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THE WORLD'S AQUATIC GENETIC RESOURCES: STATUS AND NEEDS

TABLE OF CONTENTS

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THE WORLD'S AQUATIC GENETIC RESOURCES: STATUS AND NEEDS

I. INTRODUCTION

1. The 28th Session of the FAO Conference that decided to broaden the mandate of its Commission on Plant Genetic Resources (now the Commission on Genetic Resources for Food and Agriculture) to cover all components of biodiversity of relevance to food and agriculture, recognized that approaches to plant, forestry, animal and fish genetic resources are different and require specialized expertise in each field, and that the implementation of the broadened mandate of the Commission should be step by step.

2. The time has now come to address aquatic genetic resources and in 2004, at its Tenth Session, the Commission agreed that its Secretariat, in cooperation with FAO's relevant services, should submit to its Eleventh Session a Multi-Year Programme of Work (MYPOW)[1]; the Secretariat was asked to document the status and needs of the various sectors, including fisheries.

3. For this purpose, the Department of Fisheries and Aquaculture with support of the Commission Secretariat, and in collaboration with the World Fisheries Trust (WFT)[2], convened in 2006 a workshop of internationally recognized experts to review the status of and trends in genetic resources for aquaculture and capture fisheries.[3]

4. The elaboration and elements of the MYPOW complement other activities within the FAO Fisheries and Aquaculture Department's regular programme. In 1995 the FAO Conference unanimously adopted the FAO Code of Conduct for Responsible Fisheries that established principles and standards applicable to the conservation, management and development of fisheries and aquaculture. In 2006, at its Sixth Session, the FAO Advisory Committee on Fisheries Research recommended that strengthening FAO's partnership through the Commission for work on fish genetic resources would be timely, as genetic resources were becoming increasingly important in view of their roles in improved aquaculture production and threats to biodiversity and genetic resource conservation.[4] In regards to the MYPOW, the 27th Session of the FAO Committee on Fisheries[5], "... welcomed the proposed work on genetic resources management in fisheries and aquaculture".

5. This working document describes the aquaculture and capture fisheries sector, the status of fish genetic resources for aquaculture and capture fisheries and the need for coherent policies for and management of aquatic genetic resources. Throughout this working document, management is defined as use and conservation. The international environment for work on aquatic genetic resources is then broadly mapped and proposals follow for initiating coverage of fish genetic resources in the MYPOW. Guidance on these proposals is then sought from the Commission.

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[1] CGRFA-10/04/REP, para. 83 – 91.

[2] www.worldfish.org.

[3] Background Study Paper XX. *The Status and trends in aquatic genetic resources: a basis for international policy: Report of a Workshop.*

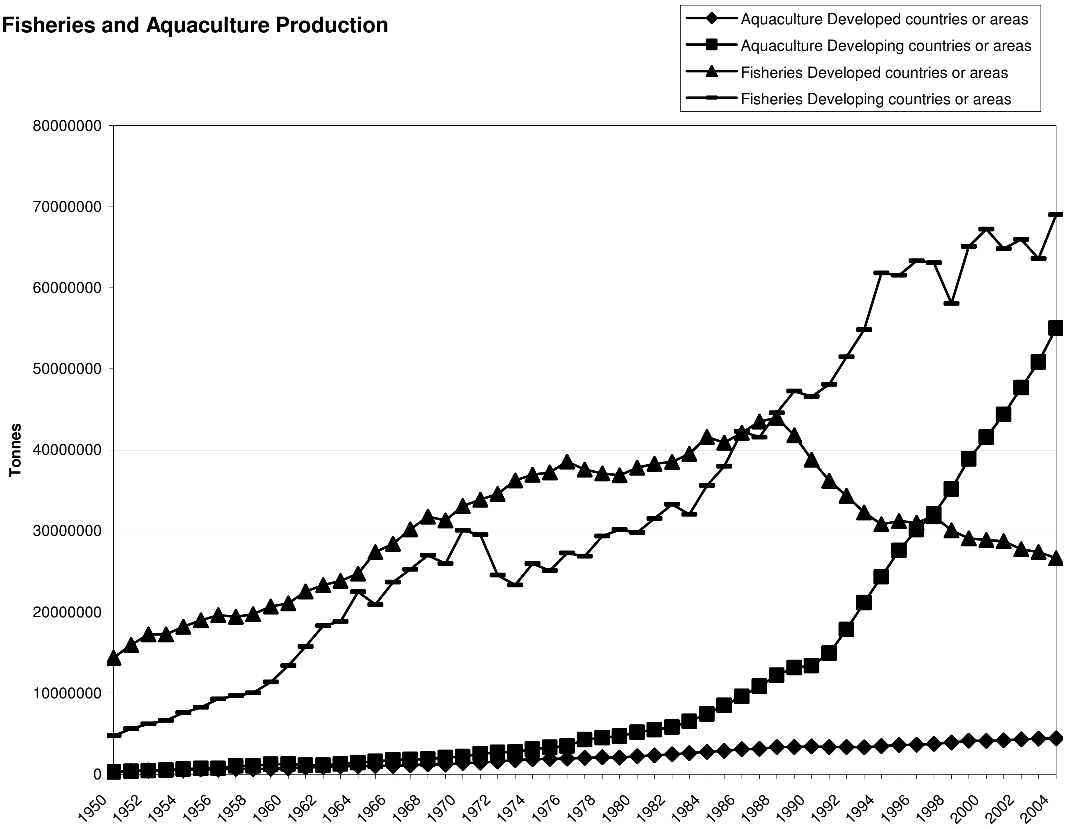
[4] FAO 2006. Report of the Sixth Session of the Advisory Committee on Fisheries Research, Rome, 17-20 October 2006. FAO Fisheries Report No. 812. 22p.

[5] Report of the 27th Session of the Committee on Fisheries 5-9 March, 2007, Rome.

II. GENETIC RESOURCES WITHIN THE FISHERIES AND AQUACULTURE SECTOR

Importance of fish for food security and poverty reduction

6. Production from capture fisheries increased substantially during the mid- to late 20th century and has levelled off in many areas of the world; aquaculture production continues to expand, especially in developing countries (Figure 1). Fish and fish products are important sources of high quality animal protein, and health giving lipids and micronutrients. The chains of fish supply, from aquaculture and capture fisheries, through post harvest processing and fish trade, provide important livelihood opportunities and incomes.



7. FAO's reviews of world aquaculture and capture fisheries [6] indicate that:

- approximately 236 species of fish, invertebrates and plants were farmed in 2004; over 1000 species were harvested from the world's capture fisheries;
- fish provide more than 2.6 billion people with at least 20% of their animal protein intake and that an additional 40 million tonnes of fish per year will be required by 2030;
- aquaculture and capture fisheries employ at least 38 million persons;
- in 2004, world aquaculture production of fish and aquatic plants was 59.4 million tonnes, valued at US$ 70.3 billion;
- in 2004, world capture fisheries production (excluding plants) was 95.0 million tonnes, valued at about US$ 84.9 billion;
- in 2004, total world export of fish and fish products trade was 52.8 million tonnes worth US$ 71.5 billion.

[6] FAO (2006) *The State of World Fisheries and Aquaculture*; and FAO (2007) *State of World Aquaculture 2006*.

8. About 90% of world aquaculture production and most of the world's capture fisheries production come from developing countries and are a vital source of food security and employment for the rural and urban poor.

Types of aquaculture

9. Aquaculture is as diverse as agriculture in its range of farmed species and wide variety of production systems. The major groups of farmed aquatic organisms are: finfish; crustaceans; molluscs; other aquatic invertebrates such as sea urchins and sea cucumbers; and aquatic plants, including seaweeds and freshwater macrophytes.

10. The contribution of aquaculture to world fish production (excluding plants) has grown from 3.9% in 1970 to about 35% and this growth is continuing (Figure 1). Aquaculture also provides increasing proportions of the world's supply of ornamental aquatic organisms, retail sales of which were valued at US$ 3 billion in 2000. About 84% of aquaculture production currently comes from Asia but aquaculture has high scope for growth in all developing regions.

11. Aquaculture takes place in fresh-, brackish- and marine waters; in lakes, rivers reservoirs, farm ponds, ricefields, lagoons, coastal waters and the open sea. Production systems range from natural, modified or artificial systems where populations use natural feeds, to semi-intensive aquaculture systems and intensive ponds, pens, cages, tanks and other containments. Fish farms and hatcheries range in size from small-scale/backyard to large scale corporate ventures, some resembling broiler poultry farming operations.

12. Fish production from culture-based fisheries (CBF) is usually included in aquaculture production statistics because these fisheries rely upon the release of large numbers of hatchery-reared fish. These are released to water bodies for subsequent harvest as adults. Successful CBF include the stocking of carps in lakes and reservoirs, the release of salmon that can be harvested on their return migrations, and the stocking of some marine finfish and invertebrates in relatively enclosed coastal waters.

13. In capture-based aquaculture (CBA), fish seed of species for which mass production in captivity is not yet practical are taken from the wild and then fattened in fish farms. This type of aquaculture is currently enjoying success with species such as eels, groupers and tunas, but faces some constraints from overexploitation of the wild seed fisheries, high feeding costs and the need to avoid adverse environmental impacts.

Types of capture fisheries

14. Capture fisheries are also extremely diverse in type and scale. They take place in inland, coastal and oceanic waters: from mountain streams to the deep sea. Fishing gear and vessels range from simple handlines operated by individual fishers to industrial vessels that are as long as football pitches and able to fish in all seas. Between these extremes there is a huge diversity of nets, dredges, traps and other fishing gears, operated from shorelines and from a wide range of inland, coastal and open sea vessels.

15. Compared to recent expansion and high scope for growth of aquaculture, most of the world's marine capture fisheries are already fully exploited or in decline, largely through overexploitation and ecosystem damage. Their continuation and rehabilitation will require in many instances improved management to address socioeconomic and ecological constraints.

16. Most inland fisheries face similar problems with the added complication that freshwater and inland ecosystems are used by other sectors that impinge on fishery resources, e.g. hydro-electric power generation, navigation, irrigation. Most inland fisheries have limited scope for growth, though some are of high local importance. Poor persons have traditionally supplemented their diets and income by fishing with simple nets and lines in inland and coastal waters. For

example, the rich aquatic biodiversity of some Asian rice -field ecosystems provides over 100 species of aquatic plants and animals of use to humans.

17. Deepwater fisheries operate on continental slopes and seamounts and extend from 400 m down to around 1200 m though trawling is possible to a depth of 2000 m. Many deepwater fisheries target species that are slow growing and are highly vulnerable to overexploitation. Many stocks of such fisheries have declined. Substantial landings are derived from fisheries that are not regulated by any regional fisheries management organization and thus do not have the protection of management plans. Many small-scale deepwater fisheries may target stocks with annual sustainable yields of only a few hundred tonnes, however, these are important for some small island states. Deepwater fisheries, as with those in more shallow waters, target resources that are valuable fishery genetic resources and need characterization and management[7].

Status of Aquatic Genetic Resources

18. Fish genetic resources comprise the DNA; genes; gametes; wild, farmed and research populations; species; and genetically altered forms - selectively bred strains, hybrids, polyploids, and transgenes - of all exploited and potentially exploitable finfish and aquatic invertebrates.

19. Fish genetic resources management merits high emphasis in ecosystem approaches to the development of responsible aquaculture and ecosystem-based management of responsible capture fisheries. Fish genetic resources help determine the performance of the farmed fish and their interactions, including genetic interactions, with aquatic biodiversity. In capture fisheries, fish genetic resources help determine the productivity of fished populations and their adaptability to environmental change, including climate change.

20. Aquatic genetic resources encompass also the genetic diversity of farmed and harvested aquatic plants, which are plant genetic resources, but have not yet been adequately covered by the Commission and by other organizations that are participating in policymaking for and management of plant genetic resources.

21. The most important fish genetic resources for aquaculture and capture fisheries by species groups are:

- for aquaculture - carps, catfishes, milkfish, salmon, tilapias, mussels, oysters and shrimps, as well as their wild relatives;
- for inland capture fisheries - carps, catfishes, characins, salmonids; tilapias and other cichlids;
- for marine capture food fisheries - small and large pelagic fishes, reef fishes, sharks and other elasmobranchs, demersal fishes, and diadromous migratory fishes such as salmon and sturgeons;
- for marine industrial and low value/trash fish fisheries – small pelagic and demersal species that provide fishmeal and fish oil for farmed animal and fish feeds.

22. Important plant genetic resources for farmed aquatic plants include those for marine seaweeds and freshwater macrophytes.

23. With few exceptions, substantial domestication and genetic improvement of farmed fish is not as advanced as in the crop and livestock sectors. This is now changing for some widely farmed aquatic species, with rapid benefits to fish farmers and fish consumers.

24. Fish genomics is also developing rapidly and is seen as having many potential applications including marker-assisted selection for the genetic improvement of farmed fish,

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[7] Shotton, R. 2006. Deepwater Fisheries. Pages 188-200 in, State of the World Marine Fishery Resources. FAO, Rome.

accurate identification of fish genetic resources for their conservation and use, and the diagnosis and prevention of fish diseases. The farming of distinct strains, hybrids, mono-sex populations, polyploids, is increasing, bringing increased needs for effective biosecurity procedures. Private sector research for the development of biotechnological products and processes in aquaculture and capture fisheries is increasing.

III. THE NEED FOR COHERENT AQUATIC GENETIC RESOURCES POLICIES AND MANAGEMENT

25. The large and increasing contributions from aquaculture to world fish supply and the problems of managing effectively capture fisheries stocks that are not well characterized genetically have not yet been recognized in terms of increased investment in making and implementing fish genetic resources management policies. The world water crisis and climate change, for example, pose some constraints for expansion of aquaculture and fisheries and threats to some fish genetic resources, but also offers some opportunities for multipurpose use of scarce water resources, adding value to them and benefits from them. The diversity of fish genetic resources may help aquaculture and fisheries adapt to these constraints, however, these potentials are largely unexplored.

26. The lack of coherent fish genetic resources management and of policies is becoming a serious problem because the recent rapid expansion of aquaculture and the overexploitation of many capture fisheries have involved irresponsible use of natural resources and lack of consideration of the needs of other sectors, resulting in adverse environmental and social impacts, intersectoral conflicts and unsustainability. A transition to more responsible, sustainable and productive aquaculture and capture fisheries has been called for by Members of FAO and the international community. Its success will depend in large measure upon effective management of fish genetic resources.

27. The management of fish genetic resources for aquaculture and capture fisheries is being constrained by the lack of effective policies. This has resulted largely from under-recognition of the importance of fish genetic resources for fish supply. Some of the major consequences of this have been:

- information about fish genetic resources in biological databases is highly inadequate;
- applications of genetics in aquaculture and capture fisheries have been limited and, despite some international networking[8], a global approach to fish genetic resources policymaking and management is still lacking;
- further domestication and genetic improvement of farmed fish are major routes to increased productivity, but many of the fish genetic resources through which this can be accomplished are poorly characterized and threatened.

28. Marine and coastal aquaculture often involve high value species with export potential, e.g. marine shrimp, but aquaculture development may impact ecologically important areas. Freshwater aquaculture has high scope for growth, especially where integrated with other sectors, but freshwater and diadromous fish are the world’s most threatened species of vertebrate used by humans[9]. In 1996, the numbers of critically endangered, endangered and vulnerable finfish species were already very high and it had increased by 2000. Major threats include: alien species introductions; climate change; dams; land use change; IUU fishing; and pollution.

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[8] For example, the International Network on Genetics in Aquaculture (INGA); http://www.worldfishcenter.org/inga/

[9] Bruton, M.N. 1995. *Have fishes had their chips? The dilemma of threatened fishes*. Environmental Biology of Fishes 43: 1-27. Jenkins, M. 2003. Prospects for biodiversity. Science 302:1175-1177. Loh, J. et al. 2002. Living Planet Report 2002. World Wildlife Fund for Nature, Gland Switzerland.

29. The African tilapias are a good example. Farmed tilapia is now an international food fish commodity – an 'aquatic chicken'. Genetic improvement of farmed tilapias, using wild germplasm from Africa, has brought large benefits to Asian countries while African tilapia farming remains underdeveloped and the wild tilapia populations of Africa - the main fish genetic resources to remedy this - are poorly characterized and face all of the threats mentioned above.

30 Adequate mechanisms for conserving the genetic diversity of farmed fish and their wild relatives are poorly developed. Gene banking of fish genetic resources – as *in situ/in vivo* fish populations, *ex situ/in vivo* fish populations and *ex situ/in vitro* collections of cryopreserved sperm, embryos and tissues – is expensive and is still at an early stage though efforts are increasing. There is still no global consensus either on how to conserve *in situ* the diversity of wild relatives of the major aquatic farmed species. Conservation of fish genetic resources by any of these means requires equitable sharing of maintenance and access costs and benefits among their stewards and users.

31. The purposeful stocking of hatchery-reared fish for culture-based fisheries (CBF) and the escapes of fish from farms have the potential to alter genetically the wild fish genetic resources with which they interact, by interbreeding and competing for food and spawning sites. However there are also benefits from CBF. The risk:benefits from CBF have often not been quantified with respect to fish genetic resources management.

32. Capture fisheries management has often not addressed fish genetic resources. The delineation and management of fish stocks as fish genetic resources, on the basis of their genetic differences, has not yet been widely implemented but is now becoming easier through new molecular genetic tools that provide high-resolution, DNA markers for assessing genetic population structure.

33. In marine and brackishwater capture fisheries, the greatest threats to fish genetic resources are overfishing, habitat degradation, land-based pollution, and climate change. The main risk is extinction of genetically unique subpopulations, many of which have yet to be well characterized. Even though many species of marine fishes are represented by very large populations, the actual genetic resources of the breeding population may be much smaller.

34. There is general agreement that many deepwater fisheries are exploited beyond sustainable levels and that urgent action is required at the global level to reduce deepwater fishing effort and to protect fragile deepwater ecosystems, especially the ancient coral 'forests' on seamounts, from the damage caused by bottom trawling. The high longevity, slow growth, and late maturity of many deepwater fish species, make them highly vulnerable to IUU fishing.

IV. MAPPING THE INTERNATIONAL ENVIRONMENT WITH RESPECT TO AQUATIC GENETIC RESOURCES

35. Only FAO and the major international conventions with responsibility for aquatic genetic resources have the necessary intergovernmental status to develop and coordinate aquatic genetic resources policies and instruments towards international agreements, as has been done for plant genetic resources.

36. The FAO Fisheries and Aquaculture Department produces a report on the State of World Fisheries and Aquaculture every two years and occasional other publications of a similar nature, though none of these addresses yet specifically the status of and issues pertaining to aquatic genetic resources. FAO also publishes useful *Species Fact Sheets* on farmed aquatic species, but their coverage of fish genetic resources is uneven and sometimes lacking.

37. The FAO Fishery and Aquaculture Information and Statistics Service compiles and publishes datasets on aquaculture and capture fisheries. These presently contain little information on fish genetic resources other than at species level, but there are future prospects for expanding

coverage at the genetic level if more information at national level can be supplied to FAO for distinct strains and hybrids in aquaculture.

38. The FAO Code of Conduct for Responsible Fisheries (CCRF) together with its Technical Guidelines and Supplements[10] are the main instruments through which the FAO provides advice and guidance and through which members are contributing to responsible aquaculture and fisheries. The Technical Guidelines cover a range of issues including policy formulation and are not limited to technical or technological matters. The CCRF helps to catalyze and facilitate international, as well as regional and national, aquaculture and fisheries regulations. The CCRF is "soft law" although it does have legally a binding section, the Compliance Agreement.[11]

39. An important international convention with respect to fish genetic resources is the Convention on Biological Diversity (CBD); it has two interlinked programmes of work of high relevance for fish genetic resources: Biological Diversity of Inland Water Systems and Marine and Coastal Biodiversity. To date, these programmes have emphasized aquatic biodiversity at species and ecosystem levels, rather than at the genetic level. Other international conventions of high importance for aquatic genetic resources are the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)[12] and the Ramsar Convention on Wetlands.[13] CITES is particularly relevant to preventing irresponsible use of wild fish in aquaculture and capture fisheries through regulation of international trade of species which are threatened or may become threatened unless their international trade is restricted. The Ramsar Convention has a world-wide system of accredited Ramsar sites many of which are protected areas for important fish genetic resources. UN General Assembly resolution 59/24 of 17 November 2004 decided to establish an *Ad Hoc* Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction.[14]

40. Among the international non-governmental organizations that work on fish genetic resources, the World Conservation Union (IUCN)[15], the World Conservation Monitoring Centre (WCMC)[16] and the World Wildlife Fund (WWF)[17] make extremely important contributions to management of fish genetic resources, though mainly at species and ecosystem levels. The World Fisheries Trust (see footnote 2) has been a pioneer with respect to capacity building for complementary *in situ* and *ex situ* gene banking and for reviewing stakeholder issues. The private sector, especially large aquaculture corporations involved in aquaculture are increasingly involved in fish genetic improvement both through their own programmes and through private-public partnerships; much of this information however is proprietary.

41. The Consultative Group on International Agricultural Research (CGIAR) includes a centre with responsibility for aquaculture and capture fisheries, the WorldFish Centre[18], which is the Member-Coordinator for INGA (see footnote 8).

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[10] Some examples of CCRF Technical Guidelines of high relevance for fish genetic resources include issues such as: Precautionary approach to capture fisheries and species introductions; Aquaculture Development; Implementation of the International Plan of Action to prevent, deter and eliminate illegal, unreported and unregulated fishing; The ecosystem approach to fisheries.

[11] http://www.ecolex.org/en/treaties/treaties_fulltext.php?docnr=3105&language=en.

[12] www.cites.org.

[13] www.ramsar.org.

[14] http://daccessdds.un.org/doc/UNDOC/GEN/N04/477/64/PDF/N0447764.pdf?OpenElement.

[15] www.iucn.org.

[16] www.unep-wcmc.org.

[17] www.worldwildlife.org.

[18] www.worldfishcenter.org.

42. Among existing regional networks, the Network of Aquaculture Centres in Asia and the Pacific (NACA)[19] is an important partner in work on fish genetic resources issues and policy. Also, the Network of Aquaculture Centres in Eastern Europe (NACEE)[20], recently set up with support from FAO, has a major focus on fish genetic resources for fish breeding programmes.

43. Thus, there is scope for enhancing synergies and cooperation in order to strengthen FAO's partnership with other relevant international organizations working on the field of fish genetic resources. It will be important to build cooperation and partnerships so that there will be synergy and no duplication of work between the MYPOW for fish genetic resources and existing programmes of work of other forums.

V. PROPOSALS FOR INITIATING COVERAGE OF AQUATIC GENETIC RESOURCES IN THE MULTI-YEAR PROGRAMME OF WORK

Improved information systems for aquatic genetic resources

44. Information on aquatic genetic resources, for aquaculture and capture fisheries, is presently incomplete, scattered and held in non-standard formats. Nevertheless, it is exceedingly valuable information As the number of farmed fish strains, hybrids, and other genetically altered forms increases in aquaculture, information systems will need to capture their relative contributions to farmed fish production and value. This will improve management of fish genetic resources for aquaculture. Similarly, fuller information on the genetics of wild fish populations will improve their management. This means that the world's databases that contain aquatic genetic resources information will ultimately need the same sort of guaranteed financial support that has been secured for plant genetic resources by the Global Crop Diversity Trust.[21]

45. No existing aquatic biological databases give adequate coverage to aquatic genetic resources but some provide substantial fish genetic resources information that can be supplemented, given additional resources, for example, FishBase.[22] Other relevant databases and networks cover aquatic plants[23], all marine life[24] and commercially important marine invertebrates[25]. These and other biological databases are increasingly working together to improve their linkages and interoperability and they link to other global databases. There are many other web-based information systems that can accept and provide access to aquatic genetic resources information.

46. Work would endeavour to build partnerships with organizations that possess relevant information and use modern information technologies to improve the quality, access and dissemination of that information. Open access web-based information currently in use, e.g. Avano project, and modern information harvesters would serve as useful models[26].As the quantity of information on aquatic genetic resources increases, improved information management will be crucial.

47. The improvement of information systems for fish genetic resources is an immediate priority. Databases and information systems should fulfil the criteria that information on aquatic

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[19] www.enaca.org.

[20] www.agrowebcee.net/subnetwork/nacee/.

[21] www.croptrust.org.

[22] www.fishbase.org.

[23] www.algaebase.org.

[24] www.coml.org.

[25] www.sealifebase.org.

[26] Avano project is part of the Open Access international movement, which aims at making scientific documentation accessible to a broad public through free publishing on the Web. www.ifremer.fr/avano/.

genetic resources should be global, authoritative, free, objective and available in standard formats. The information systems will be improved so that the flow of information will be facilitated to all FAO Members and partners.

Development of an international policy framework for management of aquatic genetic resources through analysis of the FAO Code of Conduct for Responsible Fisheries

48. The major international framework that deals with aquatic genetic resources for fisheries and aquaculture is the FAO Code of Conduct for Responsible Fisheries (CCRF); it is the world's most comprehensive and internationally agreed set of principles and guidelines applicable to the management and development of aquaculture and capture fisheries. *Appendix 1* lists the main articles that deal with aquatic genetic resources.

49. However, there are gaps in its coverage as well as gaps in other international instruments that deal with aquatic genetic resources. Increased awareness of the CCRF, especially its articles on fish genetic resources, is also required. Furthermore, there is no agreed international framework, incorporating national, regional and international levels, for policies regarding the assessment of the status of genetic resources for aquaculture and capture fisheries. A policy analysis, including an analysis of the CCRF, is described below with the goal of producing an international framework for the management of aquatic genetic resources.

50. The complexities of aquaculture and capture fisheries present significant challenges for making policies for management of their fish genetic resources, particularly in terms of the relatively recent domestication of most farmed fish, the hundreds of farmed and fished aquatic species, and the diversities of the ecosystems in which they are farmed and fished. There is an urgent need to analyze existing policies for fish genetic resources, identifying current and likely future policy gaps. Advances in molecular biology and genetics are outpacing policy formulation for their application. Regulation and policies regulating use of fish genetic resources and alien species/genotypes, even when they exist, are often difficult to enforce.

51. Policies will need to address many complex and interactive drivers including: the growing human population; environmental safeguards; the need for improved efficiencies in production, harvest, and post harvest operations; awareness and education needs; and access and benefit sharing. An analysis of aquatic genetic resources policy could explore to what extent new policies for genetic resources management could initiate a change away from the adversarial relationships that aquaculture and capture fisheries have had with each other and with other sectors that use natural resources and particularly with nature conservation.

52. Several approaches exist such as twinning aquaculture and fisheries development with conservation, eco-certification of fish and fishery products, and promoting guidelines on best management practices. For aquaculture production, the pay-offs would be not only the survival of threatened wild fish genetic resources, but also ensuring the sustainable use, in designated farming areas, of the most profitable species and genetically improved farm types available.

53. The CCRF emphasizes conservation of aquatic genetic diversity and of the integrity of aquatic communities and ecosystems, and responsible use of living aquatic resources at all levels including the genetic level. Its technical guidelines amplify these principles and outline relevant practices. However, the CCRF, while covering well general fish genetic resources issues, has not yet been supplemented with a technical guidelines publication that gathers together and amplifies principles and practices for management of fish genetic resources. In addition, recent advances in molecular genetics and genomics and their implications for fish genetic resources are not currently adequately covered by any of the CCRF guidelines.

54. FAO is organizing the preparation of an additional CCRF Technical Guidelines volume on Genetic Resource Management in Aquaculture. This specific volume on technical and

technological aspects of aquaculture will provide background information for further development of other technical guidelines on fish genetic resources.

55. The above activities lead towards the formulation of an international framework for the management of aquatic genetic resources. Such a framework is necessary so that common strategies for improved assessment and management can be developed. Specific strategies will be required for *in situ* conservation of fish genetic resources on farms and in natural ecosystems, and for *ex situ* conservation of fish genetic resources, including *in vitro* gene banking of cryopreserved sperm, embryos and tissues.

56. Analysis of the CCRF and development of the international framework with respect to aquatic genetic resources could proceed through the development of Technical Guidelines for appropriate policy on management and assessment of aquatic genetic resources. These Guidelines could serve as a format for additional international agreements or instruments in line with the CCRF and other international instruments.

57. As a first step for the MYPOW, consideration could be given to the development of such a strategy and framework that would be guided by the Commission building on the CCRF provision and on recommendations made by COFI. The mechanisms by which work is undertaken could include the formation of an *ad hoc* working group on aquatic genetic resources and could progress, if required, and if adequate resources were available, to a more formal intergovernmental technical working group.

Assessing the status of genetic resources for aquaculture and capture fisheries and capacities for their management

58. There has been recent progress in the characterization of genetic resources for aquaculture and capture fisheries, genetic improvement of farmed fish and genetic technologies, including genomics. However, information in many cases is incomplete, inconsistently organized, and often difficult to use and access. These factors constrain the accurate description of global fish genetic resources. The lack of an accurate accounting of global fish genetic resources also constrains further development and refinement of international policies for responsible use and conservation of aquatic genetic resources, as well as the development of global strategies or action plans. Thus, improvement of information and policy analyses under the international framework could lead in the long term to a global assessment of aquatic genetic resources, in the form of a *State of the World's Aquatic Genetic Resources*, as has been done in other sectors.

59. Producing a global comprehensive assessment of aquatic genetic resources will require significant human and financial resources currently not available to FAO. Given the differences between the fisheries and aquaculture sector and the terrestrial plant and animal sectors, specific strategies and a framework will need to be developed for aquatic genetic resources. Similarly, the scope and content of a *State of the World's Aquatic Genetic Resources* will need to be carefully defined. Arrangements could be made for a joint endorsement of a *State of the World Aquatic Genetic Resources* by the Commission and COFI, possibly through a high level meeting.

60. An assessment could, however, be approached in a stepwise manner appropriate to the resources that can be made available. A stepwise programme of work could focus first on the most important fish genetic resources for aquaculture and capture fisheries. There is scope to document fully the status of fish genetic resources as well as their use and conservation values for some of the most important fish groups.

Financial implications

61. Aquatic genetic resources will become increasingly important in the next decade given the many challenges to which the fisheries and aquaculture sector is confronted. Their inclusion

in the MYPOW is therefore timely. This document has identified many special features of fish genetic resources and differences as compared to plant genetic resources and animal genetic resources, the way forward proposed therefore follows unique paths, including in particular strengthening the FAO Code of Conduct for Responsible Fisheries.

62. There are many potential partners for this proposed work, including international organizations and regional networks and even the various FAO region- and fishery-specific Fisheries Commissions. However, the addition of fish genetic resources work to their mainstream aquaculture and capture fisheries work would require additional resources. The ongoing moves towards environment-friendly aquaculture development and ecosystem-based management of capture fisheries are already stretching the resources of fisheries organizations. These efforts have so far largely ignored the management of aquatic genetic resources.

63. FAO would need to be strengthened to lead and to coordinate this programme of work. Financial resources would be required to sustain human resources to manage and implement the MYPOW over the first 5 years of the programme. Estimated financial requirements for this period would be approximately US$ 1.6 million A detailed budget can be prepared on request and it is recognized that these estimates may change in view of a modified programme of work.

64. Precise cost estimates for a global assessment of aquatic genetic resources will be identified as the specific content and scope of the work are decided during the first years of the MYPOW.

65. Although the proposed programme complements the regular programme of work of the FAO, there are not sufficient human or financial resources to address adequately the scope of these activities. The above estimates are deemed necessary to begin the MYPOW process and seek other necessary funding as possible.

VI. DRAFT TIME-TABLE FOR THE MULTI-YEAR PROGRAMME OF WORK

66. The elements of the MYPOW, (i) improvement of information; (ii) development of an international framework and analysis, including analysis of the Code of Conduct for Responsible Fisheries; and (iii) development of a global assessment or *State of the World's Aquatic Genetic Resources*, should proceed in a stepwise manner with an immediate priority given to improving information and access to it.

67. It is estimated that the first three years of the MYPOW should focus on improving information and access to it; progress would be reported to the Thirteenth Session of the Commission. Elaboration of the Code of Conduct for Responsible Fisheries and the establishment of an international framework should commence in year one of the MYPOW and continue through the medium term; progress would be reported to the Fourteenth Session. Strategic reviews of ongoing work and convening expert forums will be conducted and an assessment of genetic resources of species of major importance to fisheries and aquaculture will be prepared as a mid-term output.

68. In the medium term, the scope and content of the *State of the World's Aquatic Genetic Resources* will be decided and appropriate work plans and budget will be developed in the medium term. *The State of the World's Aquatic Genetic Resources* would be jointly presented to the Fifteenth Session of the Commission and the appropriate session of the FAO Committee on Fisheries.

VII. ADVICE SOUGHT FROM THE COMMISSION

69. Advice from the Commission is sought on the elements of the MYPOW, the priorities, timetable and modalities detailed herein to implement the elements.

70. **In relation to the improvement of aquatic genetic resources information systems**, the Commission is requested to:

- confirm that the improvement of the relevant information systems is as an immediate priority, and support the establishment of partnerships with important information sources;
- decide to review the information base for aquatic genetic resources at the Thirteenth Session of the Commission.

71. **In relation to the analysis of the Code of Conduct for Responsible Fisheries and the development of an international framework**, the Commission is requested to:

- confirm this as a priority to begin immediately, in particular, through a policy analysis to identify gaps and opportunities for improved implementation of the Code of Conduct for Responsible Fisheries, with the aim of developing an international framework for the management of aquatic genetic resources;
- decide to finalize the international framework for the management of aquatic genetic resources at its Fourteenth Session;
- recognise the importance of developing technical guidelines on aquatic genetic resources management, and broader technical guidelines on aquatic genetic resources management policy as a priority within this work;

72. **In relation to the production of *The State of the World's Aquatic Genetic Resources***, the Commission is requested to:

- request Fisheries and Aquaculture Department to provide a concept note on the proposed process for the preparation of *The State of the World's Aquatic Genetic Resources* at its Twelfth Session;
- decide to endorse *The State of the World's Aquatic Genetic Resources* at its Fifteenth Session;

73. **On general matters**, the Commission is requested to:

- inform COFI of its decision, invite its advice and cooperation in this work, and request COFI to help mobilize external funds as required;
- invite COFI, in due course, to jointly endorse *The State of the World Aquatic Genetic Resources*, possibly through a high level meeting;
- recommend that FAO, in collaboration with partners, lead a process to improve the management of aquatic genetic resources, within the context of the Commission's MYPOW;
- consider the initiation of a process to form an *ad hoc* advisory group to focus the aquatic genetic resource elements of the MYPOW;
- request donors to provide extra-budgetary resources in a sustained manner to support this work, including making available the necessary human resources.

Appendix 1

SELECTED ARTICLES WITHIN THE FAO CODE OF CONDUCT FOR RESPONSIBLE FISHERIES THAT RELATE TO AQUATIC GENETIC RESOURCES[27]

Article 6.2

Fisheries management should promote the maintenance of the quality, diversity and availability of fishery resources in sufficient quantities for present and future generations in the context of food security, poverty alleviation and sustainable development. Management measures should not only ensure the conservation target species but also of species belonging to the same ecosystem or associated with or dependent upon the target species.

Article 7.2.2

…biodiversity of aquatic habitats and ecosystems is conserved and endangered species are protected;

Article 9.1.2

States should promote responsible development and management of aquaculture, including an advance evaluation of the effects of aquaculture development on genetic diversity and ecosystem integrity, based on best available scientific information

Article 9.3.1

States should conserve genetic diversity and maintain integrity of aquatic communities and ecosystems by appropriate management (in particular to minimize adverse impacts from non-native and genetically altered species)

Article 9.3.3

States should …encourage the adoption of appropriate practices in the genetic improvement of broodstock ….

Article 9.3.5

States should, where appropriate, promote research and, when feasible, the development of culture techniques for endangered species to protect, rehabilitate and enhance their stocks, taking into account the critical need to conserve genetic diversity of endangered species.

[27] Full text available at ftp://ftp.fao.org/docrep/fao/005/v9878e/v9878e00.pdf.