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BIOLOGICAL DIVERSITY OF INLAND WATERS

Note by the Executive Secretary

I. Introduction

1. This report has been prepared by the Executive Secretary for the third meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) in order to assist the SBSTTA in consideration of the status and trends of biological diversity in inland water ecosystems in accordance with decision III/13 adopted by the Conference of the Parties at its third meeting in Buenos Aires, Argentina, in November 1996.

2. Under the scope of the Convention on Biological Diversity (CBD), inland water biodiversity is a matter of concern since it relies on ecosystems and habitats containing high diversity and large numbers of endemic and threatened species, which are unique or associated with key ecological processes. Furthermore, inland water ecosystems perform valuable ecological functions and inland water species, genomes and genes are of social, scientific and economic importance.

3. In addition to those activities that directly utilize inland water biological diversity, various activities in sectors as diverse as agriculture and energy depend on inland waters and are causing disruption within natural ecosystems. Moreover, socio-cultural factors, such as population density and pressure, land tenure, the degree of knowledge and education as well as public services and policies, influence inland water ecosystems. An ecosystem approach to understanding the human impacts on inland water biological diversity is considered necessary because the effects of these various activities are interlinked and felt throughout the entire water system, from the catchment area through to the river mouth and out to the sea.

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4. This document discusses aspects considered important to analyze the situation of the biological diversity of inland waters with reference to relevant articles of the CBD. Options for actions and future programmes of work for the SBSTTA as well as the COP are suggested.

5. In preparing this document, the Secretariat benefited from comments received from various sources. This was possible since the early version of the document was posted on Internet on the home page of the CBD. The Secretariat also benefited from the contribution made by the Bureau of the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Convention on Wetlands of International Importance).

II. Inland Water Biological Diversity

1. Status and trends

6. Water provides the habitat of a myriad of living animal, plant and microbial species. These aquatic organisms and the ecosystems in which they participate represent a substantial fraction of the Earth's biological diversity. Aquatic ecosystems can be broadly divided into the following categories: (1) marine and coastal systems and (2) inland water systems that can be fresh or saline within continental boundaries[1]. Estuarine systems lie between these two categories.

7. Inland aquatic habitats are immensely more varied in physical and chemical features than in the marine environment. In addition to bogs, marshes and swamps, which are traditionally grouped as inland wetlands[2], they include systems, such as, inland seas, lakes, rivers, ponds, streams, groundwater, springs, cave waters, floodplains, backwaters, oxbow lakes, pitcher plants and even tree holes. Differences in water chemistry, clarity, velocity or turbulence, as well as depth and shape of the water body, all contribute to the diversity of biological resources found in inland waters. Also a given organism may require more than one aquatic habitat during its life cycle.

8. Despite the relatively small area they represent, fresh waters[3] contain a wide variety of recent and ancient taxonomic units. All of the major taxonomic groups which are likely to contain in excess of 100,000 species occur in fresh water[4]: insects, arachnids, crustaceans, molluscs, nematodes, plants, algae, protozoan, fungi, bacteria, and viruses. About 12 per cent of all animal species, including 41 per cent of all recognized fish species, live in the 0.008 per cent of the world's water which is available as freshwater rivers and lakes[5]. Considering that about half of all vertebrates are fishes, it can be derived that about one quarter of the world's vertebrates are restricted to fresh water. Globally, even though the absolute number of species in fresh waters is lower than in other environments, the number per unit area is relatively higher. In terms of species per unit area, the freshwater ecosystems are, on average, slightly richer than those on land and 15 times richer than the marine environment[6].

9. The increasing concern for maintenance of the richness of inland water biodiversity and for reducing the risks many species face is based on an accumulation of evidence of the loss of this biodiversity. Although the evidence remains, in general, very sparse and patchy in geographic scope, the fact that there are many species in decline or facing extinction, in the few countries where reasonable field knowledge is available, justifies real concern for the status of inland water biodiversity[7]. An alarming fact is that, although humans have always made use of freshwater systems and species, the last 200 years, through the Industrial Revolution, rapid economic development and population growth, have brought about transformations of these ecosystems on an

unprecedented scale.

10. The loss of freshwater fishes is only partially documented, though better than for marine species. Of 734 species of globally threatened fishes in the 1996 IUCN Red List of Threatened Animals, 84 per cent are freshwater. Worldwide, it is estimated that over 20 per cent of freshwater fishes are either recently extinct, endangered or vulnerable. 92 species are recently extinct in the wild. In North America, for example, 30 per cent of the 979 freshwater native species are recently extinct or at risk (endangered, threatened, or of special concern). Three genera, 27 species, and 13 sub-species have been recorded as recently extinct. Physical habitat alteration is implicated in 93 per cent of the declines. For instance, migratory species have no option but to swim upstream at spawning time and are more and more affected by the construction of dams. About one third of the 193 fish species in Australia are considered threatened and 42 per cent of Europe's are of concern[8]. In addition, some of the most rapid changes are occurring in the species-rich tropics, where many species are being lost before they are even named due to the fact that few scientific studies have been carried out. For example, a recent study of the Cross River Basin in Cameroon and Nigeria found that the diversity of fish species had been underestimated by 73 per cent[9]. The lack of knowledge on fish species is also illustrated by the example of Laos, where, as part of the Environmental Assessment on a major dam, some 60 species of fish new to science have been discovered in the last year. Other animals, such as freshwater mussels, crayfish and amphibians are all taxonomic groups that are also particularly vulnerable. In North America, where most thorough studies have been carried out, 67 per cent of mussels, 65 per cent of crayfish and 38 per cent of amphibians are considered either at risk or extinct[10]. In addition to species loss, losses are also occurring at the ecosystem level. One estimate shows that 84 per cent of Ramsar sites[11] had already undergone ecological change or are under threat[12]. In Asia and the Pacific, a survey of Ramsar sites shows that a percentage of sites under moderate to high threat varies from 15 to 86 per cent depending on the countries, with 13 out of 17 countries over 40 per cent[13].

11. The principal human use of living species from inland waters is as food. Other uses include recreation and tourism, the aquarium trade, materials for medicinal or ornamental use, and as fertilizer. With regard to fishery, compared to 90.7 million tons of total marine fishery production, inland fishery accounted for around 20 per cent of the world total production in 1995, according to the preliminary figures given by the Food and Agriculture Organization of the United Nations (FAO)[14]. However, freshwater fishes are primary sources of animal protein for a large proportion of the world's population. In 1995, inland capture fisheries and inland aquaculture production supplied 7 million tons and 14.6 million tons (both preliminary figures), respectively for direct consumption and processing, and the sale of fish generated important incomes for many communities worldwide. For indigenous and local communities, artisanal fisheries still constitute important means to obtain their subsistence needs. The world aquaculture production is growing, particularly in developing countries. Asia is the dominant region with China being the leading country. Although sub-Saharan Africa still represents a very small share in the world production, the aquaculture sector shows signs of expansion. Besides aquaculture, in many parts of the world, commercial capture fisheries and sport fishing comprise important activities. In addition to fishes, plants represent a large part of inland water biological diversity with high socio-economic value. Their main usage include food, shelter, paper making and medicinal products. The major cultivated inland water plant is rice, which is the most important single foodstuff today. Globally, more than 500 million metric tons of rice is produced annually, serving as the staple food of approximately half the world population. Close to two billion people worldwide rely on rice as the main source of calories. Other cultivated inland water plants may be of less importance globally but some are locally significant. They include taro in the Caribbean, the Pacific and West Africa, sago palms in South-east Asia and the Pacific and watercress in Europe. In addition, wild plants are also important. For example, nearly 20 per cent of the paper made in China is made from reeds from freshwater wetlands. Moreover, plants also play a critical role in the maintenance of the health of aquatic ecosystems and are the basis of all food chains.

12. In addition to the direct benefits (food, income and livelihoods), that are derived from inland water biodiversity, humans also enjoy many other economic, social and cultural benefits from inland water ecosystems, such as water supply, energy production, transport, recreation and tourism. Moreover, inland waters perform essential ecological functions, including, *inter alia*, maintenance of the hydrological balance, retention of sediments and nutrients, and provision of habitats for various animals, including migratory birds and mammals. Other ecosystem functions are the breakdown of anthropogenic pollutants and the sequestering of excess nutrients.

13. Human changes to the landscape are extensive and accelerating, and they have significant consequences on inland water ecosystems. The construction of dams, navigation channels, the drainage of wetlands, flood control and irrigation structures are the most obvious signs of human intervention in the aquatic environment. Land use activities in the catchment area, including agriculture, deforestation, mining, grazing, industrialization and urbanization, all contribute to the degradation of rivers and lakes and other water bodies through water withdrawals and/or additions of nutrients, pollutants and sediments. Increasing demand for water withdrawals for many activities is a real cause of concern, since water quantity affects maintenance of healthy ecosystems. Between 1900 and 1995, water withdrawals increased by a factor of over six, more than double the rate of population growth[15]. Besides reducing the capacity of inland water ecosystems to support life and to perform valuable ecosystem functions, the damaging activities in upstream areas will also impact on downstream coastal and marine ecosystems. In fact, about 80 per cent of marine pollution is caused by human activities on land.

14. Other human interventions, such as the introduction of alien species, intentionally or accidentally, can also cause severe damages to inland water ecosystems. Twenty-four cases of introduced species, mainly in Asia, were shown to have had deleterious effects on native biological diversity or on the local people, the example of the latter being the case of snail-contaminated aquarium plants imported from South America to Hong Kong, which introduced the human pathogen *Schistosoma mansoni*[16]. Although in many cases there has been hardly any monitoring of the processes, damages caused by introduced species are known to be immense and prevention of further biological invasion is clearly a priority. Establishing clear guidelines and codes of practices, such as the one being prepared by the FAO, are useful tools.

15. One of the well-known examples of negative impact by introduced species is that of Lake Victoria, one of the East African Rift Valley lakes. The introduction of alien fish species, especially the Nile perch and the Nile tilapia, as well as the South American water hyacinth resulted in changes in fish and plant composition including the loss of up to 75 per cent of endemic species. Another example of damages caused by human interventions is the case of the Aral Sea. The Aral Sea, once the world's fourth largest lake, has shrunk by half and lost 75 per cent of its volume since 1960, due to diversion of river flows for irrigation and mismanagement of its water resource. The salinity of the Aral Sea has tripled and 20 of its 24 fish species have entirely disappeared[17]. In contrast to the case of Lake Victoria, none of the species were endemic to the Aral Sea. In the case of the Aral Sea, however, the damage is not irreversible and restoration programmes are underway. The Governments of the five independent riparian States have begun a large and complex programme on sustainable regional development policy cooperation and on development of a framework for sustainable land, water and other natural resources development policies[18]. Through its programme of Environmentally Sound Management of Inland Waters (EMINWA), the United Nations Environment Programme has cooperated with the riparian countries of the Aral Sea. In addition, the World Bank Aral Sea project is restoring part of the area that Uzbekistan is proposing as its first Ramsar site. These are just two widely known examples of extensive damage brought about by human interventions to previously sustained inland water ecosystems.

16. Indeed, human interventions, such as, habitat alteration, the introduction of invasive alien species, water over-exploitation and pollution, are major factors affecting the biodiversity of inland water ecosystems. Most importantly, their impact may be individually cumulative over time and some effects may be synergistic. These different stresses, resulting from human settlements, industry and resource management activities, are themselves the result of human socio-economic systems, their value formation and decision-making processes. Such issues must therefore be addressed in order to understand the underlying causes of biodiversity loss in inland water ecosystems[19].

17. Under the scope of the Convention on Biological Diversity (CBD), inland water biodiversity is a matter of concern since it relies on ecosystems and habitats containing high diversity and large numbers of endemic and threatened species, which are unique or associated with key ecological processes. In addition, inland water ecosystems perform valuable ecological functions and inland water species, genomes and genes are of social, scientific and economic importance. As outlined in Article 1 of the Convention, inland water biodiversity should therefore be maintained through *in-situ* and *ex-situ* conservation, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of its genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding. *Consistent with the thematic approach, a key theme to be addressed by the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) during its third meeting is that of inland water biological diversity.*

2. The ecosystem approach

18. As outlined above, inland water ecosystems consist of a variety of systems within continental boundaries, in which a high concentration of different organisms is found. There is a high interdependency between the integrity of inland water ecosystems and sectors of human activities. Activities in sectors as diverse as agriculture, forestry, mining and energy are causing disruption in the natural inland water systems, in addition to those activities that directly utilize inland water biological diversity. In addition, socio-cultural factors, such as population density and pressure, land tenure, the degree of knowledge and education as well as public services and policies, impact on inland water ecosystems. An ecosystem approach to understand the human impacts on inland water biological diversity is necessary because the effects of these various activities are interlinked and felt throughout the entire water system, from the catchment area through to the river mouth and out to the sea. Actions to reverse the degradation of inland water ecosystems and maintain their biological diversity are urgently needed, since the impacts on them have been increasing and accelerating as human activities have intensified over recent years.

19. Amongst these actions and as an important component of the ecosystem approach, specific and sound integrated soil and water conservation practices are to be considered for the management and the sustainable agricultural use of the inland water boundaries (see the box on “wise use” on wetlands). This is of particular relevance since agriculture is the largest user of fresh water and most of these transitional areas are usually very likely to be intensively populated and/or exploited, for example, river banks, floodplains, margins of ponds, lakes, dams and reservoirs, and beaches. Negative impacts, both on the physical landscape and on biodiversity might even be stronger in the case of medium to large well delineated catchment, where erosion by water may result in an uneven redistribution of fertility, fine soil elements and organic matter. But water impounding and diversion has far greater downstream consequences, especially in areas of storm intensity where engineering designs have to make allowances for large amounts of water evacuation with silt and bedload rocks and boulders. Drainage and irrigation schemes can also have a long-term effect on the global water quality and

salinity downstream. Furthermore, sound and effective water and wind erosion control schemes applied to the surrounding areas are the "sine qua non" condition to the balanced management and the preservation of biological diversity in the inland water ecosystems. In this context, it is noteworthy that in addition to inland waters biological diversity, agricultural biodiversity will also be further addressed at the third meeting of the SBSTTA.

20. The human impacts on functions of inland water ecosystems can be grouped as changes to: water quality, including degree of salinity, acidity and availability of nutrients; water volume, circulation patterns and flow regimes; dimensions of natural water bodies, including land-fill; and biotic complexity and linkages. Contaminating inland waters with sediments, chemical and organic pollutants and effluents from agriculture, industries and households affect the quality of water, incurring impacts on inland water ecosystems and their biological diversity. Human activities, such as construction of dams and water withdrawal for irrigation and industrial uses, can cause changes in water volumes, velocities and can alter circulation patterns. In addition, changes in water temperature that can be caused by dam construction and reservoir formation are also factors that affect water quality. Many wetlands which have been landfilled, partly or wholly lost along their biological diversity. Alteration of river routes for flood controls may affect the habitats of animals and plants that are dependent on floodplains. Over-harvesting of fish by large-scale commercial fisheries, the introduction of alien species and mismanaged aquaculture, all cause negative impacts on biotic complexity and linkages.

21. In all of the areas mentioned above, the ecosystem-wide impact of human activities on inland waters can be mitigated by changes in practices, technologies and pattern of land use. Management should take a broad view of inland waters and the ecological and hydrological processes that need to be maintained for *in-situ* conservation. Therefore, for example, river inputs to and outflow from lakes need to be secured, floodplains need to be connected to river systems, dams need to be provided with fish passage ways, reserves need to be protected from upstream effects and migratory routes need to be maintained. A balance must be found between an acceptable level of human intervention on inland water ecosystems and the maintenance of their biological diversity. There is always a threshold or a non-return point which should never be exceeded in order to avoid permanent damage to biological diversity and the sustainable function of ecosystems. Without a clear knowledge of such a threshold point, however, a precautionary approach must be employed. In addition, the system-wide impacts of various human activities must be understood in a holistic manner.

“Wise use” of wetlands

The protected area approach to conservation of the biodiversity of inland water systems is in many cases inadequate, since wetlands are affected by impacts occurring outside the boundaries of the protected site. Contracting Parties to the Convention on Wetlands of International Importance accept two principal obligations: to designate wetlands in their territory for the List of Wetlands of International Importance; and to promote "wise use" of all wetlands in their territory. While the protected area approach is in many cases the main motivation for Ramsar listing, because of the difficulty of dealing with the impacts from outside the listed area, even in such huge Ramsar sites as the Okavanga Delta in Botswana, Pacaya Samiria in Peru or Parapol Valley in Russia, the Convention is now laying the emphasis on development of broadly based management plans for all Ramsar sites, and is giving much more emphasis to wise use of wetlands.

Wise use of wetlands means adoption of a national wetland policy (or at least full consideration of

wetlands in a National Biodiversity Strategy or National Environment Action Plan). The Ramsar Strategic Plan 1997-2002 places greatest emphasis on development and implementation of such policies. In practical terms on the ground, wise use means adoption of a management approach which covers a whole ecosystem (basin or catchment area of a whole river or lake system).

Some of the examples are documented in "Towards wise use of wetlands", published by the Convention on Wetlands of International Importance. The Chowilla Anabranch in the Murray-Darling Drainage Basin covers approximately one seventh of the surface of Australia. Development of the Chowilla Resource Management Plan demonstrated that consultation with community and interest groups is an essential part of developing an integrated management plan. The principal lessons learned in the Logone floodplains of Chad were: the need for embodiment of traditional practices, combined with new technology, into the social and hierarchical structure of the community; not all traditional management systems are sustainable; and that local decentralized NGOs can play an important role. In the Lake Thompson watershed of South Dakota, the U.S.A., the need for wetland restoration in the Prairie Potholes area of northern USA and Canada is emphasized.

In addition, restoration and rehabilitation of destroyed or degraded wetlands is an increasingly important theme. Striking modern examples include: the River Stern in Denmark, where bends (removed twenty years ago) are being restored to the river course; the Huleh Swamps in Israel, where the drained lands are now being reflooded; and the near-natural Biebrza Valley in Poland, where even the few existing drainage channels are being filled in.

Source: The Bureau of the Convention on Wetlands of International Importance

III. General principles

22. Article 14 of the Convention requires Parties, as far as possible and appropriate, to introduce appropriate procedures requiring environmental impact assessment of proposed projects that are likely to have significant adverse impacts on biological diversity. The Convention also requires Parties to identify processes and categories of activities that have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity. Together with the Preamble to the CBD[20], Article 14 constitutes a precautionary approach, consistent with Principle 17 of the Rio Declaration[21].

23. The precautionary approach must be effectively employed in the conservation of the biodiversity of inland water ecosystems and the sustainable use of its components. In the case of fishery, for example, efforts must be made to balance the economic needs to increase fish production and the need to conserve aquatic biological diversity. This will require planning and impact assessment. Such impact assessments should involve ecological, genetic and socio-economic criteria[22]. Even when there is sufficient scientific knowledge of a process, the preventive approach must be employed in order to prevent damages.

24. In addition, in order to address the conservation of inland water biological diversity as well as the sustainable use of its components, the general principle of the Convention provides that States possess sovereign rights over their natural resources. Article 3 recognizes that "States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction". Furthermore, Articles 4 (jurisdictional scope) and 5 (co-operation) address the scope of

the States' obligations under the CBD. Under Article 4, a Party is obliged to implement the provisions of the Convention to areas within the limits of national jurisdiction or areas beyond it, to the extent that the activities or processes are carried out under the Party's jurisdiction or control. Article 5 requires Parties to co-operate in areas beyond national jurisdiction and where there is a matter of mutual interest, in order to conserve biological diversity and sustainably use its components in these areas. The latter two Articles are of particular importance to inland water ecosystems as about 300 major river basins and many groundwater aquifers cross national boundaries[23]. These three articles together constitute the foundation upon which the Convention operates.

IV. Conservation of biological diversity in inland water ecosystems and sustainable use of its components

25. Article 6 of the CBD provides the basis for the Parties to formulate general measures for the conservation of biological diversity and the sustainable use of its components. Parties undertake to regulate or manage biological resources for conservation and sustainable use and to encourage the development of methods for sustainable use. Article 6(b) provides grounds for the focus on inland water biological diversity to be an urgent matter for the Convention by urging to integrate the conservation and sustainable use into relevant sectoral or cross-sectoral plans, programmes and policies. As inland water ecosystems are interlinked among themselves and with other ecosystems, being subject to impacts from activities in diverse sectors, this provision is of crucial importance. In order to facilitate conservation of biological diversity and sustainable use of its components, Article 11 requires each Party to adopt incentive measures, which are economically and socially sound. It is important to analyze underlying causes when formulating incentive measures. Sometimes, the causes lie within existing regulations and policies. In decision III/18, which was adopted at the third meeting of the Conference of the Parties (COP), the importance of taking appropriate action on incentives that threaten biological diversity is stressed. Parties are also encouraged to develop training and capacity-building programmes to implement incentive measures and to promote private-sector initiatives.

1. Conservation of inland water biological diversity

a. *In-situ* conservation

26. Article 8 contains the main set of the Convention provisions for *in-situ* conservation of biological diversity. This article addresses the conservation of ecosystems, wild species and genetic diversity. *In-situ* conservation is recognized as the primary approach for biodiversity conservation.

27. The establishment of biodiversity reserves in protected areas is a conservation strategy that has been widely employed in terrestrial environments and which can be used in maintaining inland waters biodiversity in certain areas where competing interests and/or external influences are low. It will be effective if such reserves and protected areas are created for species-rich areas, or areas with a high proportion of endemic species. It entails placing restrictions on the uses that can be made of resources in delimited areas, thus providing a critical management tool for biodiversity maintenance in its natural surroundings. However, the difficulty in managing protected areas for inland water ecosystems has already been highlighted under the section on the ecosystem approach, especially in the box on "wise use" of wetlands. Therefore, it is important to accompany sustainable management in the surrounding areas. In order to complement *in-situ* conservation in protected areas, such practices as integrated watershed management should be employed to encourage sustainable practices in surrounding areas with a view to maintain healthy ecological functions for the whole interlinked ecosystem. With a comprehensive management strategy which encompasses the whole watershed area, the reserves can

serve as replenishment areas for aquatic resources and the maintenance of genetic diversity of certain species.

28. As non-native or exotic animal, plant and microbial species have been demonstrated to have a significant impact on native components of inland water ecosystems, in addition to controlling or eradicating alien species which are already introduced to the concerned environment, it is also imperative to develop measures to prevent the introduction of such alien species, as stated in Article 8(h) of the CBD. In this respect, it is also important to consider the risks associated with the introduction of living modified organisms as addressed in Article 8(g).

29. The conservation of aquatic biodiversity *in-situ* has always been central to the strategies of "nurture" fisheries practices by fishing communities over time. The diversity of species has been maintained through traditional rules and practices which regulate use. Such systems are relatively successful until pressures through population growth or increased use of resources exceed the natural replenishment rates, although many artisanal fisher folks are also known to have over-exploited the resources.

30. As stated above, particular attention should be given to conservation of species-rich areas. Several fish biodiversity "hot spots"[24] have already been identified for inland water systems. Three regional fish biodiversity hot spots so far recognized, which all reside in the tropics (in central Africa, the Amazon and Southeast Asia[25]), are of critical interest if we wish to develop appropriate mechanisms and means to conserve and manage inland water biodiversity. The area between the Mississippi and the east coast of North America can also be qualified as a hot spot for freshwater mussels, since one-third of the world's mussel species are found there, many being endemic. Since 1900, 10 per cent of these species have become extinct while 67 per cent of the remaining are presently either threatened or endangered.

b. *Ex-situ* conservation

31. In addition to *in-situ* conservation measures, the components of biological diversity can also be conserved *ex-situ*, for instance, in gene banks and microbial culture collections, in captive breeding facilities and aquaria. Article 9 contains provisions for *ex-situ* conservation as being predominantly complementary to *in-situ* measures.

32. The very nature of aquatic ecosystems calls for measures that promote synergy between *in-situ* and *ex-situ* conservation. The difficulty that the protected area approach faces in providing an adequate management framework for conserving biodiversity due to the intrinsic characteristics of aquatic systems has already been mentioned. Where the original habitat is destroyed and a species has low chances of survival in the wild, then *ex-situ* conservation may offer the only opportunity to maintaining the species. However, *ex-situ* conservation has several limitations. In addition to the fact that *ex-situ* conservation measures can cover only a fraction of existing species, they include difficulty in long-term storage of frozen fish sperm, inability to freeze fish eggs and embryos, difficulty in maintaining adequate population sizes in live gene banks, and difficulty in identifying what needs to be banked. In the case of some fishes, cryopreservation of sperm has proven to provide a useful tool for conserving genetic diversity, though it fails to conserve the maternal mitochondrial DNA. While *ex-situ* conservation activities are being carried out, every effort should be made to restore wild habitats. The importance of integrated watershed management, which was already pointed out above, should be re-emphasized.

33. The establishment of captive populations of endangered species in outdoor habitat, public aquaria, hatcheries and hobbyists' aquaria is also a helpful approach, having already saved some aquatic species from

extirpation or extinction. At the same time, local breeding and development of aquatic resources are important for local ecological niches, specific markets and social needs.

2. Sustainable use

34. Article 10 of the CBD contains five provisions for promoting sustainable use of the components of biological diversity. Firstly, Contracting Parties agree to integrate consideration of the conservation and sustainable use of biological resources into national decision-making. As the maintenance of inland water biodiversity relies on the whole network of ecosystems and such ecosystems provide substantial social and economic benefits to the nation, this approach is considered highly relevant. Secondly, measures relating to the use of biological resources in order to avoid or minimize adverse impacts on biological diversity are to be taken. Together with the third provision, which encourages customary use of biological resources, these provisions lay down the ground for support of small-scale and artisanal fisheries. It must be reminded, however, that these fisheries are only effective where pressure from population growth is low. In order to enhance sustainable use, the rights and obligations of these practices must also be made clear. The fourth provision is to support local populations in developing and implementing remedial actions in degraded areas. It is important to involve all stakeholders in such a process. As will be discussed later, increasing awareness of the public is essential, as well as building on local and indigenous knowledge and practices. The last provision of Article 10 is to encourage cooperation between governmental authorities and the private sector in developing methods for the sustainable use of biological resources. Considering that water management, agriculture, industry and commercial fishery are all important sectors affecting inland water ecosystems, the importance of this provision is paramount.

35. Conservation through sustainable use plays a major role in maintaining inland water biodiversity, since a large proportion of the world's population relies on inland waters for its livelihood and food security. Rice farming and fishing are the principal human activities that directly use resources from inland water biodiversity. In most of the developing world, particularly in low income areas, fish are critical food sources, providing a significant proportion of animal protein for over one billion people. For much of the world's population living in poverty, accessibility of a self-sustaining natural fishery is critical for survival and good health. It is important to note that these population tend to eat a wide range of aquatic biological diversity and this practice tends to provide them with relatively good nutrition. A balance must be provided between large-scale commercial fisheries and artisanal fisheries, in the face of growing demand for export of fishes. In the developed countries, on the other hand, importance of recreational fishery is increasing in inland waters. In North America, for example, the level of freshwater recreational catch now well exceeds the commercial catch[26].

36. Unlike the "free for all" exploitational strategies of capture fisheries where the fishing ground is considered open access and the fish stocks are taken as common property, as mentioned earlier, "nurture" fisheries practiced by fishing communities over generations have been a major factor for the conservation of aquatic biodiversity. These nurture fisheries comprise dynamic, evolving collections of diverse species, which are maintained through the application of numerous, often unwritten, rules which conserve diversity, regulate fisheries and allow stocks to replenish themselves. However, such systems are increasingly under threat from commercialization of capture fisheries and modern intensive aquaculture production[27]. The latter may rely on exotic species which can escape and displace local species and may result in pollution or habitat destruction.

37. With better management, however, aquaculture[28] can contribute towards meeting the world's increasing demand for fish and other aquatic products for direct consumption and marketing. The most healthy and

sustainable aquaculture systems are those which rely on harmonious stocking of different species with different ecological niches (polyculture), so that a balance is achieved between plankton, fish, plants and other organisms. Rice-fish and other agriculture-fish approaches tend to use land that is already deteriorated and make fish "manure" a crop fertilizer instead of a pollutant[29]. More consideration should be given to the use of indigenous instead of exotic species in aquaculture, since use of native stock circumvents the problem of escape of exotic aquaculture stock, diseases and parasites into the wild. Moreover, native species are pre-adapted to local conditions.

38. Current licensing and management systems need to be modified so that natural ecosystems like mangrove forests and vulnerable farm ponds are not lost to aquaculture. Encouragement to eco-agriculture would lessen offsite damage by aquaculture and the present tendency for intensive exploitation followed by abandonment of deteriorated ponds, unsuitable for other uses.

39. Sustainable use should equally be emphasized in other activities which impact on inland water ecosystems, including forestry, other plant products, eco-tourism and other recreational activities, and water supply itself. Here, again, the importance of an ecosystem approach is worth noting.

3. Equitable benefit sharing

40. The third objective of the CBD arises from the understanding that benefits which stem from human utilization of genetic resources, mainly collected from developing countries, should be shared equitably and fairly between donors and recipients of such genetic resources. This issue is addressed in Article 15 on access to genetic resources, as well as in Article 16 on access to and transfer of technology and in Article 19 on biotechnology. Under Article 15, Contracting Parties to the CBD recognize the sovereign rights of States over their natural resources and that the authority to determine access to genetic resources rests with the national governments and is subject to national legislation. All three articles contain provisions to take legislative, administrative or policy measures so that such benefit sharing becomes possible through transfer of technology, including biotechnology, which utilizes the genetic resources of donor countries. When freshwater genetic resources for pharmaceuticals, agriculture, or aquaculture are derived from a country and exploited elsewhere, the resulting benefits should be shared with the country of origin.

41. Traditional knowledge and technology for the conservation of inland water biodiversity and sustainable use of its components also constitute an important aspect of benefit sharing. For example, traditional technologies in Asia and Europe for wastewater-fed aquaculture systems have proven to be successful. Recognition of such knowledge and encouragement of the equitable sharing of benefits arising from utilization of such knowledge also constitute an important provision of the CBD as contained in Article 8(j). The Article calls upon each Party, subject to its national legislation to "respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices".

42. In this regard, contributions, innovations and knowledge systems of women and men as well as indigenous communities should be recognized and rewarded for the *in-situ* conservation and management of inland aquatic biodiversity. The ownership and rights of access, and benefits derived from inland aquatic biodiversity by local and indigenous communities should be safeguarded and measures for granting preferential resource rights based on local needs and priorities should also be explored.

V. Options for action

43. Based on the observation given above, in order to implement the Convention in the area of inland water biological diversity, the following options for action are considered. Efforts must be made to coordinate and collaborate with relevant conventions, international organizations and other institutions.:

(i) undertaking scientific, technical and technological assessments on the status and geographic location of inland water biological diversity through survey, mapping and Geographic Information Systems (G.I.S.). The identification of ecosystems and habitats with high biological diversity, in terms of species, biological communities and genetic potential is necessary. It is important to establish collaboration with international scientific communities, such as International Council of Scientific Unions. The relevant work under the Convention on Wetlands of International Importance should be coordinated. The work of IUCN on assessment of the status of species in collaboration with World Conservation Monitoring Centre (WCMC) should also be taken into account. Other relevant works carried out by organizations such as FAO, ICLARM, the World Bank and the UNEP should also be considered;

(ii) developing and promoting technical guidelines for the conservation and sustainable use of inland water biological diversity, as well as criteria and indicators for monitoring the conditions of inland water ecosystems, taking into account the work being carried out by the Convention on Wetlands of International Importance, including the guidelines on wise use. The IUCN work on criteria and definition of threatened species should also be considered;

(iii) identifying indicators for assessing the effectiveness of measures taken under the Convention for the conservation and sustainable use of inland water biological diversity, collaborating with the Commission on Sustainable Development (CSD) on its work on sustainable development indicators;

(iv) identifying and developing effective tools for *in-situ* conservation of inland water biological diversity, including Integrated Watershed Management, collaboration with other relevant fora, such as the CSD and the ACC Sub-Committee on Water Resources of the United Nations, the UNEP and the World Bank;

(v) identifying scientific and technical information necessary for impact assessment of projects that have potential impacts on inland water biological diversity, taking into account the relevant work underway in the other fora, especially the Convention on Wetlands of International Importance. Collaboration should also be sought with such organizations as the World Bank, the UNDP, the UNEP, the World Water Council and the Global Water Partnership as well as the scientific and engineering communities;

(vi) identifying and developing effective tools for restoration of degraded habitat, in collaboration with relevant conventions and organizations, such as the Convention on Wetlands of International Importance, the UNEP, the UNDP and the World Bank;

(vii) identifying and assessing, in conjunction with the private sector, technologies of relevance to the conservation of inland water biological diversity and sustainable use of its components, and

encouragement of partnerships for cooperation and benefit-sharing on matters related to technology;

(viii) identifying measures and incentives that encourage the private sector to develop and transfer environmentally sound technologies relevant for the conservation and sustainable use of inland water biological diversity;

(ix) developing and promoting, in conjunction with the private sector, and involving local communities, eco-tourism and other recreational activities such as fishing;

(x) enhancing cooperation with other relevant conventions, intergovernmental processes and organizations, in particular, the Convention on Wetlands of International Importance, the CSD, the FAO, UNEP and the World Bank;

(xi) raising public awareness on the value of inland water biological resources and promoting exchange of information on relevant researches, programmes, specialized knowledge, as well as indigenous and traditional knowledge related to inland waters biological diversity through the Clearing-House Mechanism of the CBD and by actively engaging local non-governmental organizations; and

(xii) Promoting access to new and additional financial resources for the implementation of the CBD regarding inland water biological diversity in cooperation with Governments, relevant organizations and institutions, including bilateral donor countries, the Global Environment Facility (GEF), multi-lateral financial institutions and non-governmental organizations.

1. Scientific, technical and technological advice

a. Identification and monitoring of the status of inland water biological diversity

44. One area in which scientific advice is of particular importance and of urgent necessity is the identification of components of biodiversity in order to establish priorities which may need special conservation measures, or which may offer the greatest potential for sustainable use. Article 7 of the Convention contains this provision in order to ensure a solid scientific basis for the activities of Contracting Parties. The COP has indeed instructed in its decision III/10 the SBSTTA to "provide scientific advice and further guidance, through its thematic work on ecosystems, to the fourth meeting of the COP, to assist in the national elaboration of Annex I of the Convention, using as guidance the elaboration of the terms as set out in paragraphs 12-29 of document UNEP/CBD/COP/3/12". The Notes prepared by the Executive-Secretary to support the consideration of these items provide further detail (UNEP/CBD/SBSTTA/3/7, UNEP/…/8 and UNEP/…/9). The identification of processes and categories of activities which may have significant adverse effects on the conservation and use of components of inland water biological diversity is equally important. In fact, indicator development is one of the priority areas under the Convention process. Where a significant adverse effect on biological diversity has been determined, efforts should be made to regulate such activities and mitigate their impact, as provided by Article 8(l).

45. Considering that, where information is adequate, a high proportion of inland water species are classified as threatened is a cause for real concern. Although many exceptions exist, in general, inland water species have been subject to less basic field survey, collection, and inventory work, and are less known taxonomically, than are terrestrial species. It is therefore very important to gain greater understanding of the breadth of inland water biodiversity at various scales in order to choose appropriate priority actions.

46. Even for fishes, which are the best-known group, information remains very incomplete for most countries in the world. There is an urgent need to initiate, in close cooperation with relevant international organizations, the process of identification and monitoring of components of inland water biodiversity, which are important for its conservation and sustainable use. Research, collation and dissemination of data on the distribution, status and significance of inland water organisms is necessary. As recognized by decision III/10 adopted at the third meeting of the COP, capacity-building in taxonomy of inland water living organisms should therefore be accorded high priority. An important work is carried out by the IUCN in producing criteria and definitions of threatened species as well as the production of the list of those species. In addition, as an effort to produce a taxonomic database, the FAO has prepared a list of some 262 fish, crustacean and mollusc species that represent the most important native and introduced species used in aquaculture worldwide. This list will be gradually developed into a comprehensive database. In collaboration with the FAO and many institutions, the International Centre for Living Aquatic Resources Management (ICLARM) of the Consultative Group of International Agricultural Research (CGIAR) has also set up a database, called FishBase, available in CD-ROM. It contains data on over 17,000 fish species, including freshwater species, and facilitates the cross-correlation of information and data on the biology, ecology, conservation and use of fish species, including indigenous knowledge. On the basis of reports by member countries, the FAO maintains databases on fishery and aquaculture production, both of which are accessible by the World-Wide Web. Such databases and national statistics should be expanded to include aquatic animals and plants not generally sold in markets. Furthermore, since harvesting of fishes for food is an important direct human use of inland water species, it is also important to collate data on subsistence and local market use of fishery resources in order to assess the magnitude of unreported catch and its sustainability in areas of low or marginal food security. In addition to fishes, identification and monitoring of all other living organisms are also of importance as together they constitute the inland water ecosystems. These are elaborated in the above mentioned documents on indicators and monitoring (UNEP/CBD/SBSTTA/3/7, UNEP/…/8 and UNEP/…/9).

47. Distinguishing processes and categories of activities which have or are likely to have significant adverse impacts on the conservation of inland water biological diversity and on the sustainable use of its components, and monitoring their effects through sampling and other techniques also constitute important aspects of identification and monitoring. The need for such an analysis has been illustrated earlier in this document with regard to the effects of the introduction of alien species to inland water ecosystems.

2. Means of implementation

a. Impact assessment

48. The disruption of inland water ecosystems has been accompanied by an increase in the number of freshwater fish species at risk or recently extinct (to about 20 per cent), and even higher losses in mussels and crayfishes have been observed. As provided by Article 14, appropriate procedures should be established for the impact assessment on inland waters of proposed and on-going projects, not only those directly related to the use of inland water biodiversity, but also those with strong indirect effects, with a view to avoiding or minimizing such effects. For example, it is important that assessment of overall impact of land use change, construction of dams and alteration of watercourses fully address the impact on biological diversity. In addition, the impacts of activities such as, leaching of chemicals and/or soil erosion from agricultural lands, that have indirect effects on inland water living organisms, should also be assessed. At the same time, it is also important to continue the monitoring process after the completion of the projects, involving local communities where the effects are felt. It

is, therefore, important to identify scientific, technical, economic and social information necessary for impact assessment and ways and means to share this information in order to minimize adverse impacts. As recognized by Decision III/18 adopted at the third meeting of the COP, this also forms a step in implementation of Article 11 on incentive measures. Collaboration with international organizations and initiatives already addressing this issue should be sought. These include the Convention on Wetlands of International Importance, the World Bank, the FAO, the UNDP, the UNEP, the World Water Council and the Global Water Partnership. Active involvement of scientific community and the private sector, in particular, the engineering sector must also be sought.

49. The conservation of inland water biological diversity is a global issue, involving all the countries. As provided by Article 14, notification, exchange of information and consultation on activities which are likely to have significant adverse effects on biological diversity in areas beyond the limits of national jurisdiction should be promoted. Article 5 of the Convention on Wetlands of International Importance also contains provisions for consultation among concerned Contracting Parties in the case of transboundary wetlands and shared waters. At the United Nations, the General Assembly at its fifty-first session adopted a resolution to elaborate a framework convention on the law of the non-navigational uses of international watercourses (A/RES/51/206). A better coordination among relevant intergovernmental processes may be necessary regarding the issue of transboundary waters.

b. Access to and transfer of technology

50. Facilitating access to and transfer of technology plays a major role in pursuing the three objectives of the CBD, as contained in Article 16. Scientific advice is needed to facilitate the implementation of this provision. As lack of scientific, institutional and administrative capacity could impede transfer of technology, Article 16 should be implemented along with Articles 12 (research and training), Article 17 (exchange of information), Article 18 (technical and scientific co-operation) and Article 19 (handling of biotechnology and distribution of its benefits). As envisaged in Article 16, considerations must also be given to financial resources and mechanisms to facilitate implementation. These provisions are contained in Articles 20 and 21 of the Convention.

51. The COP has considered the issue of development and transfer of technologies at each of its meetings. According to decisions III/16 and III/22, the issue of technology will be dealt with in the context of benefit-sharing at the fourth meeting of the COP. As contained in Article 18, in addition to transfer of technologies on commercial bases, international cooperation must also play a major role in facilitating access to and transfer of technology. Information exchange, through such means as the Clearing-House Mechanism, can contribute greatly to effective technical and scientific cooperation among different countries.

52. During the past decade, research in biotechnology relevant to hatcheries and aquaculture has made substantial progress. Modern biotechnology now makes it possible to insert any desired cloned gene into most common food fish. These transgenes are more easily introduced into fish than into mammals because fish eggs are fertilized externally. Recombinant DNA techniques hold promise for producing such genetic improvements in fish as increased production efficiency, increased rates of growth, improved disease resistance, and extended ecological ranges.

53. Many of these new technologies can have a positive impact on the conservation and sustainable use of inland water biodiversity if used wisely and with prudence. For instance, genetically altered fishes with increased disease resistance would constitute an environmentally sound alternative to chemical methods in practice for

controlling pests in aquaculture. Also, heterologous growth hormone genes have been transferred to aquaculture fishes, resulting in important size improvement. In addition, the antifreeze protein cold tolerance gene is also being used in transgenic fishes. All of these foreign gene additions result in increased productivity. Other potential benefits of modern biotechnology to inland water biodiversity rely on the use of genetically engineered bacteria, especially designed for the detoxification of important water pollutants such as, mercury, arsenate, and cadmium.

54. However, genetic engineering can also be a threat to inland waters biological diversity as the release of genetically engineered organisms may lead to the spread of novel genes into wild populations with unpredictable results to the ecosystem. A result could be the severe reduction in native populations through cross breeding with genetically modified organisms and hatchery-bred fish. Biological control offers alternatives to biotechnology in reducing impacts of external parasites and other pests, though the total effects much be examined on a case-by-case basis, since biological control also relies on the introduction of alien species.

55. In addition to biotechnology progress in the areas of hatcheries and aquaculture, water management technologies play a major role in maintaining inland water ecosystems. Besides water quality control technologies, improvements can be made to efficiency of withdrawn water, which will lead to reduction of demand for water. However, as addressed earlier, for the maintenance of inland water ecosystems, consideration must be given also to sustainable land management. Certain farming systems, notably intensive production systems relying on high external inputs require particular attention, while programmes which have substantially reduced the potential negative impacts on the diversity of biological resources including freshwater biodiversity and their ecosystems should be further encouraged, such as, the use of constant soil cover, low tillage, integrated pest management and nitrogen-fixing bacteria in substitution to nitrogen fertilizers.

56. Artisanal fishery practices, using traditional knowledge systems, have provided the basis for the sustainable use of the inland water ecosystems over the years. Significant synergies can be obtained by the integration of aquaculture into farming systems, including crop and livestock production systems. Options include eco- and aqua-agriculture, semi-intensive polyculture systems, such as fish-rice and other combinations, the use of farm-prepared supplementary feeds, brackish water polyculture systems and culture-based fisheries in reservoirs and ponds.

c. Institutional arrangements

57. In conformity with Article 22 of the Convention, the protection of inland water biological diversity has to be developed in a manner consistent with other relevant conventions and international agreements and in collaboration with regional, national and international organizations with a view to ensuring collaborative and common efforts to enhance the capacity and effectiveness of the Convention. Article 5 establishes the basis for cooperation among Contracting Parties directly or through international organizations, in respect of areas beyond national jurisdiction and on other matters of mutual interest, for the conservation and sustainable use of inland water biological diversity. As already mentioned, this provision is particularly relevant where a water system lies across national boundaries.

58. The collaboration with the Convention on Wetlands of International Importance is particularly important as areas and aspects covered under this Convention are highly relevant to the CBD, in particular for coastal and inland water ecosystems as already pointed out. In its decision III/21, the COP specifically invited the Convention on Wetlands of International Importance to cooperate as a lead partner in the implementation of

activities under the CBD related to wetlands and, in particular, in the preparation of documents on inland water ecosystems for consideration for the COP at its fourth meeting[30]. It is also important to establish collaborative and coordinated efforts with other conventions and international programmes such as the FAO Code of Conduct for Responsible Fisheries, the Kyoto Declaration and the Plan of Action on the Sustainable Contribution of Fisheries to Food Security, as well as other more specific agreements [31.] The International Code of Conduct on the Distribution and Use of Pesticides adopted by the FAO Conference in 1985[32] is also of great relevance. Furthermore, as mentioned earlier, the General Assembly resolution of the United Nations to elaborate a framework convention on the law of the non-navigational uses of international watercourses (A/RES/51/206) can have favourable impacts on the preservation of inland water ecosystems.

59. A representative, although not complete, sample of international organizations involved in inland water issues related to biological diversity are: the FAO, the Global Environment Monitoring System of the United Nations Environment Programme (GEMS/UNEP), including the Collaborating Centre for Freshwater Monitoring and Assessment as well as other relevant offices of UNEP, the Global Water Partnership, the International Center for Living Aquatic Resources Management (ICLARM), the World Bank and the World Water Council. The Man and the Biosphere Programme of the United Nations Educational, Scientific and Cultural Organization (UNESCO), which establishes Biosphere Reserves around the world, is also carrying out an important work. A closer collaboration may be sought with the UN Commission on Sustainable Development (CSD), as its comprehensive approach to sustainable development and the focus on fresh water in its future work programme are of particular relevance to the Convention. The Special Session of the General Assembly held in June 1997 adopted a multi-year programme of the work for the CSD with the sectoral theme for 1998 being strategic approaches to freshwater management. The Report of the Secretary-General on a comprehensive assessment of the freshwater resources of the world (E/CN.17/1997/9), which was submitted to the fifth session of the CSD and to the Special Session of the General Assembly, contains well-thought recommendations for policy options for the water resource management in addition to the comprehensive assessment of freshwater resources.

60. A considerable number of national organizations[33] as well as regional bodies[34] are established throughout the world to develop effective collaboration on this issue in such areas as policy development, programming, research and development, information exchange and capacity-building.

61. A few of the major non-governmental organizations addressing this topic include Conservation International, the Earth Council, the European Bureau for Conservation and Development, the International Union for Conservation of Nature and Natural Resources (IUCN - the World Conservation Union), Wetlands International, the World Conservation Monitoring Centre, the World Wide Fund for Nature, World Wildlife Fund-US and Worldwatch Institute[35].

62. The supportive legal framework provided both at international and national levels through such policies, laws and organizational support should underpin and guide local management of resources by stakeholders.

d. Capacity-building

63. The importance of inland water systems and their biodiversity has been widely neglected, partly because much of the key information remains within the academic scientific community and within local communities, and partly because most of the species are less visible, and none has such high public profile as, for instance, whales and eagles, in spite of the fact that there are important flagships, such as freshwater dolphins, giant Mekong catfish and large freshwater turtles. It is, thus, essential to raise public awareness on the value of

inland water biological resources and to improve information on how to manage related ecosystems in a sustainable manner. In this connection, active involvement of non-governmental organizations at the local level should be encouraged.

64. Under Article 13, Contracting Parties agree to promote public awareness and education in order to promote conservation of biological diversity and the sustainable use of its components. The production of publications and other educational tools, for schools, universities and the general public should be given hither priority on freshwater species and ecosystems. Economic, legal and policy measures cannot be effective without a wider public support which should strengthen the will and ability of civil society to act. Strategies for raising awareness should take into account the culture and traditions of a given society. Article 13 also contains a provision for cooperation with other States and international organizations in pursuing this goal.

65. As part of public awareness activities, 2 February was designated as the World Wetland Day by the Convention on Wetlands of International Importance and associated programmes are organized by the Convention and its partners. In addition, the global network of wetland education centers is being established by the Wetlands International.

66. Conservation can only succeed if all the stakeholders, including policy makers as well as local communities, understand the endowment and the value of the inland water resources they rely on and if they learn how to manage to meet human needs without jeopardizing biological diversity. There is actually a general lack of knowledge about the dynamics of inland water systems and how to manage them for their full range of biodiversity and ecosystem functions. These capacities are vastly inadequate today at community, technical and policy planning levels and many countries do not have a complete vision on the present situation. For instance, little information exists on indicators and keystone species; the number of taxonomists specializing in that issue is far from adequate; and resource managers are not adequately trained or supported to conserve inland water biodiversity and manage the ecosystems. Provisions for building capacities through research and training are contained in Article 12.

67. In accordance with Article 17, efforts are required to facilitate the exchange of results from technical, scientific and socio-economic research, as well as information on training and surveying programmes, specialized knowledge, and indigenous and traditional knowledge related to inland water biodiversity. The Clearing-House Mechanism of the Convention should be employed effectively to this purpose.

68. Under Article 18 of the Convention, technical and scientific cooperation in the area of inland water biological diversity should be achieved through: the development and implementation of national policies; the strengthening of national capabilities, by means of human resource development and institution building; cooperation for the development and use of technologies, including indigenous and traditional knowledge, the training and exchange of personnel; and through promotion of joint research programmes and joint ventures for technology development.

69. There is a considerable difference in the way countries are handling and facing this issue. Most of the actions are being undertaken at regional and national levels, whereas there is a need to also develop a broad range of water strategies to undertake concerted actions regarding inland water ecosystems at the international level.

e. Financial resources and mechanism

70. The actions recommended in this paper cannot be properly implemented without access to adequate and predictable financial resources by developing country Parties. Under Article 20, Contracting Parties commit themselves to provide financial support for the implementation of the CBD. Paragraph 2 of the same Article contains provisions for the developed country Parties to provide new and additional financial resources to enable developing country Parties to meet the agreed full incremental costs of implementing measures which fulfill the obligations of the Convention. The Global Environment Facility (GEF) is currently the interim financial mechanism for the Convention. Traditionally, water resource management has been one of the most important areas of funding by some international funding and executing agencies, such as the World Bank, the UNDP and the FAO. These investments in water resource management have been, however, focusing mainly on irrigation, water supply, sanitation, flood control, and hydropower. The conservation of biological diversity in inland water ecosystems and the sustainable use of its components have not been given sufficient account in the management of water resources. In many cases, these public investments impose increased pressure on the natural environment of biological components of inland waters. Therefore, more rigorous attention is needed to protect habitats and ecosystems in the design and implementation of water resources management projects.

71. The GEF has recognized the need for conservation and sustainable use of many elements of inland water ecosystems in its operational strategy in biological diversity and international waters. The operational programme on coastal, marine and freshwater ecosystems includes the conservation and sustainable use of the biological resources in freshwater ecosystems. However, funding to sustain the integrity of freshwater ecosystems still needs to be increased. The operational strategy in international waters has been further developed into three operational programmes: a waterbody-based operational programme, an integrated land and water multiple focal area operational programme and a contaminant-based operational programme. Despite some apparent links to inland water ecosystems, these operational programmes have not, however, been formulated under the framework of the financial mechanism of the Convention. An integrated approach may be needed in order to address all issues related to inland water biological diversity. The GEF may wish to reconsider this operational guidance with a view to integrating more fully the conservation of biological diversity in inland water ecosystems and sustainable use of its components and, correspondingly, making more financial resources available for developing country Parties for these objectives.

72. In the formulation of technical assistance programmes, attention needs to be paid to special features of inland water ecosystems. First, inland water ecosystems must be considered in an integrated and comprehensive manner within the context of the watershed. Biodiversity assessment and planning as regards conservation and sustainable use will be more effective when the watershed is considered in its entirety. Second, because of the crucial interdependencies among inland water ecosystems and other sectors, funding should be provided to assist developing countries in incorporating conservation of inland water ecosystems into their sectoral development policy and strategy, especially water resource policy and management. Third, sub-national, national and regional collaboration should be promoted in the conservation of inland water ecosystems. Finally, there is need for Governments to enhance their capacity in inland water ecosystems monitoring, assessment and information management. Technical assistance to developing countries will be of great importance in this area. In order to assist policy makers and practitioners in donor agencies and developing countries to devise strategies for improved conservation and sustainable use of tropical and sub-tropical wetlands, the Development Assistance Committee (DAC) of the Organisation for Economic Development and Co-operation (OECD) prepared a guideline on the subject as one of the series of guidelines on aid and environment[36].

VI. Possible future programme of work

73. The Conference of the Parties (COP) is the governing body of the Convention, consisting of representatives of governments of all the ratifying countries, and operates as provided by Article 23. The COP is the decision making organ and may adopt amendments, annexes, and protocols to the Convention, in accordance with the procedure set forth in the Convention. The COP oversees general measures and policies for implementation of the Convention, taking into account the advice that it receives from its advisory bodies. Article 25 provides for the establishment of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) and the scope of its work[37]. The SBSTTA is composed of experts representing governments of the Contracting Parties competent in the relevant field of expertise. It provides the COP and, as appropriate, its other subsidiary bodies, with scientific advice relating to the implementation of the Convention in a timely manner.

74. In consideration of inland water biological diversity, the SBSTTA may wish to formulate its future programme of work. Such a programme of work may include:

(a) Rapid and focused scientific, technical and technological assessments on the status of inland waters biological diversity, as well as interactions between the components (biotic and abiotic) of inland water ecosystems and their ecological processes as a matter of urgency. Collaboration with the Convention on Wetlands of International Importance in the relevant area should be continued. Such work should also take into account the relevant works already underway in other fora, including the FAO, ICLARM, the World Bank, the UNEP, the IUCN and WCMC. The need for further information should not delay other steps needed for implementation described below;

(b) development of technical guidance for the conservation and sustainable use of inland waters biological diversity on criteria and indicator development, including identification of processes and categories of activities which may have significant adverse effects on the conservation and use of components of inland water biological diversity. The recommendations contained in the Notes by the Executive-Secretary on the subject (UNEP/CBD/SBSTTA/3/7) should be referred to;

(c) identification of scientific and technical information necessary for impact assessment of projects that have potential negative impacts on inland waters biological diversity. Collaboration with relevant organizations should be actively sought, including the Convention on Wetlands of International Importance, the World Bank, the UNDP, the UNEP, the World Water Council and the Global Water Partnership, as well as scientific and engineering communities;

(d) ways and means to facilitate access to and transfer of technology with cooperation of relevant international organizations, multi-lateral financial institutions, non-governmental organizations and the private sector. The consideration may include:

(i) identification of technologies relevant for the conservation and sustainable use of inland waters biological diversity
(ii) enhancement of technical and scientific cooperation; and

(e) promotion of research, training and capacity-building at international, regional and national levels. The SBSTTA may wish to collaborate with organizations active in this field, including the UNDP, the IUCN and the WWF.

75. Taking into account the advice of the SBSTTA on scientific, technical and technological matters, the COP may wish to consider measures to implement the Convention, including:

(a) integration of programmes on inland water biological diversity into national biodiversity programmes, including: *in-situ* and *ex-situ* conservation; impact assessments; incentive measures; and restoration of aquatic systems and mitigation of impacts of human activities;

In order to implement these measures effectively, the COP may wish to consider ways to integrate these measures into the Integrated Watershed Management of the water basins as the highest priority;

(b) institutional arrangements;

Efforts may be continued to collaborate with other relevant conventions and processes, in particular, the Convention on Wetlands of International Importance, the CSD, the FAO, the WWC and the GWP;

(c) increase of public awareness and capacity-building;

The importance of these issues may be addressed at local, national, regional and international levels. Active involvement of stakeholders may be sought;

(d) increase of access to new and additional financial resources

Efforts may be called for to effectively collaborate with relevant funding institutions and non-governmental organizations in formulating ways to facilitate implementation.

Notes

1/ The term "continental" here is used to mean land masses as opposed to marines, thus, includes islands.

2/ According to Article 1.1 of the Convention on Wetlands of International Importance, wetlands are defined as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres". In addition, Article 2.1 provides that wetlands "may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands".

3/ Although inland water ecosystems cover a wider range than those of freshwater, since statistics for biological species of inland aquatic systems are available mainly for freshwater ecosystems, we use the data for freshwater species to highlight the current condition.

4/ McAllister, D. E., et al., "Global Freshwater Biodiversity: Striving for the integrity of freshwater ecosystems", working draft, 1997.

5/ Kottelat, M. and T. Whitten, "Freshwater Biodiversity in Asia With special Reference to Fish", World

Bank Technical Paper No. 342, the World Bank, 1996.

6/ McAllister, D.E., et al., op. cit.

7/ The situation in North America is relatively well documented. The situation of freshwater biological diversity in Asia is well documented in Kottelat and Whitten (1996).

8/ McAllister, D.E., et al., op. cit.

9/ Stiassney, Melanie L. J., "An Overview of Freshwater Biodiversity: With Some Lessons from African Fishes", Fisheries, Vol. 21, No. 9, September 1996.

10/ Abramovitz, J. N., "Imperiled Waters, Impoverished Future: the decline of freshwater ecosystems", Worldwatch Paper No. 128, 1996.

11/ Ramsar sites are those wetlands designated to be of international importance under the Convention on Wetlands of International Importance.

12/ Dungan, P. J., and Jones, T. A., "Ecological change in wetlands: a global overview", 1993, in Moser, Prentice and van Vessen, Waterfowl and wetland conservation in the 1990s: a global perspective. The estimate was based on data provided by the Contracting Parties to the Convention on Wetlands of International Importance.

13/ Economic and Social Commission for Asia and the Pacific, the United Nations, State of Environment in Asia and the Pacific, 1995.

14/ FAO, *The sate of world fisheries and aquaculture*, 1996. This source is used for other statistics in this paragraph.

15/ The United Nations, the report of the Secretary-General's report on comprehensive assessment of freshwater resources of the world (E/CN.17/1997/9), 1997.

16/ Kottelat, M. and T. Whitten, op. cit., Table 7.

17/ Abramovitz, J. N., op. cit.

18/ The United Nations, op. cit.

19/ Although the effects to inland water ecosystems run from the water catchment area through to the river mouth, in order to avoid overlapping with work programmes of other ecosystems that are already established under the Convention, in this report we shall consider ecosystems that consist mainly of waters and their close periphery, while addressing the linkages with surrounding ecosystems, such as forests, marine and coastal.

20/ The Preamble to the CBD states that "where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat".

21/ Report of United Nations Conference on Environment and Development, the United Nations, 1992, Sales No. E.93.1.11

22/ Based on excerpt from FAO/ODA Expert Consultation on Inland Fishery Enhancement, Dhaka, Bangladesh, 7-11 April, 1997.

23/ The United Nations, op. cit.

24/ Biodiversity hot spots are geographic areas rich in species, endemic species, or other taxa. In "Freshwater Biodiversity in Asia With Special Reference to Fish" (World Bank Technical Paper No. 343, 1996), M. Kottelat and T. Whitten defines hot spots as regions with high concentration of endemic species experiencing unusually rapid rates of habitat modifications or loss, citing N. Myers, "Threatened biotas: 'hot spots' in tropical forests" (Environmentalist, 8: 187-208, 1988). They present their estimation of hot spots for freshwater biodiversity in Asia in Figure 2.

25/ McAllister, D. E., et al. op. cit.

26/ FAO, op. cit.

27/ Intermediate Technology Development Group, "Fisher-folk safeguarding aquatic diversity through their fishing technique", 1996.

28/ It should be noted, however, that boundaries between fishing and aquaculture are not so clear-cut. In China, India, Bangladesh and Cuba, fish are produced in a hatchery and stocked into reservoirs, oxbow lakes or other water bodies, where they are harvested by those with fishing rights to the concerned water body.

29/ MacKay, K.T. (edit.), Rice-Fish culture in China, International Development Research Center, Ottawa, 264 pp., 1995.

30/ The Secretariat of the CBD has already initiated this collaboration in the preparation of this document.

31/ There are approximately 300 different regional and national agreements and treaties that relate to fresh water as a resource, especially to regulate the political conflicts relating to water crossing national boundaries. Some of the agreements were stipulated by the Committee for Inland Fisheries of Africa, the Asia-Pacific Fishery Commission, the General Fisheries Council for the Mediterranean, the European Inland Fisheries Advisory Commission, the Indian Ocean Fishery Commission and the Coordinating Working Party on Fishery Statistics.

32/ FAO Conference res. 10/85. The Code was amended in 1989 to include the principle of prior informed consent in Art. 9 (FAO Conference res.6/89).

33/ American Groundwater Trust, Canada Centre for Inland Waters and Cooperative Research Centre for Freshwater Ecology, Freshwater Institute, etc. See UNEP/CBD/SBSTTA/Inf.4 for further listing.

34/ The Asia-Pacific Fishery Commission, the General Fisheries Council for the Mediterranean and the European Inland Fisheries Advisory Commission, etc. See UNEP/CBD/SBSTTA/Inf.4 for further listing.

35/ See UNEP/CBD/SBSTTA/Inf.4 for the list of relevant international, regional, national and non-governmental organizations.

36/ OECD, Guidelines for aid agencies for improved conservation and sustainable use of tropical and sub-tropical wetlands, Guidelines on aid and environment, No. 9, 1996.

37/ Under this article, the scope of the work of SBSTTA is defined as : a) provision of scientific and technical assessments of the status of biological diversity; b) preparation of scientific and technical assessments of the effects of types of measures taken; c) scientific advice on the ways and means of promoting development and/or transferring such technologies; d) advice on scientific programmes and international cooperation in research and development related to conservation and sustainable use of biological diversity; and e) respond to specific questions that the COP and its subsidiary bodies may put to the body.

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