should integrate environmental sustainability as an essential element of their core operation and programmes, and develop a culture of sustainability among personnel through training and continuous professional development (CPD) and among visitors through excellent public consultation and communications.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- develop a sustainable and well-documented collection strategy including for the acquisition of wild aquatic animals and plants that encompasses the requirements of the Convention on Biodiversity (CBD), e.g. Marine Aquarium Council (MAC) certification;
- minimise any livestock losses in the course of acquisition through optimal collection, handling and transport techniques and excellent husbandry and veterinary care – and only use accredited suppliers who meet the same rigorous standards;
- develop sustainable collections of aquatic animals and plants through in-house breeding programmes;
- where possible and appropriate, increase inter-institution livestock transactions (acquisitions/disposals), especially in terms of sourcing animals from successful breeding programmes;
- recognise sustainability as an important component of the educational responsibility of aquariums and focus on changing the attitudes, outlook and behaviours of aquarium visitors and, ultimately, the global population;
- move towards increasing the number of displays with ecological themes, such as coral reefs, subterranean cave pools, ocean depths, kelp forests, mangrove swamps, estuaries, rivers, lakes, ponds, marshes, peatlands and other wetlands and stress the need for cross-biome conservation programmes;
- incorporate eco-friendly elements into the design of exhibits;
- give due consideration to the display of local indigenous or endemic species in preference to exotics alone;
- develop exhibits that interpret successful aquatic conservation and sustainability programmes in the wild;
- participate in and promote sustainable seafood initiatives, in terms of food outlets serving the consumer and in the feeding of the aquarium collection;
- deliver sustainability messages in catering and retail outlets and elsewhere in the aquarium;
- distribute advisory cards to visitors concerning appropriate menu choices of fish and shellfish from sustainable fisheries;
- actively promote recycling and utilise, distribute or sell recycled products;
- implement and demonstrate 'model' or 'demonstrator' water-saving, lighting, sanitation and other sustainability measures;
- follow current guidance and best practice in gift shops when acquiring and selling aquatic curios of animal or geological origin (shells, corals, dried seahorses, shark teeth, fossils, pebbles etc.) and ensure that any such products are from appropriate sources;
- support worthwhile international sustainability initiatives and campaigns such as those developed by the World Ocean Network and The Ocean Project.

Chapter 9

Ethics and Animal Welfare

Vision

"All zoos and aquariums will follow ethical principles and maintain the highest standards of animal welfare in order to establish and sustain viable populations of healthy animals for conservation purposes and to convey credible conservation messages to the public."

The World Zoo and Aquarium Conservation Strategy, 2005

Manta Ray, *Manta birostris,* being transported. © uShaka Marine World, South Africa.

Recommendations

9.1 The World Zoo and Aquarium Conservation Strategy (WZACS) recommends that all zoos and aquariums seek continually to improve their management techniques and the profession's current practices, based on evolving knowledge and sensibilities.

Response

Aquariums should regularly evaluate all ethical and welfare animal outputs and activities against accepted norms or standards developed by other aquariums, regional associations and WAZA.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- utilise the WAZA and the regional and national associations as a contact point through which the need for standards and norms will be assessed and, subsequently, developed;
- ensure appropriate liaison with regional and national associations and relevant institutions;
- support WAZA and the regional and national associations from time-to-time in the development of ethical policy and best practice and in the preparation of position statements and press releases on controversial issues and give voice to these statements in appropriate forums.

9.2 The WZACS recommends that all zoo and aquarium associations have their own ethical codes and animal welfare policies and that the associations ensure that their members comply with them.

Response

Aquariums agree that each regional association should have an Ethics and Welfare Committee to develop regional animal welfare standards and ethical codes of practice and assess compliance against these codes. National association and institutional policies should reflect these international codes and, wherever possible, the codes should be harmonised internationally and globally.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- determine from each regional and national association the existence of a code of zoo and aquarium best practice in terms of ethics and animal welfare;
- ensure that any regional or national association so far without such a written code be encouraged and assisted to develop an appropriate document and systems to ensure compliance;
- confirm that regional and national associations have an established protocol to assess compliance against adopted codes of practice;
- bring unethical activities or transactions of aquariums to the attention of the national or regional association and, where appropriate, regulatory national authorities and other relevant bodies including WAZA;
- ensure that a system is in place at successive levels of responsibility to take appropriate and effective action in the case of transgression of internationally accepted standards and norms in ethics and welfare and that this system should, in terms of 'natural justice', incorporate an 'appeals' process;
- when developing standards and codes liaise with national, international and regional associations of zoo and wildlife veterinarians.

9.3 The WZACS requires that zoos and aquariums acquiring animals of threatened species from the wild will fully comply with the 'IUCN Technical Guidelines on the Management of *ex situ* Populations for Conservation'.

Response

Aquariums agree that the acquisition and subsequent holding of animals from the wild should comply with the "IUCN Technical Guidelines on the Management of *ex situ* Populations for Conservation."

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- ensure that all regional and national associations have the IUCN Technical Guidelines, and distribute these to all members or have them available electronically by readily accessible systems such as a website;
- confirm that regional and national associations have an established protocol to assess compliance against the IUCN Technical Guidelines.

Moving an Endangered Pla eesok, *Probarbus jullieni*, Chester Zoo. © Stephanie Sanderson, Chester Zoo, UK.

European common frog, *Rana temporaria*, with spawn – this is a species seriously affected by *Ranavirus* infections in the UK. © Richard Gibson, Chester Zoo, UK.

9.4 The WZACS requires that all animal transportation must be in accord with regulations, such as the International Air Transport Association's 'Live Animals Regulations', and with relevant national regulations.

Response

Aquariums agree that all animal and plant transport must be in accord with appropriate domestic and international travel regulations and conform the highest welfare standards. Similarly, the transport of living tissues, cells, gametes, seeds, DNA and other biological specimen materials should conform to international codes including CITES, the Balai Directive (http://www.defra.gov.uk/animalh/int-trde/imports/iins/livebalai/) and the transfer and maintenance protocols of bodies directly concerned with genome resource banking such as the Frozen Ark consortium (www.frozenark.org/consortium.html) and the Amphibian Ark Biobanking Advisory Committee (www.amphibianark.org).

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- ensure that all aquarium staff involved in the transportation of animals are familiar with travel regulations, sanitary, phytosanitary and welfare standards and are appropriately trained to ensure adherence to such regulations and standards;
- provide technical support and best practice guidelines on aquatic species to individual institutions and also to those international bodies concerned with domestic and international travel regulations or transactions concerning threatened species (including IATA (www.IATA.org), CITES (www.cites.org) and TRAFFIC (www.traffic.org).

9.5 The WZACS requires that zoos and aquariums undertake every effort to prevent the escape of animals and plants of invasive species.

Response

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.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- 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 (www.amphibianark.org) 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, parasites, pathogens etc. and on measures for remedial action or control should such a release take place accidentally.

Inside a biosecure amphibian conservation unit at Chester Zoo. © Richard Gibson, Chester Zoo, UK.

9.6 **The WZACS calls upon all zoos and aquariums to comply with legal requirements under which animals must be kept but points out that legislation can only define minimum standards and the zoo and aquarium community should strive for even higher standards.**

Response

Aquariums agree that legislation defining minimum standards for the holding of animals should not be seen as a benchmark for best practice. Rather, all aquariums should strive to surpass existing standards and provide the best possible environments for their animals.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- ensure that existing and appropriate minimum standards are met and surpassed;
- encourage all regional and national associations to develop optimum standards with regard to holding, husbandry, animal training, veterinary care, behavioural enrichment, biosecurity and the like;
- regularly review public access to open displays such as 'touch tanks' for live handling of specimens and ensure that the welfare of animals is not compromised or the health of the visitors;
- work with cognate bodies to update and continuously improve standards;
- do not display, maintain or propagate 'monstrous' artificially selected or genetically modified fishes or other organisms.

9.7 **The WZACS advises that if there are legal or cultural reasons why the killing of surplus animals is not an acceptable option, and the prevention of reproduction would damage the health or cause suffering of the animals concerned, then the zoo or aquarium should not have these animals in their collection and they should consider the option of transferring them to another collection.**

Response

Each aquarium should have an appropriate Institutional Collection Plan that is based on sound ethical and welfare principles. Contained in this plan should be protocols for the disposal of surplus

livestock, preferably through transfer to other institutions or reputable organisations; or through accredited programmes of release to the wild (strictly following IUCN Re-introduction Specialist Group Guidelines (www.iucnsscrsg.org). Where appropriate, inter-institutional transfers should conform to the requirements of Species Survival Plans (SSPs, EEPs) of the regional associations. In cases where other options are not practicable or advisable, then the killing of surplus animals or eggs by euthanasia must be considered, following humane and internationally accepted methods. Similar considerations apply to the euthanasia of animals for sound welfare, husbandry and veterinary reasons, including where the animals quality of life is severely compromised. Where appropriate, consideration should be given to transferring post-mortem material to accredited museums or genome resource banking centres to assist with conservation and other studies (refer, for example, to the Frozen Ark (www.frozenark.org/consortium.html) and Amphibian Ark (www.amphibianark.org).

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- encourage all aquariums to develop an Institutional Collection Plan containing or associated with an Institutional Animal Welfare and Ethics Policy which covers key areas including acquisitions, disposals and euthanasia;
- ensure that each aquarium has access to and adopts a national or regional code of animal welfare and ethical practice;
- refer to the national and regional associations and WAZA for guidance on matters of animal welfare and ethics;
- refer to the *EAZA Research Strategy* (2008) for guidance on ethical and welfare issues in the context of scientific research conducted in aquariums and zoos or in partnership with others.

9.8 **The WZACS recommends that all regional and national associations develop peer-reviewed animal husbandry guidelines, in particular for species that are managed by co-operative *ex situ* breeding programmes.**

Response

Aquariums agree that national and regional associations and curatorial unions are well placed to develop, co-ordinate, monitor and review co-operative breeding programmes, usually through Taxon Advisory Groups (TAGs). They are also well positioned to facilitate co-operative partnerships for conservation breeding and to ensure that animal husbandry guidelines form an integral part of such programmes.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- collect and collate existing husbandry guidelines produced under the auspices of national and regional associations, curatorial unions, TAGs etc. and;
- disseminate such husbandry guidelines to all regional associations;
- request commitment from each regional association to progress a set number of animal husbandry guidelines within a specific time frame and organise production in a way that maximises collaboration and minimises unproductive duplication of effort in both national and international contexts.

9.9 **The WZACS recommends that zoos and aquariums provide environmental enrichment and should direct resources toward exploring ways that enrichment techniques can be expanded, improved and evaluated.**

Response

Aquariums agree that environmental and behavioural enrichment for aquatic taxa is underdeveloped in the aquarium industry, and that a concerted effort should be made to address this welfare need. This can be through sound scientific study to determine enrichment needs and improve methods and through the designation of a budget and allocation of staff resources.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- collect and collate information on existing enrichment practices and forums;
- monitor scientific journals focusing on animal behaviour / aquatic ecology, to gather new information that might be informative when developing techniques for behavioural and environmental enrichment;
- disseminate such information to all national and regional associations and make this available electronically to member institutions and individual enquirers;
- ensure that each aquarium develops an institutional enrichment programme for routine animal care procedures and integrates enrichment topics into staff training programmes;
- encourage and resource staff to research, develop, publish and implement new techniques in environmental and behavioural enrichment;
- consider the extent to which 'animal shows' may or may not contribute to behavioural enrichment and develop an institutional policy in regard to this;
- consider the extent to which 'touch tanks' and other live-handling facilities for the public or educational school groups may cause stress to animals – and ensure that the welfare of animals is not compromised by excessive or inept handling.

9.10 The WZACS recommends that more use be made of evidence-based objective welfare assessments, and that the results be used to improve the environment of animals in collections.

Response

Aquariums agree that liaison with local authorities and mainstream welfare organisations, such as IFAW and WSPA, improve the well-being of animals in collections. Objective, evidence-based assessments need to be developed and implemented where these do not exist.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- ensure that veterinary, husbandry, research and educational departments within aquariums develop and implement an institutional animal welfare assessment programme;
- encourage aquariums to use local authorities, tertiary education institutions, non-government organisations and welfare bodies to gain insights and lend credibility to institutional animal welfare assessment programmes;
- refer to the *EAZA Research Strategy* (2008) for guidance on animal welfare/enrichment issues in the context of scientific research conducted in aquariums and zoos or in partnership with others.

9.11 The WZACS recommends that all zoos and aquariums become more familiar with the relevance of ethics and welfare issues in their conservation activities, and they should increase their efforts to educate and involve staff and the public.

Response

Aquariums concur that key ethical and welfare issues pertaining to their conservation activities, including issues in contention, need to be better understood and accurately conveyed to management, staff and the public. This is to foster constructive debate and dialogue, improve understanding and make beneficial progress.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- develop an institutional awareness of the importance of critical evaluation of activities from ethical and animal welfare perspectives;
- encourage the use of staff intranet and notice boards to publicise Ethics and Welfare Committee (see below) concerns, issues and activities and to receive feedback;

- encourage aquariums to have zoo, education and guest relations personnel explain relevant ethical issues to visiting members of the public through the use of innovative and effective interpretation and presentations;
- establish a system for receiving and, where appropriate, acting on public feedback on welfare, ethical and cognate issues;
- consider the welfare, conservation and other implications in exhibiting and breeding certain species of artificially selected, hybridised or genetically modified aquatic organisms.

9.12 The WZACS recommends that all zoos and aquariums should have an ethical committee and an ethical review process for all aspects of their operations, including those off site.

Response

Aquariums agree that all institutions should have a standing Animal Welfare and Ethics Committee that incorporates a regular ethical review process to the benefit of the animal collection and that their agenda should in part be guided by the Animal Welfare and Ethics Committee of WAZA and those of the regional and national associations.

Action

For public aquariums, national and regional aquarium/zoo associations and partners to:

- encourage all aquariums to formally constitute an Institutional Animal Welfare and Ethics Committee;
- encourage aquariums to have both senior and junior level staff as members of the Ethics Committee and encourage active participation in Committee activities;
- ensure aquariums utilise the skills of external independent experts to provide a well-informed and objective opinion to the Animal Welfare and Ethics Committee.

Green turtle, *Chelonia mydas*. Two Oceans Aquarium, South Africa.

Acknowledgements

The substantial contribution of time, effort, knowledge and experience from the following persons, institutions, associations and organisations is gratefully acknowledged by WAZA. We also warmly appreciate the helpful inputs of very many other colleagues, institutions, associations and organisations, too numerous to mention individually.

Yoshitaka Abe, Aquamarine Fukushima, Japan
Javier Almunia, Loro Parque Fundacion, Tenerife
Thomas Althaus, WAZA
Brad Andrews, Sea World Inc, USA
Kazutoshi Arai, Kamogawa Seaworld, Japan
Stephane Auffret, Oceanarium Brest, France
Laurie Bingaman-Lackey, International Species Information System
Jerry Borin, Columbus Zoo, USA
Paul Boyle, The Ocean Project, USA
Hai Chiang, National Museum of Marine Biology and Aquarium, Taiwan
Mike Crumpler, Chester Zoo, UK
Gerald Dick, Executive Director, World Association of Zoos and Aquariums
Leslie Dickie, Executive Director, European Association of Zoos and Aquariums
Peter Dollinger, Director, German Federation of Zoo Directors
Joao Falcato, Oceanário Lisboa, Portugal
Beth Firchau, Virginia Aquarium, USA
Nate Flesness, International Species Information System
Patrick Garratt, Two Oceans Aquarium, SA
Claude Gascon, IUCN SSC Amphibian Specialist Group
Suzanne Gendron, Ocean Park, Hong Kong
Claudine Gibson, Chester Zoo, UK
David Gibson, The Deep, UK
Richard Gibson, Chester Zoo, UK
Colin Grist, Chester Zoo, UK
Ian Harrison, Conservation International
Thomas Jermann, Basel Zoo, Switzerland
Kevin Johnson, Australasian Regional Association of Zoological Parks and Aquaria
Philippe Jouk, Antwerp Zoo, Belgium
Rainer Kaiser, Berlin Zoo Aquarium, Germany
Debra Kerr, John G. Shedd Aquarium, USA
Heather Koldewey, Zoological Society of London, UK
Jurgen Lange, Berlin Zoo, Germany
Bill Peters, Canadian Association of Zoos and Aquariums
Martin Phillips, Australasian Regional Association of Zoological Parks and Aquaria
Bai Li Ping, Xiangjiang Safari Park, China
Judy Mann, South African Association for Marine Biological Research and uShaka Marine World, SA
Gordon McGregor Reid, Chester Zoo, UK
Cheryl Mell, John G. Shedd Aquarium, USA
Mark Penning, South African Association for Marine Biological Research and uShaka Marine World, SA
Jone Porter, South African Association for Marine Biological Research and uShaka Marine World, SA
Diana Sarmiento-Parra, ALPZA
Wang Shi Li, Underwater World Qingdao, China
Makoto Soichi, Port of Nagoya Public Aquarium, Japan
Kevin Tanner, Oceanis, Australia
Michelle Thieme, WWF
Sue Thornton, International Zoo Vet Group, UK
Simon Tonge, Paignton Zoo, UK
Itaru Uchida, Port of Nagoya Public Aquarium, Japan
Paul Van den Sande, EUAC Executive Secretary
Kris Vehrs, AZA
Cynthia Vernon, Monterey Bay Aquarium, USA
Gerard Visser, Rotterdam Zoo, Netherlands
Chris Warhurst, Sydney Aquarium, Australia
Doug Warmolts, Columbus Zoo and Aquarium, USA
Kevin Zippel, Amphibian Ark

Orbicular batfish, *Platax orbicularis,* at uShaka Marine World, South Africa.

References

The scientific and technical literature on aquatic life is extremely large and so no comprehensive listing can be provided here even in the specific context of aquariums. The following reference list is only broadly indicative but provides a guide to some key documentation used in preparing this Aquarium Strategy and useful for reference purposes.

Abell, R. A., Olson, D. M., Dinerstein, E., Hurley, P. T., Diggs, J. T., Eichbaum, W., Walters, S., Wettengell, W., Allnutt, T., Loucks, C. J. and Hedao, P. (Eds), 2000. *Freshwater Ecoregions of North America: A Conservation Assessment.* World Wildlife Fund, United States, Washington, DC.

Baker, Andrew C., 2001. Reef corals bleach to survive change. *Nature* 411: 765–766.

Bartley, D. M., 2000. Responsible ornamental fisheries. *FAO Aquat. Newsl*. 24: 10–14.

Billard, R. and Zhang, T. T., 2001. Techniques of genetic resource banking in fish. In: *Cryobanking the Genetic Resource: Wildlife Conservation for the Future* (Eds P. F. Watson and W. V. Holt), pp. 143–170. Taylor and Francis, London.

Boyd, C. E., McNevin, A. A., Clay, J., Johnson, H. M., 2005. Certification issues for some common aquaculture species. *Reviews in Fisheries Science* 13: 231–279.

Bruckner, A. W., Field, J. D., Daves, N., (Eds), 2005. *The Proceedings of the International Workshop on CITES Implementation for Seahorse Conservation and Trade.* NOAA Technical Memorandum NMFS-OPR-36, Silver Spring, MD 171 pp.

Burgess, P. (Ed.), 2001. *Aquarium Sciences and Conservation* (Special Issue) 3:1–240. Marine ornamentals conference, Hawaii.

Carp, E., 1980. *A Directory of Western Palearctic Wetlands*. IUCN-UNEP.

Cavanagh, R. C. and Gibson, C., 2007. *Overview of the Conservation Status of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea.* IUCN, Gland, Switzerland and Malaga, Spain. vi+42pp.

Chao, N. L., Petry, P., Prang, G., Sonneschien, L. and Tlusty, M., 2001. *Conservation and Management of Ornamental Fish Resources of the Rio Negro Basin, Amazonia, Brazil – Project Piaba*. Manaus: Editoria da Universidade do Amazonas. 310 p.

Cole, G. A., 1975. *Textbook of limnology*. The C. V. Mosby Company.

Collins, J. P. and Crump, M. L., 2009. *Extinction in Our Times: Global Amphibian Decline*. Oxford University Press.

Contreras-MacBeath, T., Mejia Mojica, H. and Wilson, R. C., 1998. Negative impact on the aquatic ecosystems of the State of Morelos, Mexico from introduced aquarium and other commercial fish. *Aquarium Sciences and Conservation* 2: 67–78.

Copsey, J., Jones, J. P. G., Andrianandrasana, H., Rajaonarison, L. H. and FA, J. E., 2009. Burning to fish: local explanations for wetland burning in Lac Alaotra, Madagascar. *Oryx: The International Journal of Conservation* 43 (3) : 403–406.

Dugan, P. (Ed.), 2005. *Philip's Guide to Wetlands*. Philip's, London, UK.

EAZA, 2009. *EAZA Strategy 2009–2012*. EAZA Executive Office, Amsterdam.

Gardiner, P. R. and Kuperan Viswanathan, K., 2004. Ecolabelling and fisheries management. Penang: WorldFish Center. http://www.worldfishcenter.org/Pubs/Ecolablelling/ecolablelling.htm

Goulding, M., 1980. *The Fishes and the Forest. Explorations in Amazonian Natural History*. University of California Press, Los Angeles.

Gibson, C., Valenti, S. V., Fowler, S. L. and Fordham, S. V., 2008. *The Conservation Status of Northeast Atlantic Chondrichthyans*. Report of the IUCN Shark Specialist Group Northeast Atlantic Regional Red List Workshop, Peterborough UK, 13–15 February. The IUCN SSC Shark Specialist Group.

FAO, 1996. Fishing Operations. *FAO Technical Guidelines for Responsible Fisheries. No. 1.* Rome, FAO. 26 p. 6 annexes.

FAO, 1996. Precautionary approach to capture fisheries and species introductions. Elaborated by the Technical Consultation on the Precautionary Approach to Capture Fisheries (Including Species Introductions). Lysekil, Sweden, 6–13 June 1995. *FAO Technical Guidelines for Responsible Fisheries. No. 2.* Rome, FAO. 54 p.

FAO, 1996. Integration of Fisheries into Coastal Area Management. *FAO Technical Guidelines for Responsible Fisheries. No. 3.* Rome, FAO. 17 p.

FAO, 1997. Aquaculture Development. *FAO Technical Guidelines for Responsible Fisheries. No. 5.* Rome, FAO. 40 p.

Farquhar, M., 2009. The Maxine Project Continues: Five years of shark releases from the Two Oceans Aquarium. In: *WAZA News 3/09. pp. 2–3.*

FAWC, 1996. *Report on the Welfare of Farmed Fish*. Ministry of Agriculture, Fisheries and Food.

FishBase, 2009. FishBase Database. http://www.fishbase.org/search.php .

Fosså, S. A., Bassleer, G. M. O., Chuan, L. L. and Ploeg, A., 2007. *International Transport of Live Fish in the Ornamental Aquatic Industry*. OFI Educational publication 2. Ornamental Fish International.

Foster, S. J., Vincent, A .C. J., 2004. Life history and ecology of seahorses: implications for conservation and management. *J. Fish Biol.* 65: 1–61.

Foster, S. J. and Vincent, A. C. J., 2005. Enhancing sustainability of the international trade in

seahorses with a single minimum size limit. *Cons. Biol.* 19: 1044–1050.

Fowler, S. L., Cavanagh, R. D., Camhi, M., Burgess, G. H., Cailliet, G. M., Fordham, S. V., Simpfendorfer, C. A. and Musick, J. A., 2005. *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes*. IUCN SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. x + 461 pp.

Green, E. P. and Hendry, H., 1999. Is CITES an effective tool for monitoring trade in corals? *Coral Reefs* 18: 403–407.

Grosholz, 2002. Ecological and evolutionary consequences of coastal invasions. *TREE* 17 (1): 22–27.

Hagedorn, M. and Kleinhans, F. W., 2000. Cryopreservation of fish embryos: is it within the foreseeable future for aquaculture? In: *Cryopreservation of Gametes and Embryos of Aquatic Species* (Eds T. Tiersch and P. Mazik), pp. 161–178. World Aquaculture Society, Seattle, WA.

Hall, M. A., Alverson, D. L. and Metuzals, K. I., 2000: By-catch: problems and solutions. *Marine Pollution Bulletin* 41: 204–219.

Hall, H. J. and Warmolts, D., 2003. The Role of Public Aquaria in the Conservation and Sustainability of the Marine Ornamentals Trade. In: *Marine Ornamentals: Collection, Culture and Conservation* pp 307–327. Iowa State University Press. Cato, J. and Brown C. L. (Eds).

Hallerman, E. M. and Kapuscinski, A. R., 1995. Incorporating risk assessment and risk management into public policies on genetically modified finfish and shellfish. *Aquaculture* 137: 9–17.

Harrison, I. J. and Stiassny, M. L. J., 1999. The Quiet Crisis – a preliminary listing of the freshwater fishes of the world that are extinct or 'missing in action'. In: *Extinctions in Near Time* (Ed. R. D. E. McPhee), pp. 271–331. Kluwer Academic/Plenum Publishers, New York.

Helfman, G. S., 2007. *Fish conservation: a guide to understanding and restoring global aquatic biodiversity and fishery resources*. Island Press, USA.

Hemdal, J. F., 2003. *Aquarium Fish Breeding*. Barron's Educational Series Inc., USA.

Hindar, K., Ryman, N. and Utter, F. W., 1991. Genetic effects of cultured fish on natural fish populations. *Canadian Journal of Fisheries and Aquatic Sciences* 48: 945–957.

Hutchins, M. and Conway, W. G., 1995. Beyond Noah's ark: the evolving role of modern zoological parks and aquariums in field conservation. *International Zoo Yearbook* 34:117–130.

ISIS, 2008. International Species Information System. http://www.isis.org/CMSHOME/

IUCN, 2009. IUCN Red List of Threatened Species. www.iucnredlist.org

IUCN SSC ASG, 2009. IUCN SSC Amphibian Specialist Group. http://www.amphibians.org/ASG/Home.html

IUCN SSC CBSG, 2009. IUCN SSC Conservation Breeding Specialist Group. http://www.cbsg.org/cbsg/

IUCN SSC CSG, 2009. IUCN SSC Cetacean Specialist Group.

IUCN SSC CSG, 2009. IUCN SSC Coral Specialist Group.

IUCN SSC CSG, 2009. IUCN SSC Crocodile Specialist Group.

IUCN SSC GWSG, 2009. IUCN SSC Groupers and Wrasses Specialist Group. http://www.hku.hk/ecology/GroupersWrasses/iucnsg/index.html

IUCN SSC FCCSG, 2009. IUCN SSC Freshwater Crab and Crayfish Specialist Group.

IUCN SSC MTSG, 2009. IUCN SSC Marine Turtle Specialist Group. http://www.iucn-mtsg.org/

IUCN SSC MSSG, 2009. IUCN SSC Mollusc Specialist Group. http://www.hawaii.edu/cowielab/Tentacle.htm

IUCN SSC PSG, 2009. IUCN SSC Pinniped Specialist Group.

IUCN SSC PBSG, 2009. IUCN SSC Polar Bear Specialist Group. http://pbsg.npolar.no/en/index.html

IUCN SSC RSG, 2009. IUCN SSC Re-Introduction Specialist Group http://iucn.org/themes/ssc/programs/rsg.htm

IUCN SSC SSG, 2009. IUCN SSC Salmon Specialist Group. http://www.hku.hk/ecology/GroupersWrasses/iucnsg/index.html

IUCN SSC SSG, 2009. IUCN SSC Shark Specialist Group. http://www.iucnssg.org/index.php/about-the-ssg

IUCN SSC SSG, 2009. IUCN SSC Sirenia Specialist Group.

IUCN SSC SSG, 2009. IUCN SSC Sturgeon Specialist Group. http://www.iucn.org/about/work/programmes/species/about_ssc/specialist_groups/directory_specialist_groups/directory_sg_fishes/ssc_sturgeon/

IUCN SSC SSSG, 2009. IUCN SSC Sea Snake Specialist Group. http://www.seasnakes.info/

IUCN SSC TFT, 2009. IUCN SSC Tortoises and Freshwater Turtles Specialist Group. http://www.iucn-tftsg.org/

IUCN SSC TBSG, 2009. IUCN SSC Tuna and Billfishes Specialist Group. http://www.iucn.org/about/work/programmes/species/about_ssc/specialist_groups/directory_specialist_groups/directory_sg_fishes/

IUCN SSC / WI FFSG, 2009. IUCN SSC / Wetlands International Freshwater Fish Specialist Group. http://global.wetlands.org/Aboutus/Specialistgroups/FreshwaterFishSpecialistGroup/tabid/201/language/en-US/Default.aspx / www.iucnffsg.org (in progress).

IUCN SSC WHSG, 2009. IUCN SSC Wildlife Health Specialist Group. http://www.iucn-vsg.org/

Jacquet, J. L. and Pauly, D., 2007. The rise of seafood awareness campaigns in an era of collapsing fisheries. *Marine Policy* 31: 308–313.

Jones, J. R. E., 1964. *Fish and River Pollution*. Butterworth and Co. (Publishers) Ltd.

Kime, D. E., 1995. The effects of pollution on reproduction in fish. *Reviews in Fish Biology and Fisheries* 5: 52–96.

Kirchhofer. A. and Hefti, D. (Eds), 1996. *Conservation of Endangered Freshwater Fish in Europe*. Advances in Life Sciences. Birkhäuser, Germany.

Koldewey, H. (Ed.), 2005. *Seahorse Husbandry in Public Aquariums: Manual with chapters contributed by members of the Syngnathid Discussion Group.* Zoological Society of London.

Koldewey, H., Atkinson, J. and Shaw, A., 2009. Threatened Species on the Menu? Towards sustainable seafood use in zoos and aquariums. *International Zoo Yearbook 43*: 71–81.

Kottelat, M. and Freyhof, J., 2007. *Handbook of European freshwater fishes*. Kottelat, Cornol, Switzerland and FreyhofBerlin, Germany.

Krupp, F., Reid, G. McG. and Hamidan, N. A. (Eds), 2002. Fish of Arabia's Mountain Habitat. Section 7 (136 pp) In: *Conservation Assessment and Management Plan (CAMP) for The Threatened Fauna of Arabia's Mountain Habitat.* IUCN Conservation Breeding Specialist Group and Breeding Centre for Endangered Arabian Wildlife, Sharjah, UAE.

Lack, M., 2006. *Conservation of Spiny Dogfish* Squalus acanthias*: A Role for CITES?* Traffic International.

Langfield, J. and James, C., 2009. Fishy tales: experiences of the occupation of keeping fish as pets. *British Journal of Occupational Therapy,* 72(8), 349–356.

Leatherland, J. F. and Woo, P. T. K., 1998. *Fish Diseases and Disorders Volume 2* Non-infectious Disorders. CABI Publishing.

Leewis, R. and Janse, M. (Eds). 2008. *Advances in coral husbandry in public aquariums.* Volume 2 in the Public Aquarium Husbandry Series. http://www.coralhusbandry.org/

Lévêque, C., 1997. *Biodiversity Dynamics and Conservation. The Freshwater Fish of Tropical Afric*a. Cambridge University Press, Cambridge.

Lourie, S. A., Vincent, A. C. J. and Hall, H. J., 1999. *Seahorses: An Identification Guide to the World's Species and their Conservation.* Project Seahorse, London.

Lourie, S. A., Foster, S. J., Cooper, E. W. T., Vincent, A. C. J., 2004. *A Guide to the Identification of Seahorses*. Project Seahorse and TRAFFIC North America, Washington, DC., 120pp.

Lowe-McConnell, R. H., *Ecological studies in tropical fish communities.* Cambridge Tropical Biology Series. Cambridge University Press.

Lunn, K. E., J. R. Boehm, H. J. Hall and A. C. J. Vincent (Eds), 1999. *Proceedings of the First International Aquarium Workshop on Seahorse Husbandry, Management and Conservation*. John G. Shedd Aquarium: Chicago, USA.

Luther, H. and Rzóska, J. Project Aqua: a source book of inland waters proposed for conservation. IBP Handbook No. 21. *IUCN Occasional Paper No. 2*. Blackwell Scientific Publications, Oxford and Edinburgh.

Maitland, P. S. and Evans, D., 1986. The role of captive breeding in the conservation of fish species. *International Zoo Yearbook* 25: 66–74.

Martin-Smith, K. M., Samoilys, M. A., Meeuwig, J. J., and Vincent, A. C. J, 2004. Collaborative development of management options for an artisanal fishery for seahorses in the central Philippines. *Ocean and Coastal Management* 47: 165–193.

McKeown, B. A., 1984. *Fish Migration*. Timber Press, USA.

Meffe, G. K., 1990. Genetic approaches to conservation of rare fishes: examples from North American desert species. *Journal of Fish Biology* 37A, 105–112.

Mittermeier, C., (Ed.), 2008. *A Climate For Life: Meeting The Global Challenge*. pp. 360. CEMEX Conservation Book Series with Conservation International and the International League of Conservation Photographers.

Moe, M. A., 2001. Marine ornamentals: The industry and the hobby. In: *Proceedings of Marine Ornamentals: 99,* University of Hawaii Sea Grant College Progam, pp 53–63.

Moe, M. A., 2003. Culture of marine ornamentals: For love, for money, and for science. pp 11–28. In: Cato, J. and Brown C. L. (eds). *Marine Ornamentals: Collection, Culture and Conservation*. Iowa State University Press.

Mohan, P. (Ed.), 2009. Drum and Croaker http://www.colszoo.org/internal/drumcroaker.htm

Molur, S. and Walker, S., 1998. *Conservation Assessment and Management Plan (C.A.M.P.) Workshops: Freshwater Fishes of Indi*a. Zoo Outreach Organisation/CBSG, Coimbatore, Tamil Nadu, India.

Moreau, M.-A., Hall, H. J. and Vincent, A. C. J., 1998. Proceedings of the first international workshop on the management and culture of marine species used in traditional medicines. In: Moreau, M.-A., Hall, H.J. and Vincent, A.C.J. (Eds). *Project Seahorse*: Montreal, Canada, Cebu City, Philippines, 240 pp.

MCS, 2002. *Good fish guide* (2nd edn). Marine Conservation Society, Ross-on-Wye.

MCS, 2007. *Status of the world's fish stocks.*: FISHONLINE, Available from www.fishonline.org/information [accessed 21 June 2007]. Marine Conservation Society, Ross-on-Wye.

Munro, A. D., Scott, A. P. and Lam, T. J. (Eds), 1990. *Reproductive Seasonality in Teleosts: Environmental Influence*s. CRC Press, Boca Raton, FL.

Myers, R. A. and Worm, B., 2003. Rapid worldwide depletion of predatory fish communities. *Nature* 423**:** 280–283.

Nelson, J. S., 2006. *Fishes of the Worl*d, 4th Edn. John Wiley, New York.

Newman, P. J. and Agg, A. R., (Eds), 1988. *Environmental Protection of the North Sea*. Heinemann Professional Publishing Ltd.

Northgate, T. G. and Hartman, G. F., 2004. *Fishes and forestry. Worldwide watershed interactions and management.* Oxford: Blackwell Science.

Ogawa, T. and Brown, C., 2001. Ornamental fish aquaculture and collection in Hawaii. *Aquarium Sciences and Conservation* 3(1–3): 151–169.

Oldfield, S., 2002. *Rainforest.* pp 160. New Holland Publishers (UK) Ltd.

Olivier, K., 2003. World trade in ornamental species. pp. 49–64. In: Cato, J. and Brown, C. (Eds). *Marine Ornamental Species.* Blackwell Publishing.

Olson, D., Dinerstein, E., Canevari, P., Davidson, I., Castro, G., Morisset, V., Abell, R. and Toledo, E. (Eds), 1998. *Freshwater Biodiversity of Latin America and the Caribbean: A Conservation Assessment.* Biodiversity Support Program, World Wildlife Fund, Washington, DC.

Pauly, D., Christensen, V., Dalsgaard, J., Froese, R. and Torres F. Jr., 1998. Fishing down marine food webs. *Science* 279: 860–863.

Pauly, D. V., Christensen, V., Guenette, S., Pitcher, T. J, Sumaila, U. R., Walters, C. J., Watson, R. and Zeller, D., 2002. Toward sustainability in world fisheries. *Nature* 481: 689–695.

Paxton, J. R. and Eschmeyer, W. N. (Eds), 1998. *Encyclopedia of Fishes*, 2nd Edn. Academic Press, San Diego, CA.

Pereira, J. F., 2009. Examples of Aquarium Conservation Projects. In: *WAZA News* 03/09. pp. 27–28.

Petersen, D., Laterveer, M. and Brittsan, M., 2009. International SECORE Network: Public aquaria work on the endangered coral species. Pg 4. In: *WAZA News* 03/09.

Petersen, D., Carl, M., Borneman, E., Brittsan, M., Hagedorn, M., Laterveer, M. and Schick, M., 2008. Noah's Ark for the threatened Elkhorn coral *Acropora palmata*. *Coral Reefs* 27(3):715.

Petersen, D., Wietheger, A. and Laterveer, M., 2008. Influence of different food sources on the initial development of sexual recruits of reefbuilding corals in aquaculture. *Aquaculture* 277(3–4):174–178.

Petersen, D., Falcato, J., Gilles, P. and Jones, R., 2007. Sexual coral reproduction in live coral exhibits – current status and future perspectives. *International Zoo Yearbook* 41:122–137.

Petersen, D., Laterveer, M. and Visser, G., 2007. Sexual recruitment of *Favia fragum* and *Agaricia humilis* in a 30m³ closed system aquarium – species specific limitations and implications on reproductive ecology. *Zoo Biology* 26(2):75–91.

Petersen, D., Laterveer, M., Van Bergen, D., Hatta, M., Hebbinghaus, R., Janse, M., Jones, R., Richter, U., Ziegler, T., Visser, G. and Schuhmacher, H., 2006. The application of sexual coral recruits for sustainable management of *ex situ* populations in public aquariums. SECORE-Project. *Aquatic Conservation: Marine and Freshwater Ecosystems* 16(2):167–179.

Petersen, D., Hatta, M., Laterveer, M. and Van Bergen, D., 2005. *Ex situ* transportation of coral larvae for research, conservation and aquaculture. *Coral Reefs* 24(3):510–513.

Petersen, D., Laterveer, M. and Schuhmacher, H., 2005. Spatial and temporal variation in larval settlement of reefbuilding corals in mariculture. *Aquaculture* 249(1-4):317–327.

Petersen, D. and Van Moorsel, G. W. N. M., 2005. Pre-planular external development in the brooding coral *Agaricia humilis*. *Marine Ecology Progress Series* 289: 307–310.

Petersen, D., Laterveer, M. and Schuhmacher, H., 2005. Innovative substrate tiles to spatially control larvae settlement in coral culture. *Marine Biology* 146(5): 937–942.

Petersen, D., Laterveer, M., Van Bergen, D. and Kuenen, M., 2004. Transportation techniques for massive scleractinian corals. *Zoo Biology* 23(2): 165–176.

Petersen, D. and Tollrian, R., 2001. Methods to enhance sexual recruitment for restoration of damaged reefs. *Bulletin of Marine Science* 69(2): 989–1000.

Reid, G. McG., 1990. Captive breeding for the conservation of cichlid fishes. *Journal of Fish Biology* 37 A., 157–165.

Reid, G. McG. and Whitear, J. (Eds), 1994. Fish and Aquatic Invertebrate Taxon Advisory Group. 1994 Report. With *Proceedings of 1994 Fish and Aquatic Invertebrate Conservation Workshop*, North of England Zoological Society.

Reid, G. McG. and Hall, H. J., 1997. The UK Fish and Aquatic Invertebrate Taxon Advisory Group (FAITAG) and the challenges for public aquaria beyond the year 2000. *Proceedings of the 25th Anniversary Meeting of Members of the European Union of Aquarium Curators (EUAC)*. Basel, Switzerland.

Reid, G. McG. and Hall, H. J. 2003. Reproduction in fishes in relation to conservation. In: Holt, W. V., Pickard, A. R., Rodger, J. C., and Wildt, D. E. (Eds) *Reproductive Science and Integrated Conservation Science*. Conservation Biology 8. Cambridge University Press. pp 374–393.

Reid, G. McG. and Teugels, G., 2000. Progress in the conservation of West African freshwater fishes and aquatic habitats, 1990–2000. In: *Wildlife Conservation in West Africa II. Proceedings of a Symposium of the Nigerian Field Society UK Branch*, held at Whipsnade Wild Animal Park, Luton, Bedfordshire, pp. 47–51.

Reid, G. McG., Macdonald, A. A., Fidgett, A. L., Hiddinga, B. and Leus, K., (Eds) 2008. *Developing the research potential of zoos and aquaria: The EAZA Research Strategy.* EAZA Executive Office, Amsterdam.

Reid, G. McG. and Zippel, K. C., 2008. Can zoos and aquariums ensure the survival of amphibians in the 21st century? *International Zoo Yearbook*. 42:1–6.

Reis, R. E., Kullander, S. O., Ferraris, C. J. (Jnr.) Eds)., 2003. *Checklist of Freshwater Fishes of South and Central America*. Edipucrs, Porto Alegre. 742p.

Sadovy Y. and Vincent A., 2002. Ecological issues and the trades in live reef fishes. In: Sale, P. (Ed.), *Coral Reef Fishes. Dynamics and Diversity in a Complex Ecosystem*. Academic Press, San Diego CA, USA, pp 391–420.

Sapp, J., 1999. *What is Natural? Coral Reef Crisis*. Oxford University Press.

Schindler, D. E., Essington, T. E., Kitchell, J. F., Boggs, C. and Hilborn, R., 2002 Sharks and Tunas: Fisheries Impacts on Predators with Contrasting Life Histories. *Ecological Applications*, 12:3, pp. 735–748.

Shafir, S., Van Rijn, J. and Rinkevich, B., 2006. Coral nubbins as source material for coral biological research: A prospectus. *Aquaculture* 259: 444–448.

Skelton, P. H., 1987. South African Red Data Book – Fishes. A report of the Committee for Nature Conservation Research National Programme for Ecosystem Research. *South African National Scientific Programmes Report No. 137.* South Africa.

Smith, B., Allard, R., Hutchins, M. and Warmolts, D., 2002. Regional Collection Planning for Speciose Taxonomic Groups. *Zoo Biology*. 21(4): pp. 313–408.

Smith, M., Warmolts, D. Thoney, D. and Hueter, R. (Eds), 2004. *The Elasmobranch Husbandry Manual: Captive Care of Sharks, Rays and their Relatives.* Special Publication of the Ohio Biological Survey. xv + 600 p.

Spalding, M. D., Ravilious, C. and Green, E. P., 2001. *World Atlas of Coral Reefs*. UNEP World Conservation Monitoring Centre, Cambridge, UK. University of California Press.

Tacon, A. G. J. and Forster, I. P., 2003. Aquafeeds and the environment: policy implications. *Aquaculture* 226: 181–189.

Teugels, G. G., Reid, G. McG. and King, R. P., 1992. Fishes of the Cross River Basin (Cameroon-Nigeria): taxonomy, zoogeography, ecology and conservation. *Annales Muséee Royal Afrique Centrale, Tervuren* (Série . *Science Zoologique)* 26(6):1–132.

Tlusty, M., 2002. The benefits and risks of aquacultural production for the aquarium trade. *Aquaculture* 205: 203–219.

Thorne-Miller, B., 1999. The Living Ocean: Understanding and Protecting Marine Biodiversity. Second Edition. Island Press, USA.

Uribe, M. C. and Grier, H. J. (Eds), 2005. *Viviparous Fishes*. pp. xii–603. New Life Publications, USA.

Vernon, C., 2009. Mission Accomplished? Measuring Monterey Bay Aquarium's Role in Inspiring Ocean Conservation. In: *Journal of the International Zoo Educators Association.* 45:42–46.

Van den Sande, P., 2001. Evolution in Public Aquarium Concepts. In: *Actes: Cinquième Congrès International des Aquariums. Proceedings : Fifth International Aquarium Congress, Monaco*. November 20–25, 2000.

Vidthayanon, C., 2005. *Thailand Red Data: Fishes.* Office of Natural Resources and Environmental Policy Planning, Bangkok, Thailand. 108p.

Vié, J. C., Hilton-Taylor, C. and Stuart, S. N., (Eds), 2009. *Wildlife in a Changing World – An Analysis of the 2008 IUCN Red List of Threatened Species*. Gland, Switzerland: IUCN. 180pp.

Vincent, A. C. J., 1996. *The International Trade in Seahorses*. Traffic International, Cambridge, UK.

Vincent, A. C. J. and Hall, H. J., 1996. The threatened status of marine fishes. *Trends in Ecology and Evolution* 11: 360–361.

Vincent, A. C. J. and Koldewey, H. J., 2006. An uncertain future for seahorse aquaculture in conservation and economic contexts. *Proceedings of the Regional Technical Consultation on Stock Enhancement of Species Under International Concern*. Southeast Asian Fisheries Development Center. 13–15 July 2005. Iloilo, Panay, Philippines.

Vincent, A. and Sadovy, Y., 1998. Reproductive ecology in the conservation and management of fishes. In: *Behavioural Ecology and Conservation Biology* (Ed. T. Caro), pp. 209–245. Oxford University Press, Oxford.

Voigtlander, C. W. (Ed.), 1994. The state of the world's fisheries resources. *Proceedings of the World Fisheries Congres*s. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Wabnitz, C., Taylor, M., Green, E. and Razak, T., 2003. *From Ocean to Aquarium*. UNEP-WCMC, Cambridge, UK.

Walker, S., 1994. Results of the marine fishes TAG aquarium survey and thoughts on the status of captive marine fish reproduction. *American Zoo and Aquarium Association Annual Conference Proceedings* pp. 277–281.

Watson, I., 2000. *The Role of the Ornamental Fish Industry in Poverty Alleviatio*n. Natural Resources Institute Report 2504: Chatham Maritime, Kent, UK.

WAZA, 2009. The World Association of Zoos and Aquaria. http://www.waza.org/home/index.php?main=home

WAZA, 2009. *Changing Climate Changing Zoos*. Proceedings of the 63rd WAZA Annual Conference. Adelaide 19–23 October 2008.

Wetlands International, 2009. *Planting trees to eat fish: Field experiences in wetlands and poverty reduction.* pp iii–144 Wetlands International, Wageningen, The Netherlands.

Witte, F., and van Densen, W. L. T. (Eds), 1995. *Fish Stocks and Fisheries of Lake Victoria: A handbook for field observations.* pp. ix–404. Samara Publishing Limited, UK.

Woo, P. T. K., 1995. *Fish Diseases and Disorders* Volume 1: Protozoan and Metazoan Infections. CABI Publishing.

Woo, P. T. K., and Bruno, D. W., 1999. *Fish Diseases and Disorders* Volume 3: Viral, Bacterial and Fungal Infections. CABI Publishing.

Wood, E, M., 2001. *Collection of coral reef fish for aquaria: global trade, conservation issues and management strategies*. Marine Conservation Society, UK, 80 pp.

Wood, E. and Dakin, N., 2004. *The Responsible Marine Aquarist.* Marine Conservation Society, UK.

Appendix I

Glossary

AMPHIBIAN ARK (AARK)

- AArk is an initiative for *ex situ* amphibian conservation, managed between WAZA, IUCN Conservation Breeding Specialist Group (CBSG) and IUCN Amphibian Specialist Group (ASG) http://www.amphibianark.org/

AFRICAN PRESERVATION PROGRAMME (APP)

- PAAZAB operates a co-operative conservation-breeding infrastructure known as the African Preservation Programme (APP). In March 2004 the Council of PAAZAB approved a recommendation from the APP Co-ordinating Committee to fine-tune the APP structure to allow for the inception of meta-population conservation management programmes on a non-commercial basis.

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

- Appendix I lists species that are the most endangered among CITES-listed animals and plants. They are threatened with extinction and CITES generally prohibits commercial international trade in specimens of these species. However trade may be allowed under exceptional circumstances, e.g. for scientific research. In these cases, trade may be authorised by the granting of both an export permit (or re-export certificate) and an import permit.
- Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. It also includes so-called 'look-alike species', i.e. species of which the specimens in trade look like those of species listed for conservation reasons. International trade in specimens of Appendix-II species may be authorised by the granting of an export permit or re-export certificate. No import permit is necessary for these species under CITES (although a permit is needed in some countries that have taken stricter measures than CITES requires). Permits or certificates should only be granted if the relevant authorities are satisfied that certain conditions are met, above all that trade will not be detrimental to the survival of the species in the wild.
- Appendix III is a list of species included at the request of a Party that already regulates trade in the species and that needs the co-operation of other countries to prevent unsustainable or illegal exploitation. International trade in specimens of species listed in this Appendix is allowed only on presentation of the appropriate permits or certificates.

CONSERVATION BREEDING PROGRAMMES

- Animal collections in individual zoos and aquariums are typically too small to be of much value to long-term conservation. Therefore, co-operative international or regional ex situ breeding programmes are required to form large, viable populations. These co-operative breeding programmes serve many purposes: providing animals for public educational and/or exhibit opportunities; providing fund-raising material; providing research collections from which to gain basic knowledge of animal biology and husbandry; and, on a larger scale, providing demographic and genetic backup to wild populations. To serve in all of these roles fully, these populations must be viable over the long term. This requires that they be demographically stable, healthy, well maintained, and capable of self-sustaining reproduction, distributed among several institutions to lessen the risks of catastrophic loss, of sufficient size to maintain high levels of genetic diversity.

Favia fragum grown from larvae using SECORE methods. © ZSL, UK.

Table 1. Marine and Freshwater Fish and Invertebrate Species listed under CITES Appendix I and II.

Aquatic Species	CITES Appendix	Held in Aquariums
Sharks and Rays		
Whale shark, *Rhincodon typus*	II	Y
Great white shark, *Carcharodon carcharias*	II	Y
Basking shark, *Cetorhinus maximus*	II	N
Sawfish, Pristidae spp. (except *Pristis microdon*)	I	Y
Pristis microdon (for the exclusive purpose of allowing international trade in live animals to appropriate and acceptable aquaria for primarily conservation purposes)	II	Y
Bony Fish		
ACIPENSERIFORMES spp. (paddlefishes, sturgeons – except those in App. I below)	II	Y
Shortnose sturgeon, *Acipenser brevirostrum*	I	
Sturgeon, *Acipenser sturio*	I	Y
Arapaima, *Arapaima gigas*	II	Y
Asian bonytongue, *Scleropages formosus*	I	Y
Congo blind barb, *Caecobarbus geertsi*	II	Y?
Pla eesok, *Probarbus jullieni*	I	N?
Cui-ui, *Chasmistes cujus*	I	N
Mekong giant catfish, *Pangasianodon gigas*	I	Y
European eel, *Anguilla anguilla*	II	Y
Seahorses, *Hippocampus* spp.	II	Y
Humphead wrasse, *Cheilinus undulatus*	II	Y
Totoaba, *Totoaba macdonaldi*	I	Y?
Coelacanth, *Latimeria* spp.	I	N
Australian lungfish, *Neoceratodus forsteri*	II	Y
Invertebrates		
Giant clams, Tridacnidae spp.	II	Y
Queen conch, *Strombus gigas*	II	Y
Freshwater mussels, pearly mussels, Unionidae	I (26 species) II (3 species)	Y (some)
Date mussel (marine), *Lithophaga lithophaga*	II	N?
Blue corals, Helioporidae spp. (Includes only the species *Heliopora coerulea*)	II	Y
Organ-pipe corals, Tubiporidae spp.	II	Y
Black corals, Antipatharia spp.	II	Y
Stony corals, Scleractinia spp.	II	Y
Fire corals, Milleporidae spp.	II	Y
Lace corals, Stylasteridae spp.	II	Y
Seacumber, *Isostichopus fuscus* (Ecuador)	III	N

- Conservation breeding programmes are typically organised at the level of the regional associations, because the exchange of animals between regions is expensive and – mainly due to veterinary restrictions – difficult. At its 2003 Annual Meeting, however, WAZA adopted a procedure for establishing inter-regional programmes, which may concern a number of species for which International Studbooks have been established.
- The measures implemented by regional associations may be limited to the collection of data (regional studbooks), they may aim at maintaining a long-term *ex situ* population, or they may be linked to *in situ* conservation, e.g. by producing animal for reintroduction to the wild. To manage their programmes, the associations have established special committees, Taxonomic Advisory Groups (TAGs) and Scientific Advisory Groups.
- Altogether, there are studbooks (international and regional) and/or breeding programmes for more than 850 different taxa.

EUROPEAN ENDANGERED SPECIES PROGRAMME

- The EEP is the most intensive type of population management for a species kept in EAZA zoos. Each EEP has a co-ordinator who is assisted by a Species Committee.
- The co-ordinator collects information on the status of all the animals of the species for which he or she is responsible, kept in EAZA zoos and aquaria, produces a studbook, carries out demographic and genetic analyses, produces a plan for the future management of the species and provides recommendations to participating institutions.

EUROPEAN STUDBOOK (ESB)

- ESB's represent a level of management with species covered by a studbook to which TAG's and participating institutions may refer, in order to make decisions. The ESB is less intensive than the EEP programme.
- The studbook keeper who is responsible for a certain ESB collects all the data on births, deaths, transfers etc. from all the EAZA zoos that keep the species.
- These data are entered into special computer software programmes, which allow the studbook keeper to carry out analyses of the population of that species.

EXTINCT IN THE WILD

According to the IUCN Red List of Threatened Species (2009.1) 36 animal species are "Extinct in the Wild" and survive only in human care. The aquatic organisms listed include the following:

Molluscs

- *Aylacostoma chloroticum*
- *Aylacostoma guaraniticum*
- *Aylacostoma stigmaticum*

Crustaceans

- Socorro isopod, *Thermosphaeroma thermophilum*

Fishes

- Goodeid, *Ameca splendens*
- Tiro, *Skiffia francesae*
- Perrito de Potosí, *Cyprinodon alvarezi*
- Carchorrito de Charco palmal, *Cyprinodon longidorsalis*
- Red-tailed shark-minnow, *Epalzeorhynchos bicolor*
- Bluish Lake Victoria cichlid, *Haplochromis lividus*
- *Labrochromis ishmaeli*
- Cachorrito enano de Potosí, *Megupsilon aporus*
- Lake Saradrano cichlid, *Paretroplus menarambo*
- *Platytaeniodus degeni*
- *Prognathochromis perrieri*
- *Yssichromis argens*

Amphibians

- Wyoming toad, *Bufo baxteri*

Reptiles

- Black soft-shelled turtle, *Aspideretes nigricans*.

INTERNATIONAL SPECIES INFORMATION SYSTEM (ISIS)

- ISIS was founded in 1973 when Drs Ulysses Seal and Dale Makey proposed the idea of an international database to help zoos and aquariums accomplish long-term conservation management goals. At that time, 51 zoos in North America and Europe responded to the invitation to participate in this network.
- The American Zoo and Aquarium Association (AZA), the American Association of Zoo Veterinarians (AAZV) and other zoological associations provided grants and endorsements for ISIS. In addition, the veterinarians raised development funding from private foundations and the United States Department of Interior. The Minnesota Zoological Garden hosted the program for 15 years.

- Since 1989, ISIS has been incorporated as a non-profit entity under an international Board of Trustees elected by subscribing member institutions.
- ISIS delivers and supports the world's most current, comprehensive and reliable source of information on animals and their environments for zoos, aquariums and related organisations to serve institutional, regional and global animal management and conservation goals. It is the mission of ISIS to facilitate international collaboration in the collection and sharing of information on animals and their environments for zoos, aquariums and related organisations.
- ISIS provides its members with the world standard zoological data collection and sharing software, used by 825 zoos and aquariums in 76 countries. ISIS is the global database for the zoological community, containing information on 2 million animals – almost 15,000 taxa/10,000 species. ISIS members use the basic biologic information (age, sex, parentage, place of birth, circumstance of death, etc.) collected in the ISIS system to manage genetic and demographic programs for their animal collections.
- Today, zoos and aquariums are leaders in the effort to breed endangered animals. Aquariums and zoos and are the "gene bank" of the web of life. Some species have been rescued from extinction, bred in zoos and returned to the wild, for example, the Black Footed Ferret, Californian Condor, Przewalski's Horse, Red Wolf, Micronesian Kingfisher, Arabian Oryx. This work takes a great deal of scientific expertise, genetic research, co-ordination, co-operation – and all of this relies on collecting and exchanging accurate animal data. Breeding and population management rely on knowing information about animals across the region, especially pedigree history and demography (births and deaths). Accurate record keeping is essential for managing endangered species in a collection or across several collections. ISIS software has long been recognised as the world standard best practice for zoological record keeping.

INTERNATIONAL STUDBOOKS

- International Studbooks for endangered and rare species are kept under the auspices of the World Association of Zoos and Aquariums (WAZA). In most cases, staff of WAZA Member Institutions serve as studbook keepers. The International Studbook Office is hosted by the Zoological Society of London, and the zoological director of ZSL acts as International Studbook Co-ordinator.
- Within WAZA, the Committee for Population Management (CPM) is the body dealing primarily with studbook issues.
- As of January 2007, there were 182 international studbooks including all subspecies and species that are kept as separate studbooks.

JOINT MANAGEMENT OF SPECIES COMMITTEE (JMSC)

- In Britain and Ireland, the Joint Management of Species Committee (JMSC), which is a special group of experts set up by BIAZA, oversees breeding programmes.
- The breeding programmes answer to their respective TAGs and are referred to as Joint Management of Species Programmes (JMSPs). Depending on the level of management (there are four levels of JMSP management), it is the studbook holder that requests which animals need to be bred to keep the captive population genetically, physically and psychologically healthy for the next 100 years (or an appropriate length of time).

NORTH AMERICAN REGIONAL STUDBOOK (ASB)

- A studbook is the pedigree and demographic history of a specifically defined taxon such as a genus, species, subspecies, or other specific population. The studbook may cover a single species that contains no subspecies, a single species and its various subspecies but without specimens of hybrid or unknown origin, a single species and its various subspecies and hybrids, or a genus and as many full species as are deemed appropriate by the Taxon Advisory Group (TAG) and the AZA Wildlife Conservation and Management Committee (WCMC). A studbook is delimited by geographic region: either regional or international.
- The American Zoo and Aquarium Association (AZA) has approved over 225 regional studbooks that form the basis for genetic and demographic management of populations in North American zoos and aquariums. Studbooks were initiated to provide accurate, up to date information in a standard format that could easily be used for genetic and demographic analyses of a single population. Quantitative analyses of data in a studbook are used to develop a management plan that is carried out through specific recommendations for each

specimen in the population. Without studbooks, it would be virtually impossible to manage populations scientifically.

- The studbook keeper maintains pedigree, demographic, and other data about a captive population. This information may then be used to manage the captive population on several levels. The most intensive management levels are the *ex situ* conservation efforts, such as the AZA SSP© programs. When no SSP© exists, the studbook keeper is encouraged to develop a Population Management Plan (PMP). A PMP will come to many of the same conclusions as the SSP© about breeding recommendations but is not as intensive, with goals that may or may not have conservation as a central focus. A common goal for this level of management is to maintain a self-sustaining captive population.

POPULATION MANAGEMENT PLAN

- Population Management Plans (PMPs) are designed to provide basic population management recommendations for various captive populations. PMPs are established for studbook populations that do not require the intensive management and conservation action of Species Survival Plans (SSPs).
- A PMP is directed by a population manager, who is often the approved studbook keeper. The population manager is responsible for monitoring the captive population and drawing attention to management options that will increase the genetic and demographic health of the population. Population managers use the same genetic and demographic protocols and software used for SSPs. They are also required to contact an advisor from the Small Population Management Advisory Group (SPMAG) to assist with compiling breeding recommendations.
- Although population managers use the same tools as SSP co-ordinators, PMP recommendations are often supplemented with 'rules of thumb' not appropriate for the more intensively managed SSPs. Because PMP participation is completely voluntary, these general guidelines provide participating institutions with options on how to best manage their animal populations.

SPECIES SURVIVAL COMMITTEE (SSCJ)

- In 1988, JAZA established the Species Survival Committee (SSCJ) as the support organisation of the Board of Directors developing co-operation relations with foreign zoos and aquariums.
- The Species Survival Committee of JAZA aims to secure the independence of breeding groups of species in need of systematic conservation and propagation efforts. In this context JP-1 designates species for propagation and JP-2 species for registration.

SPECIES SURVIVAL PLAN ®

- A Species Survival Plan ® is an AZA-copyrighted breeding and conservation programme designated to maintain a genetically viable and demographically stable population of a species in human care, and to organise zoo and aquarium based efforts to preserve the species *in situ*. Each SSP manages the breeding of a species in order to maintain a healthy and self-sustaining population that is both genetically diverse and demographically stable. Currently, 107 SSPs covering 161 individual species are administered. New SSPs are approved by the appropriate AZA Taxon Advisory Group (TAG), which manages conservation programs for related groups of species (apes, raptors, freshwater fish, etc.) or by the AZA Wildlife Conservation and Management Committee (WCMC). Each SSP has a qualified species co-ordinator who is responsible for managing day-to-day activities.

TAXON ADVISORY GROUPS

- Established by the American Zoo and Aquarium Association in 1990, Taxon Advisory Groups (TAGs) examine the conservation needs of entire taxa, or groups of related species. Examples of some basic taxonomic groups for which AZA TAGs exist are amphibians, felids, penguins, and marine fish.
- Each TAG consists of representatives from AZA-member institutions, as well as individuals with special expertise, such as AZA Species Survival Plan® (SSP) co-ordinators or studbook keepers.
- Serving as committees of expert advisors, Taxon Advisory Groups assist in the selection of appropriate species for AZA conservation programs and provide a forum for discussing husbandry, veterinary, ethical and other issues that apply to entire taxa.

ZOOLOGICAL INFORMATION MANAGEMENT SYSTEM (ZIMS)

- The International Species Information System's (ISIS) ZIMS Project is the next step in providing the zoo and aquarium industry with a comprehensive, integrated and current collection of animal, veterinary, husbandry, population and environmental data on 2 million animals in a web-based real-time global database.
- ZIMS has been developed with the participation of almost 500 curators, registrars, veterinarians, aquatic and terrestrial husbandry experts, and others from zoos and aquariums worldwide.
- Zoo and aquarium staff will have the ability to track their animal collections pre-birth (eggs or pregnancy) through to post-death (autopsy and pathology) and keep all staff up-to-date as the collection changes. As a central repository for animal and environment information worldwide, ZIMS will increase our understanding of the causes and effects of disease processes, behavioural changes, mortality events, breeding success and other important events within these collections. It will provide groundwork for international communication in the zoological community on a level never before imagined.

Axolotl *Ambystoma mexicanum*. This species is commonly kept in zoos, aquariums, research facilities and schools, but is Critically Endangered in the Wild. © Richard Gibson, Chester Zoo, UK.

Appendix II

Institutions, organisations and programmes associated with aquariums and aquatic conservation

REGIONAL AND NATIONAL ZOO AND AQUARIUM ASSOCIATIONS

- African Association of Zoos and Aquaria (PAAZAB) **www.paazab.com**
- American Zoo and Aquarium Association (AZA) **www.aza.org**
- Asociación Colombiana de Parques Zoológicos y Acuarios (ACOPAZOA) **www.acopazoo.zoobaq.org**
- Asociación Mesoamericana y del Caribe de Zoológico i Acuarios (AMACZOOA) **www.amaczooa.com**
- Association Nationale des Parcs Zoologiques de France (ANPZ) **www.anpz.org**
- Australian Regional Association of Zoological Parks/Aquaria Inc. (ARAZPA) **www.arazpa.org.au**
- Austrian Zoo Association (OZO) **www.ozo.at**
- British and Irish Association of Zoos and Aquariums (BIAZA) **www.zoofederation.org.uk**
- Danish Association of Zoological Gardens and Aquaria (DAZA) **www.daza.dk**
- Eurasian Regional Association of Zoos and Aquariums (EARAZA) **www.zoo.ru**
- European Association of Zoos and Aquaria (EAZA) **www.eaza.net**
- German Federation of Zoo Directors (VDZ) **www.zoodirektoren.de**
- Iberian Association of Zoos and Aquaria (AIZA) **www.aiza.org.es**
- Japanese Association of Zoos and Aquariums (JAZA) **www.jazga.org.jp**
- Latin American Zoo and Aquarium Association (ALPZA)
- Malaysian Association of Zoological Parks and Aquaria (MAZPA) **www.mazpa.org.my**
- National Foundation of Zoological Parks and Aquaria (FUNPZA) **www.funpza.org.ve**
- Sociedade de Zoológicos do Brazil (SZB) **www.szb.org.br**
- South Asian Zoo Association for Regional Co-operation (SAZARC) **www.zooreach.org**
- South East Asian Zoo Association (SEAZA) **www.seaza.org**
- Swedish Association of Zoological Parks and Aquaria (SAZA / SDF) **www.svenska-djurparksforeningen.nu**
- Swiss Association of Scientific Zoos (Zooschweiz) **www.zoos.ch**
- Syndicat National des Directeurs de Parcs Zoologiques Français (SNDPZ) **www.sndpz.fr**
- Union of Czech and Slovak Zoological Gardens (UCSZ) **www.zoo.cz**

ASSOCIATIONS

- Amphibian Ark (AArk) **http://www.amphibianark.org/**
- American Association of Zookeepers Inc. (AAZK) **www.aazk.org**
- Animal Keepers Association of Africa (AKAA) **www.zoo.ac.za/akaa**
- Aquariums de France **www.membres.lycos.fr/aquafrce**
- Aquarium and Zoo Facilities Association AZFA **www.azfa.org**
- Asociación Ibérica de Cuidadores de Animales Salvajes (AICAS) **www.aicas.org**
- Association Francophone des Soigneurs Animaliers (AFSA) **www.leszoosdanslemonde.com**
- Association of British Wild Animals Keepers (ABWAK) **www.abwak.co.uk**
- Australasian Society of Zoo Keeping ASZK **www.aszk.org.au**
- Berufsverband der Zootierpfleger (BdZ) **www.zootierpflege.de**
- Central Zoo Authority of India (CZAI) **http://envfor.nic.in**
- de Harpij – Organisatie van en voor Nederlandse en Belgische dierentuinmedewerkers **www.deharpij.nl**
- European Association for Aquatic Mammals (EAAM) **www.eaam.org**
- European Cetacean Society (ECS) **http://web.inter.nl.net**
- European Union of Aquarium Curators (EUAC) **www.euac.org**
- International Animal Data Information Systems Committee (IADISC) **www.iadisc.org**
- International Aquarium Forum **www.intaquaforum.org**
- International Congress of Zookeepers (ICZ) **http://www.iczoo.org/**
- International Marine Animal Trainers Association (IMATA) **www.imata.org**
- International Species Inventory System (ISIS) **www.isis.org**
- International Zoo Educators Association (IZE) **www.izea.net**
- Marine Museums and Aquariums **www.seasky.org/links/sealinko7.html**
- The Ocean Project (TOP) **www.theoceanproject.org**
- Zoo News **www.zoonews.ws**
- Zoo Outreach Organisation **www.zooreach.org**
- Zoo Registrars Association (ZRA) **www.zra.homestead.com**
- Zoo Talk **www.zoo-talk.com**

- Zoo-AG Bielefeld **www.zoo-ag.de**
- Zoo-Presseschau **www.zoopresseschau.info**
- Zoobiology, Mammal Behaviour and Ecology Study Group **www.zoobiology.de**
- ZooLex **www.zoolex.org**
- Zoologic Research and Consulting **www.zoologic.ch**
- Zoological Information Management System (ZIMS) **www.zims.org**

VETERINARY ASSOCIATIONS

- Alliance of Veterinarians for the Environment (AVE) **www.aveweb.org**
- American Association of Zoo Veterinarians (AAZV) **www.aazv.org**
- Association of Amphibian and Reptilian Veterinarians (ARAV) **www.arav.org**
- British Veterinary Zoological Society (BVZS) **www.bvzs.org**
- Canadian Co-operative Wildlife Centre **http://wildlife.usask.ca**
- Centre for Fish and Wildlife Health of Berne University (FIWI) **www.itpa.vetsuisse.unibe.ch/fiwi/html/en/1_0.html**
- Edinburgh Veterinary Zoological Website **http://homepages.ed.ac.uk**
- European Association of Zoo and Wildlife Veterinarians (EAZWV) **www.eazwv.org**
- Glasgow University Veterinary Zoological Society **www.gla.ac.uk**
- International Association for Aquatic Animal Medicine (IAAAM) **www.iaaam.org**
- International Veterinary Information Service (IVIS) **www.ivis.org**
- The Australian Association of Veterinary Conservation Biologists (AAVCB) **www.zip.com.au**
- Wild Vet Austria **www.wildvet.at**
- Wildlife Disease Association (WDA) **www.wildlifedisease.org**
- Wildlife Information Network (WIN) **www.wildlifeinformation.org**
- Zoo Animals Clinic of Zurich University **www.zooklinik.unizh.ch**

CONSERVATION AGENCIES AND INTERNATIONAL CONVENTIONS

- African Eurasian Waterbird Agreement (AEWA) **www.unep-aewa.org**
- Alliance Zero Extinction (AZE) **www.zeroextinction.org/index.htm**
- Amphibian Specialist Group (IUCN-SSC) **www.amphibians.org**
- Birdlife International **www.birdlife.org**
- Centre for Amphibia and Reptile Conservation in Switzerland (KARCH) **www.karch.ch**
- Conservation Breeding Specialist Group (CBSG IUCN-SSC) **www.cbsg.org**
- Conservation des Espèces et des Populations Animales (CEPA)
- Conservation Evidence (CEED) **www.conservationevidence.com**
- Conservation International CI **www.conservation.org**
- Convention on Biological Diversity CBD **www.biodiv.org**
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) **www.cites.org**
- Convention on Migratory Species (Bonn Convention – CMS) **www.cms.int**
- ECOTEER (volunteer placements) **www.ecoteer.com**
- European Nature Heritage Fund (EURONATUR) **www.euronatur.org**
- EUROSITE **www.eurosite-nature.org**
- Fauna and Flora International (FFI) **www.fauna-flora.org**
- Freshwater Fish Specialist Group (IUCN SSC / Wetlands International) **http://www.wetlands.org/Aboutus/Specialistgroups/FreshwaterFishSpecialistGroup/tabid/201/Default.aspx, www.iucnffsg.org** (in progress).
- Frozen Ark **www.frozenark.org**
- Global Nature Fund GNF **www.globalnature.org**
- IUCN International Union for Conservation of Nature and Natural Resources **www.iucn.org**
- Living Lakes **www.livinglakes.org**
- Marine Turtle Specialist Group (IUCN SSC) **www.iucn-mtsg.org**
- Mollusc Specialist Group (IUCN SSC)
- Odonata Specialist Group (IUCN SSC)
- Reef Doctor **www.reefdoctor.org**
- Reintroduction Specialist Group (IUCN SSC) **www.iucnrsp.org/pages/1/index.htm**
- Southern African Foundation for the Conservation of Coastal Birds (SANCCOB) **www.sanccob.co.za**
- Species Survival Commission (IUCN SSC) **www.iucn.org/themes/ssc**
- Tortoise and Freshwater Turtle Specialist Group (IUCN SSC) **www.iucn-tftsg.org**
- TRAFFIC **www.traffic.org**
- United Nations Environment Programme (UNEP) **www.unep.org**
- Wetlands Convention – Convention on Wetlands of International Importance (RAMSAR) **www.ramsar.org**
- Wetlands International **www.wetlands.org**
- Wildlife Conservation Society (WCS) **www.wcs.org**
- World Conservation Monitoring Centre (WCMC) **www.wcmc.org.uk**
- World Land Trust (WLT) **www.worldlandtrust.org**
- World Wide Fund for Nature Global Network (WWF) **www.panda.org**
- Zoo Conservation Outreach Group (ZCOG) **www.zcog.org**

Appendix III

Public aquariums: the global scale of the industry

How many aquariums are there around the world?

Public aquariums represent a substantial sector of animal attractions, both as stand-alone institutions in their own right and as components of established zoological gardens. The estimated number of aquariums globally, based on submissions from the recognised regional zoo and aquarium associations, is summarised as follows:

Geographic Region	Aquariums	Zoos with a formal Aquarium
Japan	67	2
United States of America	40	23
China	60	0
Canada	4	3
Australia / New Zealand	12	3
Europe	40	100
Africa	5	1

Including aquariums which are not members of regional associations, the number is estimated to be 315. Recent years have seen an extraordinary increase in the development of new aquariums globally, creating unprecedented access to new audiences and fresh opportunities to interpret aquatic conservation issues. More than 100 free-standing aquariums have been opened since the early 1990s, representing an investment of hundreds of millions of dollars. The significant new aquariums developed since 2000 are summarised as follows:

Geographic Region	New Aquariums since 2000
Europe	15
Japan	13
North America	17
China	22
Australia / New Zealand	0
Middle East	2
Africa	1
Rest of world	70

How many people visit aquariums around the world?

The tremendous potential for the aquarium industry to influence international behaviour trends in favour of conservation action is reflected in the number of visitors to these aquariums each year. Based on submissions from the recognised regional zoo and aquarium associations, the number of visitors is summarised as follows:

Geographic Region	Visitors to Stand-alone Aquariums (millions per annum)	Visitors to Zoos with Aquariums (millions per annum)
China	*20 000 000	?
Japan	32 600 000	2 960 000
United States of America	42 500 000	32 000 000
Australia / New Zealand	4 000 000	1 200 000
Europe	20 000 000	52 000 000
South Africa	1 200 000	614 139
Canada	2 200 000	3 200 000
Total	**~150 000 000**	**~100 000 000**

* The number of aquarium visitors in China could be as high as 200 000 000 per annum.

Which aquariums currently enjoy the largest number of visitors?

The popularity of individual aquariums depends on a variety of factors, ranging from the quality of the exhibits and presentations to the population size in the region of the aquarium. The stand-alone aquariums that currently enjoy the highest visitor numbers per annum include the following:

Country	Aquarium	Visitors
USA	Living Seas	6 300 000
USA	SeaWorld Orlando	5 000 000
USA	SeaWorld San Diego	4 000 000
China	Ocean Park, Hong Kong	3 388 000
Japan	Okinawa Churaumi Aquarium	3 023 328
Japan	Osaka Aquarium Kaiyukan	2 495 277
Japan	Port of Nagoya Public Aquarium	2 122 709
Japan	Yokohama Hakkeijima Sea Paradise	1 789 309
USA	John G. Shedd Aquarium	1 710 000
USA	Monterey Bay Aquarium	1 700 000
Australia	Sydney Aquarium	1 600 000
Japan	Tokyo Sea Life Park	1 582 192
Spain	Barcelona Aquarium	1 500 000
China	Beijing Aquarium	1 500 000
China	Fuzhou Zuohai Underwater World	1 500 000
Italy	Acquaria de Genova	1 350 000
China	Shanghai Ocean World Aquarium	>1 000 000
Portugal	Oceanario de Lisboa	>1 000 000
China	Dalian Tiger Beach Ocean Park	>1 000 000
China	Qingdao Ocean Park	>1 000 000
China	Qingdao Polar Ocean World	>1 000 000
China	Dalian Sun Aisa Polar World	>700 000
China	Beijing Underwater World (Blue Zoo)	>700 000
China	Beijing Pacific Underwater World	>700 000
China	Shanghai Changfeng Ocean World	>700 000
China	Changsha Underwater World	>700 000
China	Xi'an Qujiang Ocean World	>700 000

Pacific sea-nettle exhibit at Monterey Bay Aquarium USA

The zoos with formal aquariums as part of the visitor attraction with the highest visitor numbers per annum include the following:

Country	Zoos with an Aquarium	Visitors
USA	Disney's Animal Kingdom	8 300 000
USA	Busch Gardens Tampa Bay	4 500 000
Russia	Moscow Zoo	3 500 000
Germany	Berlin Zoo	3 200 000
USA	Saint Louis Zoo	2 922 000
Austria	Wien Zoo	2 500 000
Japan	Higashiyama Zoo and Bot. Gardens	2 319 341
Germany	Stuttgart Zoo	2 200 000
Germany	Leipzig Zoo	1 800 000
USA	Denver Zoo	1 537 000
USA	Houston Zoo	1 500 000

How many animals are held in aquariums around the world?

According to the International Species Information System (ISIS), the following are listed as at December 2008:

Total number of animals*	2 314 938
Living individuals	373 498
Group count	61 637

* Aquatic and terrestrial

	Families	Genera	Species	Subspecies
Agnatha (jawless fish)	0	1	5	0
Chondrichthyes (sharks and rays)	3	22	143	1
Osteichthyes (bony fish)	51	503	3 388	43

	Individuals	Living individuals	Groups
Agnatha (jawless fish)	8	1	6
Chondrichthyes (sharks and rays)	4 314	1 435	521
Osteichthyes (bony fish)	21 452	3 113	21 995

The International Species Information System (ISIS) has historically been used primarily by zoos rather than aquariums, and the organisation has spent half of this decade developing the Zoological Information Management System (ZIMS) with aquariums in mind. This revolutionary new concept will provide the zoos and aquariums of the world with a real time web-based information system to facilitate the macro-management of these animal collections. ZIMS is due to launch late in 2009.

The aquariums of the world hold a substantial biological reservoir, and the regional associations report the following:

	Japan	USA	Europe	Australia / NZ	Africa
Orders	280	-	60	87	-
Families	1 000	-	218	254	-
Genera	2 300	-	809	516	-
Species	5 200	-	1837	946	350
Individuals	1 170 000	318 700	61 398	41 692	19 000

Appendix IV

Public aquariums: strengths and challenges in support of conservation

Strengths of aquariums in support of conservation

The following lists were compiled based on discussions held at the EAZA/EUAC Lower Vertebrate and Invertebrate Taxon Advisory Group Meeting, Prague Zoo, 21 March 2003 and the EUAC Executive Committee Meeting, Basel Zoo, 22 March 2003.

- *Ex-situ* conservation of aquatic organisms can be a very cost-effective method of maintaining Critically Endangered populations pending re-introduction;
- Public perceptions relating to aquariums are generally positive;
- There is a high degree of public awareness and interest in marine issues in developed countries;
- Aquariums have a good public image with respect to animal welfare;
- Aquariums are mostly located in highly populated areas, and require a smaller footprint than zoos;
- They are often all-weather facilities with self-contained environments;
- There is a high rate of development of new aquaria globally, and thus a lot of potential;
- The industry has a high level of staff expertise;
- There is much open and positive communication between aquariums;
- Aquarium collections cover broad species diversity and biomass;
- Aquariums provide meaningful educational opportunities, including immersion experiences;
- There is a positive association with research and academic institutions;
- There is significant potential for direct local involvement in conservation projects due to location and local representation within exhibits;
- Aquariums can accurately represent natural habitats with ecological integration of exhibits, illustrating natural ecology rather than single species;
- The relatively short natural lifespan of many species make them suitable for temporary displays/changing exhibits;
- Major advances have been made in life support technologies, and these continue to improve;
- Nutritional technologies have also improved dramatically over time;
- Aquariums can make a substantial contribution to conservation medicine;
- Aquarium staff expertise can be invaluable in field programmes;
- Aquariums have tremendous opportunities to transfer technology and expertise to field conservation efforts (e.g. reef restoration);
- Aquariums are well placed to develop programmes of certified wild sourcing of stock to ensure sustainable livelihoods for collectors;
- Aquariums have a unique opportunity to facilitate the formal collection of biological/life history data which are unknown/poorly studied for many species;
- Aquariums can contribute meaningfully to conservation assessments – only 10% of all fish species have been assessed for the IUCN Red List of Threatened Animals;
- Aquariums can develop co-operative and/or managed breeding programmes for certain species, and participate in carefully controlled reintroduction programmes;
- The development of Information Technology and biotechnology (e.g. cryopreservation) will increase the success of breeding programmes;
- Aquariums can influence public opinion, and promote the sustainable and responsible sale of fish in shops and restaurants;
- Aquariums are well placed to support and develop the aquatic conservation component of national education curricula; and
- Aquariums provide crucial platforms for lobbying on conservation issues.

Challenges for Aquariums in support of Conservation

- The biggest concentration of aquariums is in developed countries;
- Many developing countries do not have well developed aquatic conservation interests;

- Many developing countries do not have the significant resources and technology required to build and operate large aquariums;
- Aquariums are expensive to build and to operate;
- Aquariums are highly dependent on technology and skills;
- Aquariums have high energy requirements;
- There are few or no aquariums located in the areas of highest tropical freshwater biodiversity, e.g. the Amazon basin, the Congo basin;
- There is a common public perception that the oceans and fresh waterways have an infinite supply of fish;
- People don't identify with fish emotionally, and have less empathy for them than terrestrial animals;
- Fish are seen as food, and not as wildlife;
- Fish are being increasingly exploited for food as socio-economic pressures increase;
- There is a shortage of support facilities for conservation, breeding and research;


Moray eel © Richard Gibson, Chester Zoo, UK.

- There is a lack of baseline information on the number and diversity of species kept;
- Record keeping is difficult, being largely dependent on colony management;
- Specialised veterinary capacity has significantly improved, but needs to be further developed in light of huge species diversity in aquariums;
- Disease outbreaks are expensive to treat, often difficult to control in terms of biosecurity and pose logistical challenges;
- The public aquarium industry still depends on supplementation from the wild;
- There is more legislation and increased pressure on the wild-caught acquisition of stock;
- Breeding successes are limited, and the industry has few co-operative breeding programmes;
- Food culture is difficult and costly, but necessary for the holding and/or breeding of many fish species;
- Public displays may encourage the hobbyist trade;
- Irresponsible trade practices are not well controlled;
- There are increasing animal welfare/rights group pressures, particularly with respect to sharks and marine mammals;
- Local environments pose a threat to open-system aquariums e.g. oil spills;
- Aquariums can damage local ecosystems through the accidental release of exotics, or discharge of drugs and other pollutants;
- There is a lack of awareness and poor implementation of IUCN reintroduction guidelines; and
- The WAZA Aquarium Strategy is very field-orientated, and aquariums are only beginning to realise their potential in this area.

Appendix V

Public aquariums: global role in education

The World Zoo Conservation Strategy suggests that some 650 million visitors enjoy an outing to a zoo or aquarium each year. This number is roughly one-tenth of the world's population, and represents more people than those who visit all ball games in a year throughout the world. The potential impact the industry can have on the visiting public is enormous. Although people don't necessarily visit an aquarium in order to learn something, many role players in the industry believe that people shouldn't leave an aquarium without:

- having enjoyed leisure time with family or friends;
- having gained some knowledge of aquatic habitats and the creatures in them;
- having developed a greater appreciation of aquatic habitats; and
- having been empowered to make the lifestyle changes needed to ensure the sustainable use of our planet's limited resources.

The following are points raised during a series of workshops regarding the role that aquariums play in educating both the public and aquarium personnel:

- Public aquariums have a moral obligation to promote conservation education;
- Aquariums are well versed at presenting biothematic exhibits, representing realistic multi-species habitats and communities;
- Aquariums induce a feeling of awe and wonderment, resulting in emotional as well as cognitive gains;
- Aquariums take visitors into a world that is alien and inaccessible to many, using innovative methods e.g. acrylic tunnels;
- Aquariums can illustrate the socio-economic value of aquatic animals by making visitors aware of the hobbyist trade and aquaculture industry;
- Aquariums can illustrate the cultural value of aquatic animals in different countries;
- Exhibits can be designed with the interpretation thereof in mind, often using hi-tech equipment to convey a message to the public;
- Education can be focussed on changing human behaviour, and can incorporate a call to action;
- Less charismatic species can be displayed to good effect;
- Aquariums are able to showcase the diversity of species, and emphasise the importance of ecosystems;
- Several aquariums form important components of urban regeneration programmes;
- Aquariums are most often found in cities, and bridge the gap between wilderness and city life;
- Aquariums can play a positive role in educating the hobby industry in terms of welfare and responsible practice;
- Many of the newer aquariums have a more local or regional theme based on local habitats and species, thus providing visitors with a unique experience relevant to that particular region.

Diver explaining sustainable seafood programme, Monterey Bay Aquarium, USA.

Appendix VI

Public aquariums: international conventions, codes and guidelines

SPECIES SPECIFIC

- Director General, New South Wales Department of Primary Industries. Amended March 2006. ***Standards for Exhibiting Pinnipeds in New South Wales.*** NSW. Australia.
- Professional Committee for Marine Mammals of European Zoos. 1988. ***Guidelines for the keeping of the Bottle-nosed Dolphin and Marine Dolphins of the same size in member countries of the EEC.***

MARINE MAMMAL SPECIFIC

- Queensland Department of Primary Industries. August 1992. ***Guidelines for the Care, Holding and Transport of Marine mammals in Queensland.*** Queensland Australia.
- United States Department of Agriculture. Update April 2001. ***Standards for Keeping Marine Mammals in Captivity.*** USA.
- Alliance of Marine Mammal Parks and Aquariums, ***Abbreviated Standards and Guidelines***. 2003. USA.
- Swiss Animal Welfare Ordinance. Draft 2006. ***Minimum requirements for the keeping of aquatic mammals according to the Swiss Animal Welfare Ordinance.*** Switzerland.

Leafy seadragon, *Phycodurus eques*. © Richard Gibson, Chester Zoo, UK.

ANIMALS IN GENERAL

- European Association of Zoos and Aquariums. Approved 2006. ***Minimum Standards for the Accommodation and Care of Animals in Zoos and Aquaria.***
- Report to the Federal Assembly of the Swiss Confederation. 1995. ***Swiss Federal Act on Animal Protection 1978*** (Stated 1995) and ***Swiss Animal Protection Ordinance 1981*** (Stated 1998). Including Appendix 2. ***Minimum Requirements for the keeping of wild animals.***
- Le Ministre de L'Agriculture. 1999. ***Belgian Standards.*** (Non-English document).
- Swedish Animal Welfare Agency 2004. ***Animal protection regulations in regards to the husbandry of animals in Animal Parks.*** (Non-English document) Sweden.
- Canadian Association of Zoos and Aquariums. ***CAZA Standards of Animal Care and Housing.***
- Standards South Africa. 2003. ***South African National Standards for Zoo and Aquarium Practice.*** South Africa.

RECOMMENDED HUSBANDRY MANUALS

- Laurence Couquiaud. Special issue 2005. **Aquatic Mammals** – ***A Survey of the Environments of Cetaceans in Human Care.*** Especially Chapter 8 – Husbandry.
- Harris, Gabrielle, Updated 2005. ***Animal Care Manual for Mammals and Birds at SEAWORLD uSHAKA Marine World***. South Africa.
- EAZA Marine Mammal TAG (Comp. and Ed.). 2008. **Husbandry guidelines for eared seals (Otariidae).** http://www.eaza.net/members/DownlTAGs/Hg_eared%20seals%20VERSION%202008.pdf
- Sea World uSHAKA ***Marine Mammal Training Standards and Procedures Manual***. Edited Aug 2005.
- USDA ***Sterilization of Marine Mammal pool waters. Theoretical and Health Considerations***. Oct 1991.
- Smith, M., Warmolts, D., Thoney, D. and Hueter, R., 2004. ***The Elasmobranch Husbandry Manual: Captive Care of Sharks, Rays and their Relatives.*** http://www.colszoo.org/internal/elasmo_2005/page2.htm
- Koldewey, H. J. (Ed.). 2005. ***Syngnathid Husbandry in Public Aquariums.*** http://seahorse.fisheries.ubc.ca/pubs/Syngnathid_Husbandry_Manual2005.pdf
- Leewis, R. and Janse, M. (Eds)., 2008. ***Advances in coral husbandry in public aquariums.*** Volume 2 in the Public Aquarium Husbandry Series. http://www.coralhusbandry.org/

Appendix VII

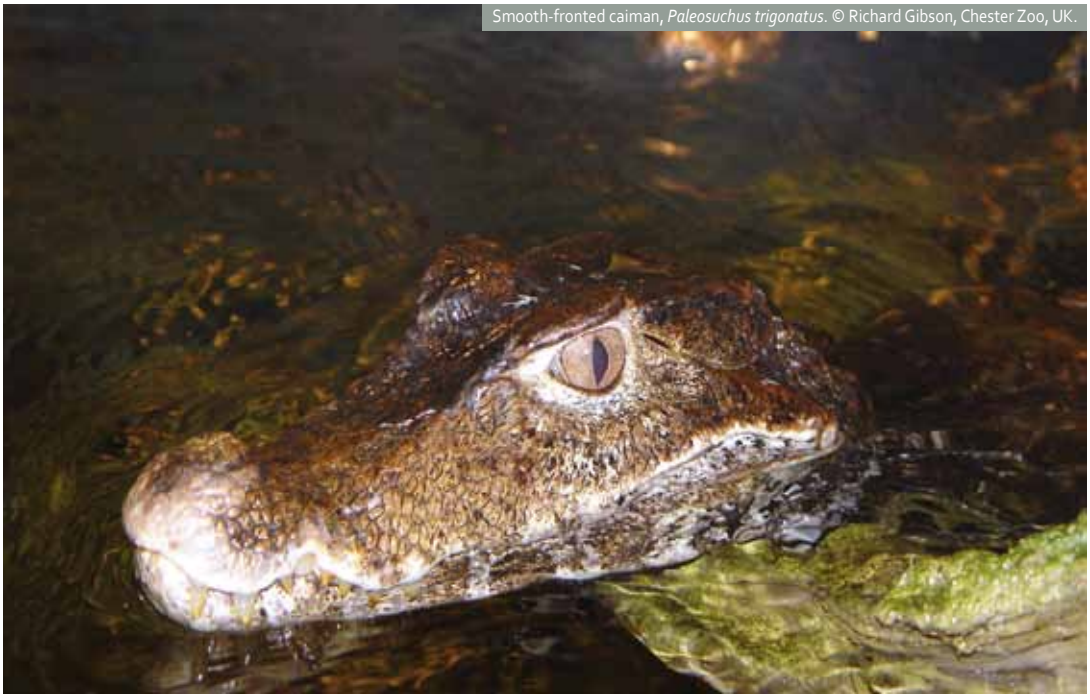
Public aquariums: examples of *in situ* and *ex situ* conservation and education projects

Species/Habitat	Project	Organisation
MARINE		
	Centre for Ocean Solutions (COS) was created to develop new knowledge to solve ocean challenges. COS researchers and staff reach out to decision-makers from government, business, and the non-profit sectors to translate the results of marine science and policy research into action	The Stanford University, Monterey Bay Aquarium, Monterey Bay Aquarium Research Institute (MBARI) http://www.centerforoceansolutions.org/
	Tagging of Pacific Predators began in 2000 as one of 17 projects of the Census of Marine Life, an ambitious 10-year, 80-nation endeavour to assess and explain the diversity and abundance of life in the oceans, and where that life has lived, is living, and will live	NOAA's Pacific Fisheries Ecosystems Lab, Stanford's Hopkins Marine Lab, and University of California, Santa Cruz's Long Marine Laboratory http://www.topp.org/
	The Ocean Project is a global initiative to increase the public's level of ocean awareness and conservation action. By improving the effectiveness of conservation communications, The Ocean Project hopes to instil in the public a lasting, measurable, top-of-mind awareness of the importance, value and sensitivity of the oceans	Over 400 aquariums, zoos, science, technology, and natural history museums, conservation organisations and others www.gdrc.org/oceans/oceans-day.html
Marine mammals		Fjord and Baelt (Denmark) www.fjord-baelt.dk
Marine mammals	The Chiloé Small Cetacean Project. Assessing the conservation status of endemic Chilean dolphins and other small cetaceans and local capacity building	Jointly implemented by Biol. Marjorie Fuentes and Dr Sonja Heinrich with the support of the NGO Yaqu Pacha (since 2001), the Wildlife Conservation Society (through a 2003 Research Fellowship Grant) and the Zoo Nuernberg (since 2007), as well as by the Society for Marine Mammalogy (2001, 2005), Universidad Austral de Chile (2001-ongoing, logistics support), University of St Andrews (2002–2004: equipment), local government authorities (Municipality of Quellón: 2004–2007 loan of equipment for educational campaigns in rural schools) www.tiergarten.nuernberg.de/v02/de/pub/index.html?navID=45andpoolID=60andIDS=bRRWrRUM http://eaam.org/index.php?option=com_contentandtask=viewandid=82andItemid=53
Humpback dolphins	The Humpback Dolphin Project was established in the 1990s to monitor the status of humpbacked dolphins; a threatened species which is negatively affected by shark nets off the KZN coast	Operated by the Endangered Wildlife Trust's (EWT) Marine and Coastal Conservation Group, supported by uShaka Marine World, and the Kelley Legge Dolphin Fund. In co-operation with Natal Sharks Board, Richards Bay Coal Terminal, Local Municipalities along the Natal-Kwazulu Coast, and the National Ports Authority www.ewt.org.za
Manatees	Manatee Conservation Centre	Operated under an agreement between the Ministry of Environment and Natural Resources of the Bolivarian Republic of Venezuela (MARN), the National Foundation of Zoological Parks and Aquariums of Venezuela (FUNPZA), the Zoological Foundation of South Park Zoo, Maracaibo, and The Dallas World Aquarium www.funpza.org.ve/centro_manati.html http://www.waza.org/conservation/projects/projects.php?id=48
Manatees	The US Fish and Wildlife Service's Manatee Rescue and Rehabilitation Program. Eight male manatees have been housed at Manatee Coast with four being rehabilitated and sent to Florida for release to the wild over the past five years	Columbus Zoo and Aquarium, US Fish and Wildlife Service, Sea World, Orlando http://www.columbuszoo.org/conservation/ongroundsprograms.aspx http://www.seaworld.org/animal-info/info-books/manatee/conservation.htm
Marine otters, *Lontra felina*	Marine Otter Conservation Programme	Implemented by PRO DELPHINUS with the support of Columbus Zoo and SECAS Zoo, the Fulbright Commission, and Idea Wild, and in partnership with the Fishermen Association at Ilo, Morro Sama and Vila Vila www.prodelphinus.org
Humboldt penguins, *Spheniscus humboldt*i	The Humboldt Penguin Conservation Center, Punta San Juan	Jointly operated by the Brookfield, Philadelphia and Saint Louis Zoos in co-operation with the American Zoo and Aquarium Association's (AZA) Humboldt Penguin Species Survival Plan (SSP) and Penguin Taxon Advisory Group (TAG), in the current effort include Spondulus and ACOREMA (two Peruvian NGOs), and the Proabonos Fertilizer Company, which is the landowner www.stlzoo.org/wildcareinstitute/humboldtpenguinsinperu.htm

Species/Habitat	Project	Organisation
MARINE		
Humboldt penguins, *Spheniscus humboldti*	Supporting the Conservation of the Humboldt-Penguin and its Habitats in Southern Chile	The conservation work of the Fundación Otway is supported by the Zoo Landau in der Pfalz, the Zoo am Meer, Bremerhaven, the Zoo Magdeburg and the Zoo Osnabrück (all in Germany), the Zoological Society of Ireland – Dublin Zoo, as well as by the Frankfurt Zoological Society, Martin Will's Trust, WWF Germany, Batsford Arboretum, Berufsverband der Zootierpfleger (German Zookeepers Association), Naturschutzbund Sachsen, Senckenberg Research Institute and Nature Museum, and Friends of Landau Zoo www.zoo-landau.de
African penguins, *Spheniscus demersus*	Helping SANCCOB (*The Southern African Foundation for the Conservation of Coastal Birds*) to rescue African penguins Establishing new breeding colonies of African penguins	Artis Zoo, Banham Zoo, Bristol Zoo, Paignton Zoo, Baltimore Zoo, Birmingham Zoo (USA), Landau Zoo Zoologischer Garten Wuppertal and PAAZAB Implemented by Bristol Conservation and Science Foundation (Bristol Zoo), and supported by SANCCOB, New England Aquarium, IFAW, Dyer Island Conservation Trust, University of Cape Town, and the Marine Coastal Management Authority of South Africa www.sanccob.co.za
Sea turtles	There are several regional programmes related to marine turtle, some of which focus on research (e.g. Naples), others on rehabilitation of cold-shocked turtles (e.g. New England), others breeding (e.g. Nagoya) and others public education (e.g. impact of plastic bags ingested by turtles – (Oceanopolis)	Naples (Italy), Genoa (Italy), Monterey Bay (USA), Port of Nagoya (Japan), La Rochelle (France) New England (USA), La Coruna (Spain), Oceanopolis (France) http://www.szn.it/SZNWeb/showpage/115?_languageId_=2; http://www.neaq.org/conservation_and_research/projects/conservation_medicine/rescue_and_rehabilitation/index.php
Grey nurse shark, *Carcharias taurus*	The use of Assisted Reproductive Techniques in large sharks in aquaria: Potential for helping the grey nurse shark, *Carcharias taurus*	Implemented by UnderWater World and Melbourne Aquarium, and supported by ARAZPA www.underwaterworld.com.au
Northern bluefin tuna, *Thunnus orientalis* and *Thunnus thynnus*	Revealing tuna secrets. Since 1994, staff have been tagging giant bluefin tunas in the wild and studying tunas at the facility in Pacific Grove, next door to the aquarium	Monterey Bay Aquarium, Tuna Research and Conservation Center (TRCC) http://www.montereybayaquarium.org/cr/trcc.asp
Seahorses, *Hippocampus* spp.	Project Seahorse is an international organisation committed to conservation and sustainable use of the world's coastal marine ecosystems. It engages in connected research and management at scales ranging from community initiatives to international accords. Collaborating with stakeholders and partners, it uses seahorses to focus its efforts in finding marine conservation solutions	University of British Colombia, Canada; Zoological Society of London (ZSL), UK; John G. Shedd Aquarium, USA www.projectseahorse.org
Banggai cardinalfish, *Pterapogon kauderni*		New Jersey State Aquarium www.njaquarium.org
Coral and zooxanthellae	Molecular genetics studies	Wildlife Conservation Society
FRESHWATER		
Mexico's endemic goodeid fishes and aquatic *Ambystoma* salamanders	Established in 1998, FishArk endeavours to preserve of Mexico's threatened, sometimes Extinct in the Wild, Goodeid fishes and aquatic *Ambystoma* salamanders. Based at the University in Morelia, more than forty fish species are successfully maintained and reproduced in aquariums whilst related laboratory and field research and conservation initiatives are undertaken by university staff and students. Lake Zacapu, one of the focuses of field work, has received RAMSAR designation as a result of FishArk attention	University Michoacana de San Nicolas de Hidalgo, Morelia, Mexico, Chester Zoo, UK, Private Goodeid enthusiasts
Alpine fish fauna		Innsbruck Aquarium
Lake Victoria cichlids	Managing studbook for Lake Victoria cichlids	New England Aquarium, Toledo Zoo
Turtles	The International Centre for the Conservation of Turtles. Enhancing the survival of threatened South-East Asian wildlife by linking *ex situ* measures with *in situ* conservation *(South East Asian Wildlife)*	Münster Zoo www.allwetterzoo.de
European pond terrapins	Nest-adoption scheme for European Pond Terrapins at the Donau-Auen National Park	Vienna Zoo www.zoovienna.at
Western pond turtle	Western Pond Turtle Recovery Programme	Implemented by Woodland Park Zoo and Oregon Zoo, in partnership with the Washington State Department of Fish and Wildlife, Nature Conservancy, U.S. Forest Service, Western Aquatic Turtle Education and Research, and supported by the American Zoo and Aquarium Association's Conservation Endowment Fund www.zoo.org/conserve/worldwide.turtle.html

Species/Habitat	Project	Organisation
FRESHWATER cont'd		
Western swamp tortoise	Western Swamp Tortoise Breeding for Release Programme	Implemented by Perth Zoo, in partnership with the Western Swamp Tortoise Recovery Team members with input from Dr Gerald Kuchling of UWA, Conservation and Land Management (CALM), the World Wildlife Fund and Friends of the Western Swamp Tortoise
Desert fishes		Dallas Zoo; El Paso Zoo; Columbus Zoo and Aquarium
Sturgeon	Sturgeon recovery programmes	La Rochelle www.aquarium-larochelle.com Tennessee Aquarium http://www.tnari.org/
Corfu killifish, *Valencia letourneuxi*	Rapid assessment of population status and development of conservation management plan	Hellenic Centre for Marine Resources, Greece; Zoological Society of London www.zsl.org
Freshwater fishes	Endangered endemic freshwater fish	Rhodes Aquarium
Otjikoto tilapia	Protected areas for *Otjikoto tilapia*	Chester Zoo
AMPHIBIANS		
	The El Valle Conservation Center	Operated by the Houston Zoo, (USA) in collaboration with the El Nispero Zoo at El Valle de Antón (Panamá), which has provided the site and will maintain the facility once it is completed. The partner institutions involved in this project are numerous, including representatives of Project Golden Frog and the Amphibian Recovery and Conservation Coalition. Key institutions involved in the planning process were the Atlanta Botanical Gardens, Zoo Atlanta, Denver Zoo, and the Maryland Zoo in Baltimore all of which hold amphibians that are destined for return to Panama once the Center is operational. The Conservation International's Neotropical Critically Endangered Species Fund, San Antonio Zoo, Zoological Society of San Diego, Moody Gardens (all USA) , Banco Continental – Panamá, Ripard Holding Corp. – Panamá, and Continental Airlines provided financial support The Summit Natural Park, at Panama City has, and will continue to, provide construction expertise, manpower, and equipment to this project www.houstonzoo.org/Golden_Frogs.aqf
	Perth Zoo Frog Breeding and Research	Implemented by Perth Zoo, in partnership with the Western Australian Department of Conservation and Land Management, Western Australian Museum, University of Western Australia, and Murdoch University, and funded through a grant from the Western Australian Office of Science and Innovation
Southeast Asian frogs	Reproductive variation in common Southeast Asian frogs	Implemented by Miss Jennifer Sheridan, University of California, San Diego, and supported by the American Society of Ichthyologists and Herpetologists and the Singapore Zoological Gardens
Vietnam amphibians	Vietnam Amphibian and Reptile Breeding Station	Implemented by Cologne Zoo in co-operation with the Institute of Ecology and Biological Resources, Vietnamese Academy of Science and Technology (IEBR), Hanoi, Vietnam www.zoo-koeln.de
	Amphibian Conservation in the Wildnispark Zürich, Switzerland	www.wildpark.ch, www.sihlwald.ch
Bufo viridis	Saving Sweden's most endangered amphibian species	www.nordensark.se
European tree frog	Re-introduction of the European tree frog at the Lake of Lauerz, Switzerland	www.tierpark.ch
Common midwife toad, *Alytes obstetricans*	Loss of genetic diversity and chytridiomycosis in the common midwife toad, *Alytes obstetricans* in Switzerland	www.zoo.ch/xml_1/internet/en/application/d693/f717.cfm
Titicaca water frog, *Telmatobius culeus*	Assessing the threats and conservation status of the Titicaca water frog, *Telmatobius coleus*	Implemented by Stiftung Artenschutz and Asociación Armonía (section of BirdLife International), Santa Cruz de la Sierra, Bolivia, with the support of Thrigby Conservation Fund (Thrigby Hall Wildlife Gardens und AmazonaZOO), Zoo Salzburg, Blue Planet Aquarium (United Kingdom), and Natuurpunt (Belgium) www.armonia-bo.org

Species/Habitat	Project	Organisation
AMPHIBIANS cont'd		
Puerto Rican crested toad	The Puerto Rican Crested Toad Species Survival Plan	Implemented by The Audubon Zoo, The Maryland Zoo in Baltimore, Buffalo Zoological Gardens, Central Florida Zoological Park, Central Park Zoo, Chester Zoo , Cincinnati Zoo and Botanical Garden, Cleveland Metroparks Zoo, Columbus Zoo , Dallas Zoo, Detroit Zoo, Disney's Animal Kingdom, Fort Worth Zoo, Granby Zoo, Juan Rivero Zoo, Louisville Zoological Gardens, Lowry Park Zoo, Miami MetroZoo, Milwaukee County Zoological Gardens, North Carolina Zoo, Oklahoma City Zoo, Omaha's Henry Doorly Zoo, Saint Louis Zoo, Santa Barbara Zoological Gardens, Sedgwick County Zoo, Toledo Zoo, Toronto Zoo and The Vancouver Aquarium Marine Science Center, in co-operation with Puerto Rican Department of Natural Resources, The United States Fish and Wildlife Service, University of Puerto Rico, Ciudadanos del Karso, and Inciativa Herpetologica, Inc. The SSP is supported by the American Zoo and Aquarium Association (AZA)
Amphibians in South-West Colombia	Conservation of Amphibians in South-West Colombia	Implemented by Zoo Zürich (Switzerland) and Cali Zoo (Colombia) with financial support from EUAC www.zoo.ch
Hellbender	The Ron Goellner Center for the Conservation of the Hellbender at St Louis Zoo	Operated by the St Louis Zoo in co-operation with the Missouri Department of Conservation, the Arkansas Game and Fish Commission, the University of Missouri – Rolla, the Southwest Missouri State University, the University of Arkansas, and the United States Fish and Wildlife Service. The project is supported by AZA and a number of Accredited AZA-Institutions, AZA's Cryptobranchid Interest Group www.stlzoo.org/wildcareinstitute/hellbendersinmissouri.htm
HABITAT		
Mangroves	Mangrove management	Bonaire, Rotterdam Zoo Philippines, Zoological Society of London www.zsl.org
Seagrass	Seagrass beds in Chesapeake Bay	National Aquarium in Baltimore www.aqua.org
Marine protected areas	Transboundary Marine Protected Areas in Mozambique and Tanzania	SAAMBR
Glovers Reef		WCS/AZA www.aza.org
Coral rehabilitation	Project SECORE is a unique initiative to address coral conservation issues by combining the best of two worlds. It creates a platform where public aquaria and zoos work closely together with marine science, sharing knowledge and practical skills in coral husbandry and coral research. SECORE aims at contributing to a healthy future for the most diverse ecosystem of the sea: the coral reef	A consortium of more than 50 aquariums including Rotterdam Zoo and Columbus Zoo and Aquarium. The full list of collaborating organisations can be found on the Secore website http://www.secore.org/



Smooth-fronted caiman, *Paleosuchus trigonatus*. © Richard Gibson, Chester Zoo, UK.

Appendix VIII

Public aquariums: global list of breeding programmes

Species	Common Name	CITES	ISB	Regional Associations
MAMMALS				
Trichechus manatus latirostris	Florida manatee	I		AZA, EAZA
Arctocephalus australis	South American fur seal	II		EAZA
Arctocephalus forsteri	New Zealand fur seal	II		ARAZPA
Arctocephalus pusillus	Cape fur seal	II		ARAZPA, BIAZA
Arctocephalus tropicalis	Sub-antarctic fur seal	II		BIAZA
Eumetopias jubatus	Steller's sea lion	-		JAZA
Neophoca cinerea	Australian sea lion	-		ARAZPA
Otaria byronia	Patagonian sea lion	-		EAZA, JAZA
Otaria flavescens	South American sea lion	-		EAZA
Zalophus californianus	Californian sea lion	-		ARAZPA, EAZA, JAZA
Halichoerus grypus	Grey seal	-		EAZA, BIAZA
Phoca largha	Largha seal	-		JAZA
Phoca vitulina	Harbour seal	-		BIAZA
Phoca vitulina stejnegeri	Insular seal	-		JAZA
Phoca sibirica	Baikal seal	-		BIAZA
Aonyx capensis	Cape clawless otter	II		AZA, JAZA
Amblonyx cinereus	Oriental small-clawed otter	II	X	ARAZPA, AZA, BIAZA, JAZA
Enhydra lutris	Sea otter	I/II		AZA, JAZA
Lontra canadensis	Canadian otter	II		AZA, JAZA
Lutra lutra	Eurasian otter	I		EAZA, BIAZA, JAZA
Lutra lutra lutra	European otter	I	X	EAZA
Lutra perspicillata	Indian Smooth-coated otter	II		JAZA
Pteronura brasiliensis	Giant otter	I	X	AZA
Tursiops aduncus	Indian ocean bottlenose dolphin	II		SEAZA
Tursiops truncatus	Bottlenose dolphin	II		AZA, EAZA, JAZA, SEAZA
Neophocaena phocaenoides	Finless porpoise	I		JAZA
Delphinapterus leucas	Beluga	II		AZA
BIRDS				
Aptenopdytes patagonicus	King penguin	-		EAZA, BIAZA, JAZA
Eudyptes chrysolophus	Macaroni penguin	-		BIAZA. JAZA
Eudyptes chrysocome (crestatus)	Rockhopper penguin	-		EAZA, BIAZA, JAZA
Eudyptula minor	Blue penguin	-		ARAZPA
Pygoscelis papua	Gentoo penguin	-		EAZA, BIAZA, JAZA
Spheniscus demersus	African blackfoot penguin	II		AZA, EAZA, JAZA, PAAZAB
Spheniscus humboldti	Humboldt's penguin	I		AZA, EAZA, JAZA
Spheniscus magellanicus	Magellanic penguin	-		BIAZA, JAZA
REPTILES				
Pseudemydura umbrina	Western swamp turtle	I		ARAZPA
Cuora amboinenis	Asian box turtle	II		EAZA
Geoclemys hamiltonii	Spotted pond turtle	I		EAZA, JAZA
Heosemys grandis	Giant Asian pond turtle	II		EAZA
Heosemys spinosa	Asian pond turtle	II		EAZA
Kachuga tecta	Indian tent turtle	I		JAZA
Orlitia borneensis	Giant river turtle	II		EAZA
AMPHIBIANS				
Andrias japonicus	Japanese giant salamander	I		JAZA
Hynobius hidamontanus	Hakuba salamander	-		JAZA
Hynobius takedai	Hokuriku salamander	-		JAZA
Atelopus zeteki	Panamanian golden frog	I		AZA
Bufo baxteri	Wyoming toad	-		AZA
Peltophryne lemur	Puerto Rican crested toad	-	X	AZA
Dendrobates azureus	Blue poison arrow frog	II		ARAZPA, BIAZA
Littoria aurea	Golden tree frog	-		ARAZPA
Leptodactylus fallax	Mountain chicken frog	-		EAZA
Rana ishikawae	Okinawan jewelled frog	-		JAZA
Philautus romeri	Romer's tree frog	-		ARAZPA

Species	Common Name	CITES	ISB	Regional Associations
FISH				
Neoceratodus forsteri	Lungfish	II		JAZA
Arapaima gigas	Arapaima	II		JAZA
Scleropages formosus	Asian bonytongue	I		JAZA
Leptobotia curta	Kissing Loach	-		JAZA
Acheilognathus longipinnis	Deep-bodies bitterling	-		JAZA
Acheilognathus typus	Netted bitterling	-		JAZA
Aphyocypris chinensis	Green chubb	-		JAZA
Hemigrammocypris rasborella	Golden venus chubb	-		JAZA
Pseudorasbora pumila	Moroko	-		JAZA
Rhodeus atremius suigensis	Suwon rosy bitterling	-		JAZA
Rhodeus ocellatus kurumeus	Japanese rosy bitterling	-		JAZA
Tanakia tanago	Miyako bitterling	-		JAZA
Lefua costata echigonia	Hotoke loach	-		JAZA
Coreobagrus ichikawai	Stumpy bullhead	-		JAZA
Goodeids	Mexican livebearers	-		EAZA
Cyprinodonts	Killifish	-		EAZA
Hippocampus guttulatus	Long-snouted seahorse	II		EAZA
H. hippocampus	Short-snouted seahorse	II		EAZA
H. barbouri	Barbour's seahorse	II		AZA
H. erectus	Lined seahorse	II		AZA
H. kuda	Yellow seahorse	II		AZA
Gasterosteus microcephalus	Three-spined stickleback	-		JAZA
Pungitius sp.	Nine-spined stickleback	-		JAZA
Pungitius pungitius tymensis	Short-spined stickleback	-		JAZA
Lates japonicus	Japanese snook	-		JAZA
Haplochromis spp.	Lake Victoria cichlids	-		AZA
Hypseleotris cyprinoides	Tropical carp-gudgeon	-		JAZA
Coreoperca kawamebari	Japanese aucha perch	-		JAZA
Stegostoma fasciatum	Zebra shark	-		EAZA, AZA
Carcharias taurus	Sand tiger shark	-		AZA
Taeniura lymma	Blue spotted stingray	-		EAZA
Pristis pectinata	Smalltooth sawfish	I		AZA
Pristis zijsron	Green sawfish	I		AZA

Chinese three-striped box turtle, *Cuora trifasciata* – Critically Endangered as a result of unsustainable trade use for Traditional Chinese Medicines. © Richard Gibson, Chester Zoo, UK.

Appendix IX

Public aquariums: selected serial publications on aquatic and wetlands research and associated environmental aspects

Africa – Birds and Birding
Frequency: six times a year (one volume of six issues)

Africa Geographic
ISSN: 1609-154X. Frequency: 11 times a year (one volume of 11 issues). Former title: *Africa Environment and Wildlife*

African Journal of Aquatic Science
Internet, ISSN: 1727-9364. Frequency: twice a year (one volume of two issues). Only available in electronic format

African Journal of Marine Science
ISSN: 1814-232X. Frequency: three times a year (one volume of three issues)

American Fisheries Society
Journals Library Package – Print and Internet. Frequency: 36 times a year (one volume of 36 issues)

Aquaculture Magazine and Buyer's Guide and Products Issue
Frequency: seven times a year (one volume of seven issues)

Aquarium Fish
ISSN: 0899-045X. Frequency: 12 times a year (one volume of 12 issues)

Aquatic Conservation: Marine and Freshwater Ecosystems
Print (ISSN:1052-7613) and Online (ISSN: 1099-0755)

Aquatic Mammals
ISSN: 0167-5427. Frequency: four times a year (one volume of four issues)

Asian Fisheries Science
Print and CD ROM and Internet. Frequency: eight times a year (one volume of eight issues)

Canadian Journal of Fisheries and Aquatic Sciences
ISSN: 0706-652X. Frequency: 12 times a year (one volume of 12 issues). Formerly: Jnl of the Fisheries Research Board of Canada

Climate Summary of South Africa
Internet. Frequency: 12 times a year (one volume of 12 issues). Only available in electronic format

Coastal Management
Print and Internet. Frequency: 12 times a year (one volume of 12 issues)

Copeia
ISSN: 0045-8511. Frequency: four times a year (one volume of four issues)

Coral Reefs– Journal of the International Society for Reef Studies
Print and Enhanced Access–Internet. Frequency: eight times a year (one volume of eight issues)

Crustaceana
Print and Internet, ISSN: 0011-216X. Frequency: 24 times a year (one volume of 24 issues)

Current – the Journal of Marine Education
ISSN: 0889-5546. Frequency: three times a year (one volume of three issues)

Environmental Biology of Fishes
ISSN: 0378-1909. Frequency: 12 times a year (three volumes of four issues)

Estuaries and Coasts
ISSN: 1559-2723. Frequency: six times a year (one volume of six issues)

Estuarine Coastal and Shelf Science
ISSN: 0272-7714. Frequency: 20 times a year (five volumes of four issues)

Fish and Fisheries
Print (ISSN: 1467-2960) and Online (ISSN: 1467-2979) Frequency: Quarterly

Fisheries – American Fisheries Society
ISSN: 0363-2415. Frequency: 12 times a year (one volume of 12 issues)

Fisheries Management and Ecology
Print (ISSN: 0969-997X) and Online (ISSN: 1365-2400). Frequency: Bi-monthly

Fisheries Research
ISSN: 0165-7836. Frequency: 18 times a year (six volumes of three issues)

Fisheries Science
ISSN: 0919-9268. Frequency: six times a year (one volume of six issues). Our reference: 100SPRIA972, 00000370

Fishing News International
ISSN: 0015-3044. Frequency: 12 times a year (one volume of 12 issues)

Freshwater and Marine Aquarium Magazine
ISSN: 0160-4317. Frequency: 12 times a year (one volume of 12 issues)

International Association for Aquatic Animal Medicine
Membership. Frequency: four times a year (one volume of four issues)

International Zoo Yearbook
Print (ISSN: 0074-9664) and Online (ISSN: 1748-1090), Frequency: Once a year

Journal of Applied Ichthyology
Print (ISSN: 0175-8659) and Online (1439-0426) Frequency: Bi-monthly

Journal of Aquatic Animal Health
ISSN: 0899-7659. Frequency: four times a year (one volume of four issues)

Journal of Coastal Research
Print and Internet. Frequency: 10 times a year (one volume of 10 issues)

Journal of Crustacean Biology
ISSN: 0278-0372. Frequency: four times a year (one volume of four issues)

Journal of Experimental Marine Biology and Ecology
E-Select – Internet. ISSN: 0022-0981. Frequency: 28 times a year (14 volumes of 2 issues) Only available electronically

Journal of Fish Biology
Print and Standard – Internet. ISSN: 0022-1112, Frequency: 40 times a year (one volume of 40 issues)

Journal of the World Aquaculture Society – Print (**ISSN:** 0893-8849) and Internet **(ISSN:** 1749-7345) Frequency: Bi-monthly

Limnology and Oceanography
Print and Internet. Frequency: 26 times a year (one volume of 26 issues)

Marine and Freshwater Research
Print and Internet, Frequency: eight times a year (one volume of eight issues). Not available through subscription agencies.

Marine Biology
ISSN: 0025-3162. Frequency: 12 times a year (one volume of 12 issues)

Marine Ecology Progress Series
ISSN: 0171-8630. Frequency: 25 times a year (25 volumes)

Marine Mammal Science
Print and Premium – Internet. ISSN: 0824-0469 Frequency: eight times a year (one volume of eight issues)

Marine Ornithology
ISSN: 1018-3337. Frequency: twice a year (one volume of 2 issues)

Marine Pollution Bulletin
ISSN: 0025-326X. Frequency: 24 times a year (two volumes of 12 issues)

New Zealand Journal of Marine and Freshwater Research
ISSN: 0028-8330. Frequency: four times a year (one volume of four issues)

North American Journal of Aquaculture
ISSN: 1522-2055. Frequency: four times a year (one volume of four issues)

Ocean and Coastal Management
ISSN: 0964-5691. Frequency: 12 times a year (one volume of 12 issues)

Reviews in Fish Biology and Fisheries
ISSN: 0960-3166. Frequency: four times a year (one volume of four issues)

Wildlife Society Membership – including African Wildlife
Frequency: four times a year (one volume of four issues)

Zoological Society of South Africa – Membership – including South African Journal of Zoology
Frequency: twice a year (one volume of two issues).

Humboldt penguin, *Spheniscus humboldti*, Chester Zoo, UK. © Steve Rawlins.

Hairy hermit crab, *Anomura* sp. © Dennis King, South Africa.

High school lake ecology, Shedd Aquarium USA.

Publisher
WAZA Executive Office
Lindenrain 3
3012 Bern
Switzerland

www.waza.org

This publication was produced with financial support from the North of England Zoological Society