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Report of the

EXPERT CONSULTATION TO DEVELOP THE FAO TECHNICAL GUIDELINES FOR RESPONSIBLE FISHERIES: RECREATIONAL FISHERIES

Berlin, Germany, 5–6 August 2011

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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PREPARATION OF THIS DOCUMENT

This is the final report of the Expert Consultation to Develop the FAO Technical Guidelines for Responsible Fisheries: Recreational Fisheries, held in Berlin, Germany on 5 and 6 August 2011. The document (Working Document) used as the basis for discussion by the experts at the Expert Consultation, attached as Appendix C, was prepared by three FAO consultants, Mr Robert Arlinghaus, Mr Steven Cooke and Mr Brett Johnson. The Department of Biology and Ecology of Fishes of the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), located in Berlin, Germany, hosted the Expert Consultation at its premises.

The FAO Secretariat to the Expert Consultation, consisting of Mr Raymon van Anrooy, Mr Devin Bartley, Mr Blaise Kuemlangan, Ms Karine Erikstein and Ms Cana Salur, would like to thank the staff of the host institution, the consultants, experts, observers and others attending and supporting the organization of this Expert Consultation for their contributions to the success of the Expert Consultation.

The Annexes have been technically cleared but not reviewed for FAO language or house style.

Distribution:
All FAO Members
Participants of the Expert Consultation
Other interested nations and national and international organizations
FAO Fisheries and Aquaculture Department
FAO Regional Fisheries Officers
Regional Fishery Bodies (RFBs) and Regional Fisheries Management Organizations (RFMOs)

FAO

Report of the Expert Consultation to Develop the FAO Technical Guidelines for Responsible Fisheries: Recreational Fisheries, Berlin, Germany, 5–6 August 2011.

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ABSTRACT

The Expert Consultation was convened by FAO to Develop the FAO Technical Guidelines for Responsible Fisheries: Recreational Fisheries. It was held at the Department of Biology and Ecology of Fishes of the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) in Berlin, Germany, on 5 and 6 August 2011. The Expert Consultation was organized in recognition of the growing global importance of recreational fisheries in the overall development and management of the fisheries sector. Recreational fisheries has become an important Subsector of the fisheries sector in terms of employment and income generation.

The Expert Consultation was attended by ten experts, three resource persons and six observers, representing a wide range of recreational fisheries expertise, experience and geographical areas, including Africa, Asia and the Pacific, Europe, Latin America and North America.

The Expert Consultation had before it a comprehensive Working Document on the subject matter. The Expert Consultation reviewed the Working Document and provided specific guidance for the finalization, publication, dissemination and global level promotion of the Technical Guidelines. The Expert Consultation recommended ways to support implementation of these Technical Guidelines and creating awareness on the Technical Guidelines among members of the Committee on Fisheries (COFI), through inclusion of references in background documents for the Thirtieth Session of COFI, listing of the Technical Guidelines as an information document for the Thirtieth Session of COFI, or alternatively by organizing a side-event on recreational fisheries at the COFI session.

The Expert Consultation also provided general recommendations on recreational fisheries management and development aspects to FAO and other relevant stakeholders. Recommendations made by the Expert Consultation relate, among others, to assessing the value and social and economic benefits of recreational fisheries; increasing communication; developing the governance and management capacity in support of recreational fisheries; collecting disaggregated data and information on recreational fisheries, and developing a network of recreational fisheries practitioners to facilitate the exchange of information, knowledge techniques and experiences to further the Subsector.

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INTRODUCTION

1. The Expert Consultation to Develop the FAO Technical Guidelines for Responsible Fisheries: Recreational Fisheries was held at the Department of Biology and Ecology of Fishes of the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) in Berlin, Germany on 5 and 6 August 2011.

2. The Consultation was attended by ten experts, three resource persons and six observers, representing a wide range of recreational fisheries expertise, experience and geographical areas, including Africa, Asia and the Pacific, Europe, Latin America and North America. They included academics, researchers, policy-makers, fisheries managers, socio-economists and recreational fisheries experts in the widest sense of the word. The participants are listed in Appendix B. The document used as the basis for discussion by the experts is attached as Appendix C (Working Document).

OPENING OF THE CONSULTATION

3. The Consultation was called to order by the Technical Secretary, Mr Raymon van Anrooy, FAO Subregional Fisheries and Aquaculture Officer for the Caribbean.

4. The opening statement was delivered by Mr Devin Bartley, Senior Fisheries Officer. Mr Bartley informed the participants of the process that led to the preparation of the Technical Guidelines for Recreational Fisheries and called attention to the possible submission of the document to the Thirtieth Session of the FAO Committee on Fisheries (COFI). Mr Bartley's opening statement is given in Appendix D.

ELECTION OF OFFICERS

5. Mr Ian Cowx (United Kingdom) was appointed chairperson of the Consultation.

ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE CONSULTATION

6. The Consultation adopted the agenda attached as Appendix A. The Chairperson then called for a round of introduction of all participants attending the Consultation and briefly outlined the timetable for the Consultation.

INTRODUCTION OF THE FAO CODE OF CONDUCT FOR RESPONSIBLE FISHERIES AND ITS TECHNICAL GUIDELINES

7. The Secretariat provided a summary overview of the process that led to the preparation of the FAO Code of Conduct for Responsible Fisheries (the Code), the elaboration process, objectives of the CCRF, its structure and what is being done in support of its implementation. The Secretariat also emphasized the importance of the Code for recreational fisheries management and development and why specific technical guidelines on recreational fisheries are needed to assist the implementation of the Code by recreational fisheries stakeholders.

PRESENTATION AND DISCUSSION OF DRAFT TECHNICAL GUIDELINE CHAPTERS

8. Mr Robert Arlinghaus gave a presentation on the section of the Working Document "Introduction, definitions and scope and guideline objectives". The presentation provided an overview of the status of recreational fisheries in the world in terms of social and economic value, its biological impacts, how recreational fishing is defined, the scope and implications of recreational fisheries, the goals of the Technical Guidelines, the approach taken in the Technical Guidelines, its target audience and objectives, and its relationship with other policy documents and related technical guidelines.

9. The Consultation made the following recommendations and comments towards improvement of the draft Technical Guidelines:

- Summarize the context/background parts in the main guidelines document and provide the extended context in the appendix.
- Increase the information in the overview part, by adding information from a broader global perspective.
- While the Technical Guidelines is meant to be broad in its scope and application, it specifically targets policy and decision-makers, recreational fisheries managers and representatives of recreational fisheries stakeholders, in contrast to individual recreational fishers, although some sections will be of interest to those fishers.
- Increase guidance in the introductory chapters of the Technical Guidelines on "how to use the guidelines".

10. Mr Robert Arlinghaus gave a presentation on the "Ethical framework and key management approaches". Sustainability and its various dimensions were at the core of the presentation. Adaptive management processes and uncertainty issues were introduced and the precautionary approach (PA), ecosystem approach to fisheries (EAF), aquatic stewardship issues, and decision-making processes and approaches were presented.

11. In the discussion that followed, some experts argued that the EAF, PA and the Adaptive management approach should not be presented as very separate of one another, as they are interlinked and complementary.

12. The Consultation agreed that risk-based approaches could be used as a basis and that the three above-mentioned approaches could be integrated under such an approach.

13. The Consultation acknowledged that responsible fisheries is broader than sustainable fisheries and includes social, economic and political elements that should be included in the document.

14. There was some discussion on the need for standardization of terminology used in the document; specific reference was made to using recreational fishing as more inclusive than angling, and using the precautionary approach instead of the precautionary principle, and defining "fish" to include all aquatic animals.

15. Recognizing the benefits of adaptive management, it was noted by some experts that adaptive management has numerous benefits (e.g. in terms of stakeholder participation and joint decision-making processes) but that the guidelines should make clear that adaptive management is also time-consuming and that recreational fisheries stakeholders should be prepared to allocate time and effort to the process.

16. Mr Brett Johnson delivered a presentation on "Policy and institutional frameworks". He addressed issues such as policy objectives, ambiguous terminology used in the draft document, and perspectives on different ways of recreational fisheries management and the draft guidelines on the subject.

17. Some experts noted that certain management systems presented are of less relevance in their countries, while acknowledging that the systems may be practised elsewhere.

18. The Consultation agreed to present the fisheries (co-)management continuum. It was further agreed that decisions on the specific governance system to use were case-specific and that the guidelines should give advice on what should be in place if a certain governance system is established.

19. A major part of the discussion took place around the issue of recreational fisheries registration and licensing. The differences between registration and licensing were discussed; registration being a means to quantify and identify participation, and licensing being a means to do the same and generate income. Also discussed were "user pay–user benefit" systems, the costs of licensing scheme establishment and operation, ensuring that licence collection revenues flow back into the sector, and specific problems of certain developing countries with implementing licensing and registration schemes.

20. Mr Brett Johnson presented the overarching goals of management in the fisheries sector and objectives of management. He then showed various decision trees proposed to facilitate management decision-making processes.

21. The guidelines are primarily directed at managers, researchers and policy-makers. Fishers and fishing clubs are encouraged to take them and make them more specific and applicable to a given fishery or area. The Consultation recognized that this top-down approach is not ideal, but necessary for these broad global guidelines.

22. The Consultation endorsed the three overarching management goals of the conservation and sustainable use of biological diversity and the fair and equitable sharing of benefits derived from that use. For individual recreational fisheries, there will be more specific management objectives.

23. The Consultation realized that many fisheries, especially marine fisheries, are already being managed under a commercial fishing regime. However, recreational fisheries require a dedicated management regime and may have different management objectives than commercial fisheries.

24. Fishery management of recreational fisheries needs to address recreational fisher satisfaction among its priorities.

25. Experts were asked what kind of advice to give managers that have little or no information on the fishery to be managed, i.e. management in data-poor fisheries. This was a common request throughout the Consultation. The guidelines should therefore examine alternative means to address the status of recreational fishers.

26. The Consultation noted that there are differences in efficacy of habitat enhancement in inland waters versus marine waters.

27. Recreational fishers should be aware of mechanisms to reduce their carbon footprint, for example by using fuel-efficient boats and fishing practices.

28. Mr Steven Cooke gave a presentation on "Recreational fishing practices". He provided some context and noted that the technical guidelines under this chapter are highly relevant for recreational fishers, non-govermental organizations (NGOs) and fishing clubs, as well as fisheries managers and decision-makers.

29. The Consultation agreed that the context provided and guidelines under this section encompass a very wide diversity of perspectives. It was further noted that the guidelines are not a place where the debate on fish welfare needs to be undertaken, but that awareness of the issue is important and that recreational fishers are to take measures to reduce stress where possible. It was also emphasized that the guidelines should provide guidance on how to increase survival rates from catch-and-release recreational fishing.

30. Some experts suggested that other gear types (e.g. spear fishing, gillnetting and bowfishing) used in their regions and circumstances would need to receive some attention as well.

31. There was some discussion on catch-and-release practices, fight time, and the use of live bait and artificial baits in recreational fisheries.

32. Mr Steven Cooke delivered a presentation on "Information, knowledge sharing and research and implementation of these Technical Guidelines". He referred to the existing FAO Technical Guidelines on information and knowledge sharing as a starting point for the information and knowledge guidelines in the Working Document. He then presented the guidelines for research, highlighted the importance of related implementation issues and discussed the role of different target groups of the Technical Guidelines in terms of supporting implementation of these guidelines.

33. The discussion on information sharing focused on the correlation between trends and shifts from commercial/subsistence fisheries towards recreational fisheries and economic development. The guidelines in this respect were thought to be sufficiently useful on a whole for developing countries. There was some expression of the need for sharing of knowledge of local fishers and indigenous knowledge.

34. There was extensive discussion on monitoring, the need for fishery independent data and the need for adequate funding for recreational fisheries research. While the Consultation acknowledged the need for quality studies based on applicable scientific standards, it was considered that, in certain instances, it was better to have descriptive studies based on sound methods than none at all.

35. The Consultation acknowledged the value of having information in the public domain, the potential role of social networks (e.g. Twitter, Facebook) and having information readily available on mobile phones and other modern technologies as being developed and applied by the International Game Fishing Association (IGFA).

36. The Consultation discussed the need for the Working Document to include guidelines on research areas. The Consultation also discussed the need for dissemination of tools and methods to those who need them.

37. The Consultation discussed the need to define the role of different stakeholders with regard to implementation, including the role of experts, States and state entities, FAO, regional fishery bodies, angling groups, co-management entities and gear providers. It was emphasized that the approach for implementation should be inclusive.

38. Mr Robert Arlinghaus provided a presentation on "Special requirements of developing countries and conclusion". Issues that were emphasized included the value of fishing as a safety net, the multiple dimensions (social, economical, ecological) of recreational fisheries, allocation and access issues, FAO prioritizing meeting basic human needs over recreational needs, capacity of institutions and capacity building aspects, fishing tourism, costs and benefits of recreational fisheries, the differences between the situation in countries in transition and the situation in the poorest developing countries, and learning lessons from other areas.

39. The Consultation noted that the recreational fisheries sector can have substantial benefits for the local community, also in developing countries. It was agreed that the guidelines are intended to be valid globally and that some developing countries will require assistance in the implementation of the Technical Guidelines. In order to enable international organizations (including FAO) and others to provide specific attention and technical support to developing countries on this subject, it was decided that a dedicated section in the Guidelines on special requirements for developing countries would be required.

40. The Consultation agreed to remove the Conclusion section from the Technical Guidelines document and move the substantive issues to the Introduction section of the document.

41. The Consultation also agreed that the experts would provide the resource persons with more information and general studies, examples of the recreational fisheries gears (including spearfishing, gillnetting, trap fishing and bowfishing) and technologies and management practices applied in their regions. Moreover, the experts would provide specific examples of recreational fisheries from different cultures and regions in order to make the document wider in scope.

42. Various other issues were also discussed under this agenda item, such as the need for management planning for recreational fisheries, recreational fishing tourism and how to ensure proceeds from fishing tourism benefit local and regional communities, zoning and allocation issues to enable existence of subsistence and recreational fishing sector to interact without conflicts, and terminology issues.

CONCLUSIONS OF THE CONSULTATION AND RECOMMENDATIONS

43. The Consultation made the following conclusions and recommendations for strengthening global institutional arrangements and mechanisms for advising on recreational fisheries policy and management:

44. The Consultation agreed that a short report of this Consultation be published (in English only) within two months as an FAO Fisheries and Aquaculture Report and that the Technical Guidelines be published by FAO as "Technical Guidelines for Responsible Fisheries No. 13: Recreational Fisheries" (in English) before the end of 2011. Publication in other languages will follow in 2012.

45. To this effect, the Consultation agreed with the following process to finalize the Technical Guidelines:

- Provision of additional comments and suggestions by the experts and observers on the draft technical guidelines (as presented to this expert Consultation) before 10 September to Mr Van Anrooy.
- Compilation of comments and suggestions into one document by Mr Van Anrooy before 15 September, and passing these to the resource persons, Mr Arlinghaus, Cooke and Johnson.
- Preparation of the final draft Technical Guidelines by the resource persons before 1 November 2011.
- Technical editing of the final draft Technical Guidelines by Mr Phil Hickley before 1 December; including moving some context parts to the appendix.
- Circulation (by the FAO Secretariat) of the final draft for endorsement by 1 December to all experts (copy to observers).
- Internal clearance in FAO Fisheries and Aquaculture Department between 1 December and 10 December 2011.
- Printing of the Technical Guidelines in English before 15 December by the FAO Subregional Office for Central Asia (SEC) in Ankara and dissemination following FAO official distribution lists and to participants in the Consultation.
- Online publication of the Technical Guidelines, along with a short "news" message and notification of list servers such as Fishfolk, International Institute for Fisheries Economics and Trade (IIFET), World Council of Fisheries Societies (WCFS) and other non-fisheries networks by 15 December 2011.
- Translation, publication and dissemination in Spanish, French and Russian in 2012, supported by, respectively, FAO Subregional Office for the Caribbean, Marine and Inland Fisheries Service and SEC. Other official languages (Arabic and Chinese) will follow when sufficient funds are found by the FAO Fisheries and Aquaculture Department.
- Translation in other non–UN languages by recreational fisheries authorities, experts, NGOs and other interested stakeholders.

46. As a second output from this expert Consultation, it was further agreed to publish the Report of the Expert Consultation in the FAO Fisheries and Aquaculture Report Series (in English) by 1 September 2011 (FAO Secretariat). The following steps in the process were agreed upon:

- Publication of the report by 1 October 2011.

- Dissemination through FAO distribution lists and to participants of the Expert Consultation by 1 November.
- Online publication of the Report and notification of list servers such as Fishfolk, IIFET, IGFA, European Angling Alliance and other non-fisheries networks by 15 December 2011
- Make the report available to the Thirtieth Session of COFI for information and increasing awareness among policy-makers.

47. The Consultation recommended:

- Recreational fisheries should be considered a Subsector in its own right and it should be noted that its management goals and needs are often different than those of the commercial fisheries sector and other sectors.
- The value of recreational fisheries and its contribution to food security, poverty alleviation and livelihoods development should be assessed.
- The social and economic benefits generated by recreational fisheries activities should be maximized.
- Communication between the recreational fisheries sector and other related sectors and stakeholders should be increased.
- Recreational fisheries should be acknowledged as a legitimate use of resources in inland and marine waters.
- Governance and management capacity in support of recreational fisheries should be promoted and developed.
- FAO should request Members to collect and submit disaggregated data and information on recreational fisheries catches, harvest and participation (in line with Technical Guideline number 1 on Knowledge and Information Sharing).
- FAO should start to collate, analyse and disseminate the above information.
- The development of a network of recreational fisheries practitioners should be encouraged in order to facilitate the exchange of information, knowledge techniques and experiences to further the sub sector.
- Awareness on the Technical Guidelines should be created among COFI members, through inclusion of references in background documents for the Thirtieth Session of COFI, listing of the technical guidelines as an information document for the Thirtieth Session of COFI, or alternatively organizing of a side-event on recreational fisheries at the COFI session.
- The implementation of the Technical Guidelines should be monitored and evaluated after five years in line with Chapter 8 of the Technical Guidelines, including the experts that assisted in the preparation.
- Regional fisheries management organizations (RFMOs) and regional fishery bodies (RFBs) should consider these Technical Guidelines in their respective regions.
- All stakeholders should make efforts towards supporting the implementation of the Technical Guidelines through the preparation and dissemination of the technical guidelines through their Web sites, newsletters, news messages, workshops and brochures, and assist in translation of the technical guidelines in other (non-UN) languages.

ADOPTION OF THE REPORT

48. The report of this Consultation was adopted on 6 August 2011.

APPENDIX A

Agenda

1. Opening of the Expert Consultation
2. Election of the officers
3. Adoption of the agenda
4. Introduction of the FAO Code of Conduct for Responsible Fisheries and its Technical Guidelines
5. Presentation and discussion of draft Technical Guideline chapters
   - Introduction, definitions and scope and guideline objectives
   - Ethical framework and key management approaches
   - Policy and institutional frameworks
   - Recreational fisheries management
   - Recreational fishing practices
   - Information, knowledge sharing and research and implementation of these Technical Guidelines
   - Special requirements of developing countries and conclusion
6. Conclusions of the Consultation and recommendations (for strengthening global institutional arrangements and mechanisms for advising on recreational fisheries policy and management)
7. Adoption of the Report
8. Closing of the Consultation

APPENDIX B

EXPERT CONSULTATION TO DEVELOP THE FAO TECHNICAL GUIDELINES FOR RESPONSIBLE FISHERIES: RECREATIONAL FISHERIES

5–6 August 2011, Berlin, Germany

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APPENDIX C

WORKING DOCUMENT – DRAFT TECHNICAL GUIDELINES

FAO Technical Guidelines for Responsible Fisheries No. 13 -
Recreational Fisheries

Second Draft as of July, 15, 2011
Authors of First Draft: R. Arlinghaus, B.M. Johnson & S.J. Cooke
Reviewed by: D. Bartley, B. Kuemlangan and R. van Anrooy (FAO)
Revisions completed by: R. Arlinghaus, B.M. Johnson & S.J. Cooke

Preparation of this Document

These technical guidelines have been prepared by Robert Arlinghaus (Leibniz-Institute of Freshwater Ecology and Inland Fisheries and Humboldt-Universität zu Berlin, Germany), Steven J. Cooke (Carleton University Canada) and Brett M. Johnson (Colorado University, U.S.A.) under the coordination by Raymon van Anrooy (Food and Agricultural Organization of the United Nations, FAO, Subregional Office for Central Asia, now at the Subregional Office for the Carribbean). Their production has been supported by Devin Bartley and Blaise Kuemlangan from FAO.

The initial discussions leading to the preparations of these guidelines took place at an International EIFAC Workshop on a Code of Practice for Recreational Fisheries November, 5-6, 2007, in Bilthoven, The Netherlands, the twenty-fifth session of EIFAC, May 21 – 28, 2008, in Antalya, Turkey, held in conjunction with an EIFAC Symposium on Interactions between Economic and Ecological Objectives of Inland Commercial and Recreational Fisheries and Aquaculture, the FAO Regional Workshop on Recreational Fisheries in Central Asia, Issyk Kul, Kyrgyzstan, 14–16 September 2009, and the FAO Workshop on Implementation of the Ecosystem Approach in Inland Fisheries, held December, 07-10 2010, in Lao PDR. A final expert group convened from 5-6 August 2011 in the FAO Expert Workshop on Technical Guidelines for Responsible Fisheries: Recreational Fisheries held at the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) in Berlin, Germany, under the organizational help by Ms Leonore Osswald from IGB The international experts and observers from academia, national and international fisheries bodies, fisheries and non-fisheries governmental and non-governmental organizations (NGOs) contributing to the development of the guidelines.

The initial drafts of the guidelines were prepared by Robert Arlinghaus, Steven J. Cooke and Brett M. Johnson. Additional comments were provided by the above-mentioned experts, Devin Bartley, Blaise Kuemlangan, and Raymon van Anrooy provided editorial assistance in the finalizing of the manuscript. Funding was provided by FAO. Further funding was received by the German Ministry for Education and Research through the project Besatzfisch granted to Robert Arlinghaus (www.besatz-fisch.de).

ABSTRACT

The present Technical Guidelines for Responsible Fisheries: Recreational Fisheries – detail the standards of environmentally sustainable and – depending on cultural conditions - socially acceptable recreational fisheries. The guidelines detail advice and recommendations for responsible recreational fisheries as an important component of the global's fisheries. Thereby, the guidelines translate the relevant provisions for responsible fisheries according to the FAO Code of Conduct for Responsible Fisheries into specific advice for sustainable recreational fisheries. Recreational fishing constitute the dominant use of wild fish stocks in all freshwaters of industrialized countries, and many coastal ones, and its importance is rapidly increasing in many economies in transition. Recreational fishing is defined as fishing for reasons other than to satisfy essential nutritional needs and where fishing products are generally not sold or otherwise traded on markets. The concept of aquatic stewardship is introduced as an overarching Zeitgeist needed to achieve sustainable recreational fisheries on a global scale. Other major management approaches introduced in the present technical guidelines for responsible recreational fisheries include the ecosystem approach, the precautionary approach and adaptive management using structured decision-making based on quantifiable management objectives. Detailed sections on policy and institutional frameworks (tailored towards policy makers), recreational fisheries management (tailored towards fisheries managers) and recreational-fisheries practices (tailored towards individual recreational fishers) provide useful guidance and advice for achieving responsible recreational fisheries. The special considerations of recreational fisheries in developing countries are considered. By adhering to the principles and guidelines presented in the present document, policy makers, managers and indeed the entire recreational fisheries sector can increase the likelihood of sustainable recreational fisheries. To facilitate national or international applications of the present technical guidelines for recreational fisheries, an abbreviated document entailing the major guidelines and recommendations is presented in the annex, labeled the Code of Practice for Recreational Fisheries.

ACRONYMS AND ABBREVIATIONS

AM – Adaptive Management

CCRF – FAO Code of Conduct for Responsible Fisheries

CoP – EIFAC Code of Practice for Recreational Fisheries

COFI – FAO Committee on Fisheries

EAF – Ecosystem Approach to Fisheries

FAO – Food and Agricultural Organization of the United Nations

EEZ – Exclusive Economic Zone

EIFAC – European Inland Fisheries Advisory Commission (former name)

EIFAAC – European Inland Fisheries and Aquaculture Advisory Commission (current name)

NGO – Non-governmental organization

PA – Precautionary Approach

RFB – Regional Fisheries Body

RFMO – Regional Fisheries Management Organization

SOFIA – State of World Fisheries and Aquaculture

STK – Stakeholder and Traditional Knowledge

TG – Technical Guideline

BACKGROUND

From ancient times, fishing from oceans, lakes and rivers has been a major source of food, a provider of employment and other socio-economic benefits for humanity. Ocean productivity seemed particularly unlimited. However, with increased knowledge and the dynamic development of fisheries, it was realized that living aquatic resources, although renewable, are not infinite and need to be properly managed, if their contribution to the nutritional, economic and social well-being of the growing world's population was to be sustained. However, for many years, because of the dramatic increase in pollution, habitat change, fishing mortality, abusive fishing techniques, and illegal, unreported and unregulated fishing, catches, landings and size of fishes captured have been shrinking, and many fish stocks and aquatic biodiversity are declining, often at alarming rates.

Stock depletion and aquatic biodiversity loss not only has negative implications for food security and economic development but also reduces social welfare and the well-being of humans in many countries around the world, especially those relying on fish as their main source of animal protein and income such as subsistence fishers in developing countries. To address this situation, living aquatic resources need to be properly managed, if their benefits to society are to be sustainable. This holds true across all fisheries sectors, in both capture fisheries and aquaculture, and the combined sectors such as culture-based fisheries. Sustainability of social benefits generated by aquatic living resources mainly requires a recovery of depleted stocks and maintenance of the still-healthy ones, through sound management that maximizes the benefits generated by fisheries for society at large.

World fisheries have a dynamically developing sector of the food industry, and many States have striven to take advantage of their new opportunities by investing in modern fishing fleets and processing factories in response to growing international demand for fish and fishery products. It became clear, however, that many fisheries resources could not sustain an often uncontrolled increase of exploitation. In this regard, the adoption in 1982 of the United Nations Convention on the Law of the Sea was instrumental by providing a new framework for the better management of marine fisheries resources. The new legal regime gave coastal States rights and responsibilities for the management and use of fishery resources within areas under their national jurisdiction, which holds some 90 percent of the world's marine fisheries. However, overexploitation of important fish stocks, modifications of ecosystems, significant economic losses, and international conflicts on management and fish trade still threaten the sustainability of fisheries and the contribution of fisheries to food supply despite the existence of the Law of Sea and other international agreements and conventions such as the United Nations Convention on Biological Diversity.

To improve the prospects for sustainable fisheries, the Nineteenth Session of the FAO Committee on Fisheries (COFI), held in March 1991, recommended that new approaches to fisheries (including aquaculture) management embracing conservation and environmental, as well as social and economic, considerations were urgently needed. FAO was asked to develop the concept of responsible fisheries and elaborate a Code of Conduct to foster its application. Subsequently, the Government of Mexico, in collaboration with FAO, organized an International Conference on Responsible Fishing in Cancún in May 1992. The Declaration of Cancún, endorsed at that Conference, was brought to the attention of the United Nations Conference on Environment and Development Summit in Rio de Janeiro, Brazil, in June 1992, which supported the preparation of a Code of Conduct for Responsible Fisheries. The FAO Technical Consultation on High Seas Fishing, held in September 1992, further recommended the elaboration of a Code to address the issues regarding high seas fisheries.

The One Hundred and Second Session of the FAO Council, held in November 1992, discussed the elaboration of the Code, recommending that priority be given to high seas issues and requested that proposals for the Code be presented to the 1993 session of the COFI. The twentieth session of COFI, held in March 1993, examined in general the proposed framework and content for such a Code, including the elaboration of guidelines, and endorsed a time frame for the further elaboration of the Code. It also requested FAO to prepare, on a "fast track" basis, as part of the Code, proposals to prevent reflagging of fishing vessels which affect conservation and management measures on the high seas. This resulted

in the FAO Conference, at its twenty-seventh session in November 1993, adopting the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, which, according to FAO Conference Resolution 15/93, forms an integral part of the Code.

The development of the Code was carried out by FAO in consultation and collaboration with relevant United Nations Agencies and other international organizations, including non-governmental organizations (NGOs). The twenty-eighth session of the Conference in Resolution 4/95 adopted the Code of Conduct for Responsible Fisheries (CCRF) on 31 October 1995. The Code of Conduct consists of five introductory articles: Nature and scope; Objectives; Relationship with other international instruments; Implementation, monitoring and updating and Special requirements of developing countries. These introductory articles are followed by an article on General principles, which precedes the six thematic articles on Fisheries management, Fishing operations, Aquaculture development, Integration of fisheries into coastal area management, Post-harvest practices and trade, and Fisheries research. The Code is voluntary and was formulated so as to be interpreted and applied in conformity with the relevant rules of international law, as reflected in the United Nations Convention on the Law of the Sea of 10 December 1982. The Code is also in line with the Agreement for the Implementation of the Provisions of this Law, namely the 1995 Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. It is equally in line with, *inter alia*, the 1992 Declaration of Cancún and the 1992 Rio Declaration on Environment and Development, in particular Chapter 17 of Agenda 21, and other international agreements relating to fisheries and aquatic environments.

The Code is voluntary. However, certain parts of it are based on relevant rules of international law, as reflected in the United Nations Convention on the Law of the Sea. The Code also contains provisions that may be or have already been given binding effect by means of other obligatory legal instruments amongst the Parties, such as the 1993 Agreement to Promote Compliance with Conservation and Management Measures by Fishing Vessels on the High Seas. Due to its historical legacy, the Code is generally focused on marine capture fisheries, with some coverage of aquaculture. Recreational fisheries issues are implicitly dealt with in the Code, but are not prominent, and the term recreational fisheries is absent from the CCRP. Indeed, due to a focus on industrial marine fisheries many of the provisions in the CCRP are not well suited to deal with the specificities of recreational fisheries. This particularly relates to freshwater recreational fisheries, where the main factor impacting wild fish populations is probably not fishing (in contrast to what is the case in the marine environment) but habitat change and loss induced by sectors other than fisheries. Moreover, the people engaging in recreational fishing are characterized by seeking different benefits, aspiration and expectations compared to commercial or subsistence fishers, which ultimately result in different goals and objectives of recreational and commercial fisheries. Therefore, different guidelines and strategies for sustainable management exist in recreational and commercial fisheries.

The FAO Resolution 4/95 adopting the CCRF on 31 October 1995 requested FAO *inter alia* to elaborate appropriate technical guidelines in support of the implementation of the Code in collaboration with members and interested relevant organizations. As mentioned before, the Code was primarily elaborated to meet the needs of marine capture fisheries and in particular industrial fisheries; it is therefore difficult to interpret in the light of the rather different conditions pertaining in most of the world's inland waters and to recreational fisheries in both inland and coastal waters. The FAO Technical Guidelines for Responsible Fisheries No. 6: Inland Fisheries, and its supplement No. 6.1 on Rehabilitation of Inland Waters for Fisheries, oriented the interpretation of the various articles of the Code towards the specific needs of the inland fisheries sector, and the TGRF No. 6 was the first FAO document relating to the CCRF that explicitly and prominently addressed some recreational fisheries issues. The only FAO-related document that prominently discusses issue of responsible recreational fisheries is the 'EIFAC Code of Practice for Recreational Fisheries', endorsed by the twenty-fifth session of EIFAC, May 21 – 28, 2008, in Antalya, Turkey. This document builds on the CCRF, is specifically directed at recreational fisheries and is adopted and disseminated by the European Inland Fisheries Advisory Commission (EIFAC). The present Technical Guidelines for Responsible Fisheries: Recreational Fisheries are based on the CCRF,

taken due consideration of the EIFAC Code of Practice for Recreational Fisheries, and are overall meant to fill an important gap by explicitly dealing with the salient issues faced by recreational fisheries in both freshwater and saltwater. By providing orientation and guidance for principles and strategies for responsible recreational fisheries, the present technical guidelines are meant to help sustain the global's recreational fisheries in the face of expanding threats and local and regionally existing unsustainable management practices.

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INTRODUCTION

There is a growing recognition of the immense societal (economic and socio-cultural) and ecological importance of recreational fishing in many industrialized countries world-wide, and the sector is growing rapidly in many areas of the world that currently experience rapid economic development (e.g., Brazil, China, India) (Arlinghaus et al. 2002; Pawson et al. 2008; Mora et al. 2009; Ihde et al. 2011). Recreational fisheries today involve millions of people, generating billions of U.S. dollars in developed countries, and the activity is also emerging as a significant economic factor in many developing countries (FAO 2010). Recreational fishing is today the sole or dominant user of most wild freshwater fish stocks, and many coastal ones, in more prosperous countries, thereby creating a fair share of sustainability and biodiversity conservation issues (Cowx et al. 2010) that justify a need for guidance on how to orient the sector towards sustainability on an international level. This is particularly relevant in light of the potential conflict amongst commercial/subsistence and recreational fisheries and potential ecosystem-level impacts of excessive recreational fisheries mortality or unsustainable management actions (e.g., release of non-native fish). The present document provides such guidance in light of the FAO Code of Conduct for Responsible Fisheries (CCRF) (FAO 1995) in general, and the EIFAC Code of Practice for Recreational Fisheries (CoP) in particular (EIFAC 2008). It should be particularly useful for countries lacking experience with recreational-fisheries development and management, and it might also make existing approaches more coherent and more sustainable in more experienced nations and regions.

Definitions and Sectoral Scope of the Guidelines

What do we mean by recreational fishing? It is useful to approach a generic definition of recreational fishing to better distinguish it from commercial and subsistence fishing by focusing on primary human needs and analyse which needs particular forms of fishing are mainly fulfilling. Recreational fisheries is different from commercial and subsistence fisheries because – for the individual fishing protagonist - recreational fishing usually does not contribute substantially (e.g., > 50%) to meeting the basic of human needs, i.e., essential nutritional/physiological needs (Arlinghaus et al. 2010). By contrast, commercial and subsistence fisheries are primarily directed towards livelihood by the fisher (and his or her family), and therefore fishing contributes substantially to meeting physiological needs of the individual. Moreover, recreational fishing products are generally not sold on markets (see Mike and Cowx 1986 for exceptions where recreational fishers sell surpluses to offset costs). To distinguish recreational fishing unequivocally from commercial fishing and subsistence fishing, the following generic definition of recreational fishing is useful (EIFAC 2008):

Recreational fishing is fishing of aquatic animals that do not constitute the individual's primary resource to meet nutritional needs and are not generally sold or otherwise traded on export, domestic or black markets.

This definition is sufficiently broad to include other animals beyond fish (e.g., invertebrates such as lobsters and crabs), it avoids pointing to individual motivations (fun, sport, enjoyment, thrill of the catch, social bonding), does not discriminate against particular methods of fish capture (e.g., recreational rod and line angling versus recreational gill netting, which is an important recreational fishing activity in some countries), does not preclude the catch being taken for personal consumption (as long as the catch does not become the primary resource to meet essential physiological needs), does not discriminate against non Western cultures, but does discriminate commercial and subsistence fishing from recreational fishing (Arlinghaus et al. 2010). It is acknowledged that the unambiguous demarcation between recreational fisheries and subsistence fisheries is impossible because many recreational fishers, even in very wealthy countries, have strong subsistence-like incentives to harvest fish (Macinko & Schumann 2007). However, using fishing activity to generate resources for livelihoods marks a clear differentiation between recreational fisheries and subsistence fisheries, and, as a rule, recreational fishers have the financial capacity to substitute the fishing products by other products to meet nutritional needs and secure protein intake and survival. Note, however, that the fact recreational fishing is not an activity

that contributes substantially to generating resources for survival for the individual fish, the spill-over economic effects associated with recreational fishing creates a multi-billon industry that supports economic activity and livelihoods for many.

Globally, angling is by far the most common recreational fishing technique, which is why recreational fishing is often used synonymously with (recreational) angling (Arlinghaus et al. 2007). Throughout this document, recreational fishing shall be used as a standard term, and only when specific context relates to angling, we will refer to angling or angler. The recreational fisheries sector is then the entire network of stakeholders involved in or fully or partly dependent on recreational fisheries including amongst others fisheries ministries and agencies, managers, non-governmental organizations (e.g., umbrella angling associations and clubs), anglers, non-angling recreational fishers, tackle shops and tackle manufacturers, bait suppliers, charter-boating industry, recreational boat builders and chandlery suppliers, marina operators and specialised angling and fishing media, recreational fishing tourism and other related business and organisations as well as all other enterprises supporting recreational fisheries including aquaculture operations that produce stocking material or commercial fishing enterprises that sell angling tickets on their waters. A range of other stakeholders and managerial regimes are not included in this definition though they may run or advocate activities and developments that have a direct impact on the recreational fishing quality and the recreational fisheries sector, the sector's viability and growth potential (e.g., hydropower generation, water management, irrigation, commercial fisheries, nature conservation groups). In the following, they will be referred to as "external sectors", as appropriate. The present guidelines are directed at the "core recreational fisheries sector" meaning all people, organizations and actors with direct involvement in fishery resource use and fisheries management, e.g., policy, governance, management bodies and individual recreational fishers, and to some degree the recreational gear industry and recreational fishing media. The guidelines will not prominently deal with the supply and demand chains in the recreational fisheries sector that are more remote to fisheries resource use and management, e.g., there will be no treatment of good practices in marketing or good business practices.

Magnitude and Scope of Recreational Fisheries Globally

The importance of recreational fishing increases with economic development of societies (Fig. 1.1, Smith 1986, Cowx et al. 2010). First, nations place a premium on using fish stocks for commercial or subsistence fisheries, but with industrialization and economic development the focus shifts towards recreational fishing. At some point with increasing urbanization, interest of members of societies in recreational fishing tends to decline again; at the same time societal concerns about the protection and rehabilitation of usually anthropogenically modified aquatic ecosystems (e.g., due to land use changes, flood control etc.) seem to grow in importance alongside rise in concern about the welfare of individual fish in the process of being captured and handled by recreational anglers. This situation places constraints on the further growth of recreational fishing as urbanized societies become increasingly alienated from natural fish resource use questioning the use of fish "for fun" in recreational fishing (Fig. 1.1). Neverless these development with increasing urbanization, recreational fisheries today tend to constitute the dominant or sole user of wild freshwater fish stocks in most, if not all industrialized countries, and its importance in coastal and marine fisheries is often substantial. For example, marine recreational fisheries are present in 76% of the world's exclusive economic zones (EEZ) (Mora et al. 2009). Some marine stocks in more industrialized nations are today exclusively exploited by recreational fisheries, or intensive co-exploitation of commercial and recreational fisheries occurs (Mora et al. 2009; Ihde et al. 2011). Generally, recreational fishing participation hotspots with > 15% of the total population participating in recreational fishing exist in Scandinavia (here record values of > 35% are found in Norway), Australia and North America (Arlinghaus & Cooke 2009), but many countries in economies in transition in Asia, Latin America and Africa currently experience explosive development of recreational fisheries (FAO 2010; Welcomme et al. 2010). This is due to the fact that with economic development small-scale and subsistence fisheries transform into more leisure-like forms of fishing where fishing continues to provide important resources for food security by "subsistence" fishers, and/or because in

some developing countries angling tourism becomes a locally and regionally important activity (Fig. 1.1, Mike and Cowx 1986, Potts et al. 2009; Everard and Kataria 2011).

The global participation in recreational fishing is substantial. On average across economically developed countries with reliable statistics, the participation rate in recreational fishing by the total population in a given country is 10.6 ± 6.1 % (SD) (N = 28 countries, Arlinghaus and Cooke 2009). Using this estimate for extrapolation, about 140 million recreational fishers are present in three of the most industrialized continents North America, Europe and Oceania alone. Extrapolating to the globe is more difficult due to the paucity of information on participation rates in recreational fishing in less developed countries. Using extrapolations from Canadian recreational fishing participation rates, Cooke and Cowx (2004) guessed up to 700 million people worldwide might engage in recreational fishing. Specific for marine recreational fishing, Cisneros-Montemajor & Sumaila (2010) estimated that globally a minimum of 58 million marine recreational anglers generate a total of c. 40 billion US $, supporting over 954 000 jobs. However, given the lack of reliable statistics from many countries of the world and the omission of freshwater fisheries, this is surely a vast underestimate.

The 100s of millions of people participating in recreational fishing in inland, coastal and marine fisheries indicate that there are many benefits associated with this activity (Weithman 1999, Arlinghaus et al. 2002, Parkkila et al. 2010) that go beyond the job-effects and extent the social and cultural domains. For example, recreational fisheries benefits people and households as a resource for food (provisioning service), and through providing many less tangible cultural ecosystem services, including recreation, education, social and aesthetic pleasures. Furthermore, recreational fisheries motivates interest by a sizable fraction of society in the maintenance and enhancement of the supporting and regulating services of aquatic ecosystems and fish populations through fisheries-management actions serving fish stocks the recreational experience they support (Parkkila et al. 2010). In fact, in many countries of the world expenditure and taxes by recreational fisheries are the main funding sources for fish population management and conservation actions (Arlinghaus et al. 2002). The value of recreational fishing for conservation of aquatic systems in general has a simple economic root: recreational fishers have a vested interest in preserving or enhancing the resources they depend on. There is ample evidence that recreational fishers directly, through for example, supportive stocking of native fish, or indirectly through habitat management and other fisheries management actions, usually financed by recreational fishing license money, work proactively to conserve, and if possible enhance, aquatic biodiversity (Granek et al. 2008). There is also evidence that anglers are instrumental in shaping pro-environmental legislation and combating pollution incidences and other environmental harm through legal action (Bate 2001; Kirchhofer 2002). Clearly, there is also a downside in terms of some well-meant fisheries-management actions, such as release of fish carrying diseases or non-native genes, strongly and sometimes irreversibly impact aquatic biodiversity (van Poorten et al. in press) and the ecosystem (Eby et al. 2006, Laikre et al. 2010), inter alia justifying the present technical guidelines to help assuring that future recreational fisheries management and developing is responsible and ecologically sustainable.

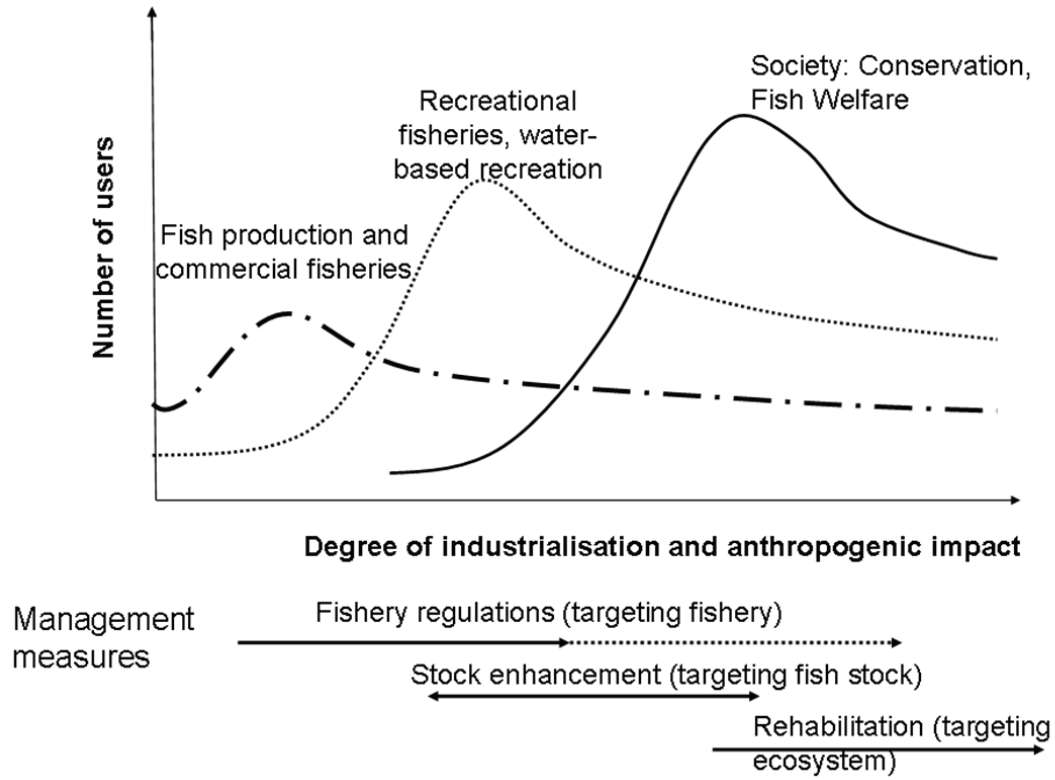

Fig. 1.1. A sketch of the life-cycle of fisheries (based on Cowx et al. 2010). The number of users involves direct users or those with a stake in aquatic ecosystems.

Recreational fishing takes place in many forms and formats, from the natural fisheries on naturally recruited wild fish stocks in lakes, rivers and the ocean, to the stocking-enhanced fisheries in natural or artificial water bodies, culminating in artificial, purely put-and-take operated high-intensity fisheries that can be often found in small impoundments or ponds and in more urban areas (Cowx 2002). Not only the types of fisheries differ dramatically within and across countries, but also the types of recreational fishers are plentiful and diverse. They range from the specialist fly fisher on the remote river that voluntarily releases all the trout captured on barbless hooks, to the highly harvest-oriented "meat fisher" exploiting intensively stocked put-and-take stillwater fisheries in the middle of a large cite. The range also involves multiple objectives that drive different people and fishing groups that engage regularly in recreational fishing. On the one end of the spectrum there are many recreational fishers whose motives involve a range of aspects other than a desire for achieve high catch or harvest; here motives such as "escape from daily routines", "being outdoors" or "relaxing in nature" are prominent (Fedler and Ditton 1994). On the other end of the extreme, there are the highly avid, strongly catch-oriented types who may even seek records, trophies and other rewards (e.g., competitive recreational angling). One dimension that place a role here is the investment of time and money, and there is a gradient from the low monetary investment, hand-lining-type of recreational fishing trip to the thousand dollar big game fishing trip on the open seas. Recreational fishing takes place locally and regionally with engagement by resident people, but increasingly also involves international travel and a growing tourism sector, where tourists seek particular fishing experiences abroad. It is difficult to generalize, but there seems to be a trend of high consumptive (e.g., harvest-orientation) recreational fisheries in economies in transition developing towards almost catch-and-release only fisheries at the other end of the spectrum, when prosperity meets with a certain ethical conduct and culture. In between, one finds all the variety one can imagine within and among countries, and it is impossible to even attempt to classify recreational fisheries into distinct groupings according to mode of fishing or underlying objectives.

Unintended consequences of capture fisheries, including habitat destruction, incidental mortality of non-target species, shifts in population structure and demographics, and changes in the function and structure of ecosystems, are being increasingly recognised (e.g., Welcomme 2001; Worm et al. 2009). There is the need to recognise that recreational fishing can also induce similar, sometimes irreversible, changes in fish communities and aquatic ecosystems through actions such as excessive harvest mortality, selective mortality, unwanted catch-and-release mortality, injury and disease transmission, illegal release of fish, introduction of non-natives, stocking, litter, groundbaiting, and disturbance of the environment and wildlife from, for example, gaining access to the water or boat noise (Post et al. 2002; Cooke & Cowx 2004, 2006; Lewin et al. 2006). Such impacts involve the potential for particularly troublesome issues, such as genetic change in fish stocks, which may result from recreational-angling induced ecological and evolutionary changes in the fish stocks (Cooke & Cowx 2006; Lewin et al. 2006; Philipp et al. 2009; Matsumura et al. 2011), or be a result of detrimental fishing practices or management actions, especially stocking of native, hatchery-reared fish and introduction of exotic species or non-native genotypes, or transfer of fish or diseases across catchments (Cooke and Cowx 2006; Lewin et al. 2008; Johnson et al. 2009). Having said this, many declines in wild fish stocks are only partly the result of, or facilitated by, recreational fishing or its management practices. In particular in freshwater ecosystems, non-fishing related activities, such as agriculture, damming, deforestation, navigation, wetland reclamation, urbanisation, water abstraction and transfer and waste disposal have altered freshwater ecosystems profoundly, probably more than terrestrial ecosystems (Arlinghaus et al. 2002). Consequently, in most areas of the world the principal impacts on freshwater recreational fisheries do not originate from the fishery itself but from outside the fishery (Cowx et al. 2010). In addition to ecological impacts, many social issues and conflicts are present in recreational fisheries, e.g., conflicts between nature conservation interest and fisheries interests, or among commercial and recreational sectors. Addressing these biological and social issues is needed, justifying the present technical guidelines.

In light of the life-cycle of fisheries and the shifts from commercial to recreational dominance with increasing industrialization and anthropogenic impacts of once natural ecosystems (Fig. 1.1) there are also clear shifts in main management tools that align with the increasingly intensive recreational fishing exploitation demanding intensified management attention. Initially, fisheries are mainly managed using fisheries-management regulations such as size-limits or mesh restrictions, which is soon complemented by stock enhancement measures to maximize production and yield in light of exploitation or environmental damage, and to bias fish assemblages towards more desired species. These two tool boxes are also highly prominent in today's recreational fisheries world-wide, where harvest regulations (targeting the fishery) and stock-enhancement (e.g., stocking, targeting the fish stocks) dominate (Cowx et al. 2010). However, both tools also have a fair share of issues and potential for negative impacts on biodiversity (e.g., stocking) and need to be properly managed (see chapter 5). With increases in industrialization, usually also anthropogenic, non-fishery related habitat loss and damages to the natural productivity of water bodies increase, such that in the most economically developed nations a third toolbox emerges – actions to manage and rehabilitate habitats and ecosystems, e.g., in-stream habitat improvements (Cowx and Welcomme 1998). Each of these tools has its own strength and weaknesses and its choice depends on underlying objectives, risk analyses and feasibility as detailed later in these guidelines (see chapter 5).

Guideline Objectives and Relation to Previous Technical Guidelines

In the light of the large scope and potential for social and economic impacts of recreational fisheries, the objective of the present *Technical Guidelines for Responsible Fisheries: Recreational Fisheries* is to provide guidance on responsible recreational fisheries conforming to the principles outlined in the FAO CCRP (FAO 1995). This is done with a view to helping develop sustainable recreational fisheries in areas where sustainability is lacking, and to maintain them on sustainable trajectories where they are currently sustainable. To this end, in the following chapters the text is structured as follows: first, some initial background and context is given before specific principles, guidelines and strategies for specific areas of recreational fisheries governance and its management are provided. This involves a focus on fisheries resource use and management, and excludes the supply chain, marketing and business aspects of recreational fishing. Chapters are structured "from the general to the particular",

emphasizing the general ethical and managerial frameworks first, before moving into management and recreational fisheries practices. The final chapters deal with implementation and research aspects and the particularities of developing nations are treated separately.

The specific objectives of the present guidelines for recreational fisheries are:

- to describe best practice and management principles, guidelines and strategies forresponsible recreational fisheries, always in accordance with relevant national and regional legislation and international law.
- to serve as a guiding instrument of reference in establishing or improving the institutional and policy frameworks required to exercise responsible management of recreational fisheries nationally.
- to promote international exchange of knowledge and experiences on recreational fisheries, on their management and sustainable development.
- to facilitate and promote cooperation among fisheries bodies, non-governmental organisations and individual stakeholders in the conservation, management and development of recreational fisheries resources, including the aquatic ecosystems of which they are an intrinsic part.
- to promote recreational fisheries in the long-term by outlining and facilitating best practices within the sector for long-term sustainability, and for the responsible use of all ecological services generated by aquatic ecosystems and aquatic organisms.
- to promote research into recreational fisheries as well as on associated aquatic ecosystems and the relevant environmental factors which influence recreational fisheries.

The present technical guidelines are directed at decision-makers, planners, and all those involved in developing and implementing policy and technical interventions relevant to recreational fisheries. The guidelines shall also be of use to NGOs, representatives of the recreational fisheries sector, environmental organizations, and academic and scientific institutions and all entities, parties, organizations and individuals that are concerned with, or directly or indirectly impact or depend on, aquatic ecosystems, recreational fisheries resources and recreational fishing activity. This includes human activities that support recreational fisheries, such as aquaculture production of fish for stocking, the manufacture of gear, the tourism industry, the media, as well as fisheries management and research.

While the present technical guidelines are meant to orient the CCRF towards recreational fisheries based on the specific particularities of recreational fisheries practises and management demand (e.g., catch-and-release fishing, put-and-take fishing, urban fishing, angling tourism), other FAO Technical Guidelines for Responsible Fisheries are equally relevant for some specific aspects that also pertain to recreational fisheries. For example, when recreational fisheries operate mainly based on extraction of fish from natural fish stocks without stock enhancement the situation mirrors unconstrained (marine) capture fisheries in that they do not seek to manipulate the stock other than by removal of fish. Here the provisions of FAO Technical Guidelines for Responsible Fisheries **4 -** Fisheries Management (FAO 1997a), and its **Supplements 4.2** Ecosystem Approach to Fisheries (FAO 2003) and 4.2.2 Human Dimensions of an Ecosystem Approach (FAO 2009a), as well as the FAO Technical Guidelines for Responsible Fisheries **6** – Inland Fisheries (FAO 1997b) and its **Supplement 6.1** Rehabilitation of Inland Waters for Fisheries should be taken into consideration (FAO 2008a). Similarly, recreational fisheries that are stock-enhanced, e.g., in small stillwater fisheries, share similarities to extensive aquaculture, and here the provisions of FAO Technical Guidelines for Responsible Fisheries **2** – Precautionary Approach to Capture Fisheries and Species Introductions (FAO 1996), Technical Guidelines for Responsible Fisheries **5 - Aquaculture Development** (FAO 1997) as well as the FAO Technical Guidelines for Responsible Fisheries **6 – Inland Fisheries** (FAO 1997) and the respective supplements (e.g., Aquaculture Development Supplement 5.3 Genetic resource management, FAO 2008b) are highly relevant and should therefore be consulted as complementing the present guidelines.

ETHICAL FRAMEWORK FOR SUSTAINABLE RECREATIONAL FISHERIES

Ethics means dealing with the morality of fisheries and fisheries management in light of changing social values and norms. Fisheries ethics deals with the values, rules, duties and virtues of relevance to both human well-being and ecosystem, providing a critical moral compass on which subsequent goals, objectives and means are based (FAO 2005). Because social values and norms continuously change, the guiding ethical framework may change as well. For example, while fishing in general, and recreational fishing in particular was truly universal and probably not questioned on moral grounds for long, recreational fishing is today questioned on moral grounds in some highly urbanized countries (Arlinghaus et al. 2009), while fishing for food seems to almost universally accepted as an acceptable form of using renewable resources (Arlinghaus et al., unpublished manuscript). In light of a given social climate that results in a given ethical framework of what is considered to be generally acceptable or not, there is still a range of particularly difficult ethical decisions to be taken to govern recreational fisheries, such as those related to access and allocation of fisheries resources among competing demands. Many fisheries-management decisions are moral decisions, such that advice giving to the recreational fisheries sector in the present guidelines demands the disclosure of the underlying ethical framework on which the advice and guidance is built. The ethical framework followed in the present document follows key normative statements inherent in the CCRF (FAO 1995), such as

- "…users of living aquatic resources should conserve aquatic ecosystems. The right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources" (Article 6.1),
- "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 (Article 6.2)
- " States should … ensure that decision-making processes are transparent and achieve timely solutions to urgent matters. States, in accordance with appropriate procedures, should facilitate consultation and the effective participation of … interested organizations in decision-making with respect to the development of laws and policies related to fisheries management, development, international lending and aid" (Article 6.13).

When transferred to recreational fisheries these articles call upon flexible management and governance strategies that include stakeholders and their diverse views and that result in actions and behaviours that are ecologically sustainable by maintaining biodiversity at all levels and socially just and fair to all. Such norm is the basis of the sustainability perspective taken in this document for recreational fisheries. In this context, recreational fisheries are conceptually seen as a subsystem of the overarching life-support system who depends on the conservation of functional and diverse aquatic habitats, unless otherwise noted (e.g., artificial high intensity put-and-take fisheries may not be judged against this ethical framework).

Sustainability in Recreational Fisheries

Sustainability is today a socio-political norm in fisheries and other natural resource use that equally applies to recreational fisheries. A fishery is sustainable if the fish population and aquatic ecosystem is healthy (ecological dimension), providing high socio-cultural (social dimension) and socio-economic (economic dimension) benefits to fishers and society at large, governed by way of an efficient governance and management system (institutional dimension). Because the ecological services provided by fish stocks depend on functional aquatic ecosystems, any fishery depending on naturally reproducing fish stocks is on sustainable trajectory if the aquatic ecosystems, including all social and economic uses of fish stocks, and target and non-target fish populations persist in the long term. Similarly, any recreational fishery in non-sustainable if access to the resource is excluded, e.g., through bans on fishing in a no-fishing natural conservation area. The major goals of fisheries management are then to maximize benefits to society, while ensuring an equitable distribution of goods and services, while maintaining ecosystems

and biodiversity. Depending on the ecosystem at stake (e.g., natural stream versus purpose-built fishing pond), the weights put on the various dimensions of the sustainable triangle will differ. For example, the biodiversity and ecology axes might be considered more important than some social aspects (e.g., maximizing angler satisfaction) when debating about the actions planned on a natural stream, while the opposite might be true in the case of an artificial pond. Deciding on the weights attached to each of the three sustainability axes (ecological, social or economic) in a given situation is for stakeholders and decision-makers to decide, which clearly will be value-based. Achieving sustainability in recreational fisheries, and in fisheries in general, will however always involves the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations (FAO 1997). Such a process can be termed sustainable if the development conserves (land) water, genetic resources, is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable (FAO 1995). The sustainability pillars to be jointly considered are then ecological/evolutionary, social and economic, framed by institutional aspects of sound governance, management and stakeholder participation principles (see the Lisbon-principles below, Costanza et al. 1998). Because of the complexity of the task, the strong links between nature and social systems, and in light of the vulnerabilities of exploited ecosystems also to recreational fisheries (Post et al. 2002), sustainable recreational fisheries management systems require (Arlinghaus et al. 2002): (a) ecosystem thinking and an ecosystem approach to fisheries-management to be able to deal with the ecosystem-level effects of fishing; (b) precaution to avoid undue risk in the face of uncertainty; (c) adaptive management to remain flexible to change; (d) participation of all stakeholders to increase legitimacy and increase rule compliance; (e) integrated (across disciplines, sectors, stakeholder groups and generations) science, research, assessment and management systems to be able to deal with social-ecological interactions to its full extent, (f) consideration of all externalities inherent in individual actions and internalization of all costs, and (g) scale-matching and multi-level governance to be able to deal with the full suite of issues impacting a given recreational fishery. Sustainability will be particularly likely if those responsible for aquatic ecosystem and recreational fisheries management actions embrace the fundamental ethical principles of aquatic stewardship as a guiding moral compass, which is particularly important in today's recreational fisheries in light of moral burden placed on anglers and fisher to use natural resources while minimizing impacts on the exploited or otherwise managed ecosystems, both aquatic and terrestrial, and the fish populations making up these system (see Fig. 1.1 and below for details).

Guidelines – the Sustainability Paradigm in Recreational Fisheries

I. Relevant international, national and regional administrations, fishing rights holders and other parties and persons that own or are responsible for fisheries resources shall consider recreational fisheries, and subsequently protect, promote and encourage access to recreational fisheries while ensuring exploitation is sustainable and that potentially conflicting societal demands are taken into account in integrated management plans.

II. The fisheries sector and other non-fishery sectors in charge of management of water and aquatic ecosystems and their supporting terrestrial habitats should ensure that recreational fisheries interests, including the need to conserve the resources and supporting habitats, are taken into account along with the other multiple uses of aquatic ecosystems. Recreational fisheries stakeholders should be integrated into all decision-making processes that affect aquatic ecosystems.

III. Engaging in recreational fisheries carries with it the obligation to do so in a socially and ecologically responsible and overall sustainable manner to ensure long-term use, conservation, management and development of wild living aquatic resources and the aquatic ecosystems and fisheries habitats for present and future generations.

IV. Managers and policy makers should guard against favoring management solutions that cater to contemporary stakeholder desires at the expense of options in the future.

V. The following principles are conducive to achieving sustainable recreational fisheries, which are briefly provided here and further elaborated in chapter 3

(1) responsibility – responsibility to use resources in an ecologically sustainable, economically efficient and socially just matter

(2) precaution – the need to take uncertainty about potentially irreversible impact into account by erring on the side of caution

(3) adaptive management – continuously monitoring social, economic and ecological variables because they are dynamic and have some level of uncertainty, and adjusting actions and strategies based on new knowledge

(4) participation – the importance of full stakeholder participation in the formulation and implementation of decisions about fisheries resources

(5) full cost allocation – the need to identify and allocate all internal and external costs and benefits (social and ecological) of alternative uses of resources, e.g., the need to account for, unintended consequences of own actions on third parties and other stakeholders (externalities)

(6) scale-matching – decision-making at the scale of governance which has the most relevant information and power to address the issues at stake, which considers all actors, and which internalizes costs and benefits

(7) multi-level governance – the sharing of decision-making power across multiple levels of organization to take advance of multi-level power and knowledge networks, in particular if the recreational fisheries system crosses scales (e.g., a large river) and is impacted by issues outside the operational power of local fisher communities.

Aquatic stewardship as Zeitgeist for Sustainability

To develop sustainable recreational fisheries as expounded above, one needs a particular mindset or moral compass for pro-environmental thought and action. Such Zeitgeist that best aligns with a number of challenging issues characterized by coupled social-ecological systems such as recreational fisheries is the concept of environmental stewardship (Chapin et al. 2009, 2010). From a governance and management perspective, environmental stewardship constitutes an action-oriented framework to foster the social-ecological sustainability of natural resource use. From a psychological perspective, aquatic stewardship constitutes the moral obligation to proactively and voluntarily care for aquatic environments, and the actions undertaken to provide that care (Knuth and Siemer 2007). This includes care for habitats and populations, but also the care for each individual fish that is captured by recreational fishing gear and that makes up exploited fish stocks. Such perspective of valuing each individual fish (rather than other biological entities such as fish populations or gene pools) and treating each fish with the least harmful means (e.g., through appropriate hook choice, see Chapter 6) is also the cornerstone of a pragmatic approach to fish welfare in recreational fishing (Arlinghaus et al. 2009). The fact that recreational fishing usually happens during leisure time and does not generate resources that are important for survival of the fishing protagonist provides potentials for a more cautious relation to the aquatic environment compared to situations where food security and survival favour aggressive and non-sustainable fishing practices. This is a major difference between, say, subsistence and recreational fisheries, which facilitates the application of aquatic stewardship principles many recreational fisheries stakeholders.

The moral compass of aquatic stewardship behaviour is something carried by each fisher involving the individual moral norm to say, not litter the environment, not waste captured fish and treat every fish

captured with the greatest respect for its well-being (Chapter 6). However, aquatic stewardship also extents to the entire recreational-fisheries management system, with a view of developing actions and strategies that maintain and improve the biotic communities and the aquatic ecosystem(s) of which humans are a part (*sensu* Leopold 1949). Because diversity provides the raw material on which selection and innovation is based, both in the human and the non-human biotic world, maintaining diversity across all levels constitutes a key component of aquatic stewardship. In particular the slowly changing variables that have potentially large impacts on the functioning and resiliency of the recreational fisheries system need careful analysis and management attention. On the biological side, vegetation, spawning habitat, habitat diversity (such as variable flows in rivers), and food webs with long-lived top predators with a broad age class distribution in turn resulting in long spawning durations represent key variables driving system dynamics and the variability of fish stocks (e.g., Hsieh et al. 2010 for an example of age class diversity). On the social side, institutional diversity and stakeholders diversity is common across the world and any system, including all recreational fisheries systems, will become more resilient and able to cope with change if institutional diversity is maintained and tailored to local and regional conditions, including cultural differences, and strong linkages between stakeholders, monitoring activities and decision-making, between different sources of knowledge and generally integration across sectors (e.g., recreational fishing interest incorporated into wider aquatic ecosystem decision-making) is achieved. The central goal of a stewardship approach is then to sustain the capacity of aquatic ecosystems to provide the full range of services that benefit society by sustaining or enhancing the integrity and diversity of ecosystems as well as the adaptive capacity and well-being of the social system.

The framework of aquatic stewardship as put forward here is an explicit strategy to respond to and shape social-ecological systems, such as recreational fisheries, under conditions of uncertainty and change, both ecologically or socially, to sustain the supply and opportunities for use of ecosystem services to support human well-being (Chapin et al. 2009, 2010). This requires not only appropriate individual actions by recreational fishers (e.g., releasing fish in the best condition possible if undersized), but also a radical shift in how management of recreational fisheries, and indeed fisheries in general, is perceived. The old-adage of managing a single fish stock against single, often ill-defined objectives, such as maximum sustainable yield (MSY), is complemented in the aquatic ecosystem stewardship *Zeitgeist* by emphasis on multiple objectives and precautionary, adaptive and flexible (see Chapters 3) management of critical slow (i.e., low turn over rate) variables, such as spawning habitat, genotypic diversity, biodiversity, human value diversity, institutional diversity, and the feedbacks between social and natural system. These variables may be slow in their turnover, but they are the key ingredients determining the future trajectory of a social-ecological system and therefore require particular management attention (Fig. 2.1, Chapin et al. 2010).

Thresholds and feedbacks between recreational fishers and the fish stocks are particularly critical components of the action-oriented management framework of aquatic stewardship. In terms of thresholds, the key features of slow variables in a coupled social-ecological recreational fisheries system, such as habitat structure in lakes, is that abrupt, sudden shifts in system states are possible once critical thresholds are reached. The critical states are usually not known and difficult to predict for a fisheries manager, inter alia, because changes in critical slow variables tend to not have large impacts over a large parameter space, and thus tend to go unnoticed for a long-time. Therefore, managers and anglers tend to be unresponsive to changes in critical slow variables until it is too late and the system has flipped into an alternative state (Brock and Carpenter 2007, Biggs et al. 2009, Horan et al. 2011). Such patterns are for example to be expected in the selective exploitation of single species in complex food webs, e.g., top predatory fish, as revealed by several modelling studies where exploitation of top predators merged with angling-use induced alterations of critical slow variables such as dead woody debris, in turn resulting in sudden, rapid system shifts between states with and without abundant top predators present (Brock and Carpenter 2007; Biggs et al. 2009). Another example is spawning habitat, which when eroded does not substantially affect adult population size until a certain threshold is achieved after which impacts are severe (Minns et al. 1996), or the fitness of stocked non-native genotypes, which once a certain fitness thresholds is crossed may result in two alternative states – one with and one without the existence of wild genotypes (van Poorten et al. in press).

Another critical aspects relates to positive or negative feedbacks between anglers and fish stocks. For example, positive feedbacks between anglers and fish stock may result in ever increasing stocking levels to meet every-increasing angler expectations (Johnson and Staggs 1992) that may in turn prove catastrophic for recreationally exploited fish stocks (van Poorten et al. in press). If such positive feedback loops happen, it will be impossible to manage the system against single, traditional objectives such as maximum sustainable yield or optimal social yield (Johnston et al. 2010), because these objectives will not be reached in light of shifting expectations and dynamic angling effort. Aquatic stewardship would then call upon the management of the feedback loop, e.g., by education of realistic expectations on the side of anglers. Negative feedback loops are also possible, e.g., when angler keep being attract to low abundance and low-catch rate fisheries because many aspects other than catch determine the utility of a given water body to anglers. Coupled with inverse density-dependent catchability these depensatory mechanisms may cause widespread collapse of recreationally exploited fish stocks (Hunt et al. in press). To be able to deal with these complex interactions of humans and nature, the ethical framework of aquatic stewardship goes beyond modification of the single-objective fisheries-management approach such as MSY and also provides an extension to environmental management, by focusing on change, adaptation and flexibility and the management of key variables and feedbacks in the system rather than reliance on aggregated indices or reference points only as is typical in many marine commercial fisheries or environmental management in general. In particular, the (theoretically sound) idea of identifying one objective against which to judge management regulations in recreational fisheries has often been found to fail due to uncertainty in the actual biological population and the behavioural response to anglers to management interventions (Arlinghaus et al. 2008; Hunt et al. in press), overly optimistic assumption about the capacity of standard tools such as size limits to sustain the resource in the absence of effort controls (Cox and Walters 2002), and inability to efficiently regulate angler behaviour that are free to move among large spatial scales in a landscape or coastal area (Post et al. 2008; Hunt et al. in press). Therefore, in the aquatic stewardship framework emphasis is placed on regional diversity in management objectives, flexible adaptive management and acknowledgement of multiple stakeholders and knowledge sources to approach management interventions.

The ethical framework of aquatic stewardship acknowledges multiple objectives that may be region or even locality-specific. Overarching this is the idea that all actions that foster diversity of future options rather than a single presumed, usually unrealistic optimum (e.g., continued flow of maximum sustained yield in eternity) provide the needed system resilience in the face of unknown futures and possible sudden disturbances to the recreational fisheries system (see Chapin et al. 2009, 2010). Against this background, uncertainty and change become expected features of ecosystem stewardship rather than impediments to management actions (Chapin et al. 2010). This involves adherence to the more concrete management approaches that will be outlined in the next chapters, including ecosystem approach, precautionary approach and adaptive management, and addressing of novel ethical challenges, equally dealt with in subsequent sections, such as those stemming from fish welfare demands in the process of catching, handling, holding, releasing, and sacrificing of fish captured in recreational fisheries.

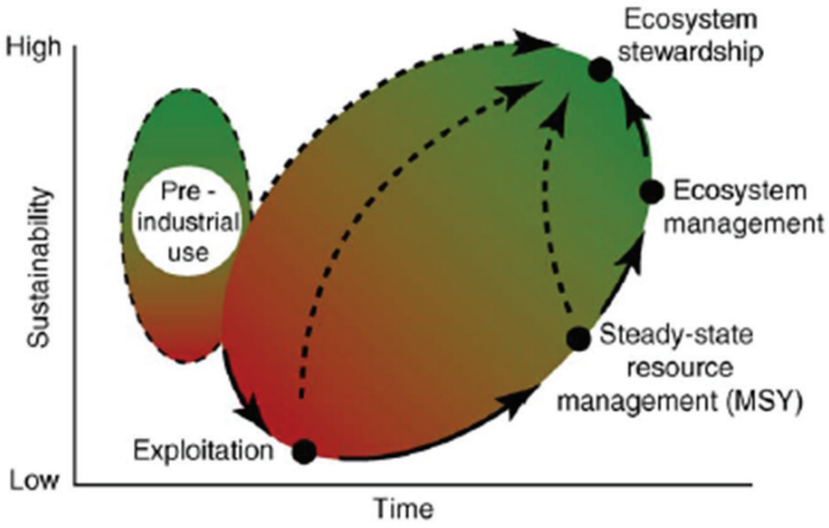

Fig. 2.1. The evolution of renewable resource-management regimes observed in many western nations. Dashed arrows show opportunities for developing nations to 'leap frog' from current management directly based on single objective, "steady-state" management (such as maximum sustainable yield, MSY) to ecosystem stewardship. The red-to-green gradient represents the probability of increased sustainability (from Chapin et al. 2010).

Guidelines – aquatic stewardship as action-oriented ethical framework

I. *Embracing aquatic stewardship at all levels (governance, management, managers, individual fisher behaviour) provides a useful ethical framework to sustain recreational fisheries in the face of uncertainty and change.*

II. *Aquatic stewardship involves the engagement in pro-environmental behaviours (individual fisher) and measures (behaviour of management) that proactively address the biological and social impacts of recreational fishing practices and management actions on individual fish, fish populations and the aquatic ecosystems as a whole.*

III. *Maintaining biological diversity within and among populations, including habitat diversity and genetic and age class diversity, is preferable over actions that erodes this key source of system resiliency. Similarly, maintaining diversity and flexibility at all levels, socially and institutionally, is advisable to facilitate the adaptive capacity of the system to be empowered to react to unexpected developments, uncertainty and change.*

IV. *Behaving with a high level of aquatic stewardship means to avoid irreversible, costly or slowly reversible changes to aquatic biodiversity, fish populations and aquatic ecosystems and to engage in actions that align with salient values and expectations of other members in society, e.g., addressing the issue if fish welfare in the process of catching, handling and killing fish.*

V. *Aquatic stewardship acknowledges that fish populations and aquatic ecosystems provide many ecological services to society, in addition to the opportunity for recreational fishing. In this context, managing recreational fishing exploitation becomes important whenever excessive exploitation or certain management tools (e.g., overstocking, release of non-native fish) affect other ecological services and the biological diversity on which these ecological services are based.*

VI. *Aquatic stewardship involves acknowledging multiple management objectives, local and regional diversity in objectives, and a move away from single objectives (such as maximum sustainable yield) to the management of multiple objectives and critical variables that*

crucially affect the entire system in the long term (e.g., habitat diversity, angler diversity, genetic diversity, age class diversity). Aquatic stewardship places a premium on managing these critical slow variables, threshold and feedbacks, both positive and negative, in coupled fish-fisher interactions.

VII. *Maintaining key ecosystem properties such as resilience and connectedness is advisable and an awareness be created for the possibility of alternative stable states, of which certain states might be undesirable (e.g., with or without top predators present, clear versus turbid water in lakes). Having said this, change is to be accepted as key component of aquatic stewardship ethics.*

KEY MANAGEMENT APPROACHES TO SUSTAIN RECREATIONAL FISHERIES

Responsible recreational fisheries require the application of key management approaches that operate under the overarching normative frameworks of sustainability and aquatic stewardship (Chapter 2). The most salient management approaches for recreational fisheries are the ecosystem approach, the precautionary approach and adaptive management using structured decision-making.

Ecosystem Approach

Recreational fishers tend to selectively exploit and remove certain fish species, often the top-predators in a given ecosystem (Arlinghaus and Cooke 2009). Historically, recreational fisheries managers have thus focused their attention on measures that manipulate this interaction between anglers and a single targeted fish population using tools such as size-based harvest limits, daily bag limits or stock enhancements. However, it is now recognized that recreational exploitation of selected components of a food web (e.g., the top predators) (Post et al. 2002; Roth et al. 2007, 2010), recreational fishing-induced alterations of key habitat features and ecological services (e.g., removal of dead woody debris in lakes, Carpenter and Brock 2004; altered nutrient cycling due to stocking of large number of benthivorous fish in lakes, Eby et al. 2006) and recreational fishing-induced spread of non-native fish (e.g., Johnson et al. 2009) can have important ecological and evolutionary consequences for populations that in turn feed back on ecological communities and indeed ecosystem structure and function (Walters and Kitchell 2001; Post et al. 2002; Eby et al. 2006; Lewin et al. 2006). Also, beyond the direct effects on target species, the selective exploitation of key stone species such as top predators may be responsible for the successful invasion by non-native species once a threshold exploitation rate is crossed that when looked at in isolation is biologically sustainable for the exploited species (Roth et al. 2010). Responsible recreational-fisheries management must therefore consider the broader impacts of fishing on the ecosystem as a whole, taking ecosystem traits, food webs and biodiversity across genetic, species and population levels into account. This is the basic premise of the ecosystem approach to fisheries (EAF), i.e. the sustainable use of aquatic ecosystems, including their functions, services and fish stocks, to persist in the long term, not just a targeted species (FAO 2003; Arlinghaus and Cowx 2008). This generally plausible and increasingly accepted management approach to sustainable fisheries (e.g., FAO 2003) is equally relevant in recreational fisheries in principle. The evil lies in the detail in terms of opportunities and constraints to operationalize the EAF for application in management practice, in particular when a range of non-fishery related factors such as waste disposal, urbanization, climate change, agriculture, channelization of rivers, flood control interact with ecosystem-level impacts stemming from recreational fishing, as is often the case (Arlinghaus and Cowx 2008). Implementation of an ecosystem approach is then particularly challenging, because of the dependency of the sector on external sectors, management organizations and institutions that are outside of the control of recreational fisheries managers (Cowx et al. 2010).

The ecosystem approach to sustainable fisheries is characterized as "to plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by ecosystems" (FAO 2003). This definition of EAF emphasizes strongly the social component of the social-ecological

"ecosystem", and is thus strikingly similar to the sustainability concept introduced earlier. Therefore, in the context of recreational fisheries Arlinghaus and Cowx (2008) argued that the EAF is rooted in any properly defined sustainability concept. However, the EAF has still is role by emphasizing the ecosystem-level impacts that may occur in response to fishing and by emphasizing that some constraints in the system can only be managed by attacking some higher-level habitat-related disturbances (e.g., spawning habitat loss, loss of connectivity in rivers). To move forward specifically in recreational fisheries, the first step is then simply to accept that ecosystem-level impacts are possible through fishing, rather than discounting such effects as has happened in the past (Arlinghaus 2006). A further advancement would then be to translate the broad policy statements about the need for conservation and management of ecosystems in an EAF into practical ways of setting and measuring progress towards ecosystem-levels goals, by specifying ecosystem-level indicators and reference points for performance monitoring as they currently exist for single-species fisheries management in recreational fisheries (Gangl and Pereira 2003). However, the paucity of research, monitoring and thus knowledge about how many recreational fisheries behave and impact in a wider ecosystem and catchment framework, coupled with the fact that non-fishery influences have probably a much greater ecosystem effect in many freshwater ecosystem compared to recreational fishing, limits the applicability of such operationalized EAF, which depends on development of sophisticated ecosystem-related indicator systems against which performance can be assessed in recreational fisheries (Arlinghaus and Cowx 2008). There are exceptions to this, such as the Great Lakes in the U.S. or other high profile, high-value recreational fisheries, but the standard recreational fishery is usually small-scale and low-value when looked at in isolation. It is therefore naïve to assume such systems would ever have enough resources to develop an indicator-system based EAF.

This caveat does not discount the importance of the EAF, however, its application is maybe less quantifiable than in many industrial marine fisheries applications. What is instead recommended an ecosystem perspective to all decision-makers responsible for local and regional recreational fisheries is to acknowledge explicitly and prominently the potential for ecosystem impacts associated with recreational fishing or fisheries-management actions (e.g., stock enhancement), and indeed develop a broader ecosystem outlook, and use these thinking in the routine assessment and evaluation, including risk analysis, of management options. This perspective thus supplements the rather piscicentric perspective on a single target species or a singly fishery that seems to be prevalent among many recreational fisheries stakeholders and managers today (Arlinghaus and Cowx 2008). Thus and as a specification of the aquatic stewardship principle (Chapter 2), the ecosystem approach is to be viewed as an guiding philosophy to consider and integrate ecosystem considerations (e.g., the impact of once actions on the broader ecosystem, not just the target species) into more conventional recreational fisheries management, and as a mechanism to account for ecosystem processes in the formulation of management measures (Sissenwine and Murawaski 2004). The EFA hence emphasizes an evolution of fisheries management rather than a revolution as sometimes perceived (Mace 2004; Rice 2011). Although the EAF is sometimes considered a novel strategy to fisheries management, in the freshwater and coastal environment it has its foundations in catchment management planning and coastal zone management. Here the key is to extend the perspective to also include recreational fisheries desires and impacts in catchment and coastal zone management. The EAF to fisheries should then (FAO 2003):

- manage fisheries so as to limit their impact on the ecosystems, as measured by indicators of environmental quality and system status;
- minimise the risk of irreversible change to natural assemblages of species and ecosystem processes as a result of fisheries;
- through good governance obtain and maintain long-term socioeconomic benefits without compromising the ecosystem; and
- generate knowledge of ecosystem processes sufficient to understand the likely consequences of human actions.

Where knowledge is insufficient, as of the case in small-scale recreational fisheries (Post et al. 2002; Arlinghaus 2006), the EAF calls for robust and precautionary (see below) recreational fishery management measures that address the wider ecosystem not just target species (Arlinghaus and Cowx 2008). Critical in this respect is awareness of potential ecosystem impacts by recreational fisheries and the right incentives among resource users, including those of recreational fisheries, to strive for an improved ecosystem state or avoiding ecosystem-level impacts. Good management must motivate recreational fishers to ensure that their fishing activities are responsible and do not impose socially or environmentally unacceptable impacts on the ecosystem. Clearly, judgement of what is acceptable or not is socially constructed and always need to balance trade-offs between risks and socio-economic benefits. Some aspects are also subjected to inter-generational change in values. For example, while around 1900 it was seen as perfectly reasonable to introduce exotic species into a given country (e.g., rainbow trout into central Europe) to supplement the native fish community and provide fisheries benefits, such perspective is in stark disagreement with today's societal values and international and national legislation in many countries, in part due to the fear that ecosystem-level impacts are induced (Eby et al. 2006) and the introduction of an exotic is irreversible. Therefore, one has to sometimes accept that once popular practices (e.g., release of exotics to supplement a fishery) has to follow a strict policy before being accepted, and maybe confined to artificial ecosystems to minimize potential impacts on biodiversity. From an EAF it is usually recommended to favor actions that minimize the potential for ecosystem-level effects by "erring on the side of caution", by avoiding losses of crucial habitats (see also chapter 2), and by avoiding biodiversity impacts (e.g., no release of non-natives unless the benefits strongly outweigh the impacts) or impacts on genotypic frequencies due to trait-selective recreational fishing (Jørgensen et al. 2007). Moreover, all activities that strongly modify food webs, e.g., by selectively removing key stone species and therefore predation control, by strongly altering the size and age structure of stocks (which alters predation pressure and the stability of recruitment, van Kooten et al. 2010; Hsieh et al. 2010) or by altering nutrient cycling or predation pressure through bottom-up or top-down processes (Lahtrop et al. 2002) are to be thoroughly reviewed and the risks and costs-and-benefits be properly valued (Francis et al. 2007). Usually, in the face of trade-offs between social and economic benefits, the EAF will call upon avoiding the irreversible or very costly to reverse option and will also avoid actions that strongly affect the ecosystem, unless the ecosystem is artificial or highly controlled (such as ponds). In artificial water bodies the demands are usually much more relaxed (Hickley and Chare 2004), but in reservoirs the real danger is maintained that exotic or non-natives escape impacting fish communities downstream of the reservoir. Therefore, also in these artificial conditions, ecosystem impacts, also in different water bodies, need to be properly considered and traded off against social and economic benefits created using risk analysis.

Guidelines - the Ecosystem Approach to Recreational Fisheries Management

I. *Given the usually tight dependency of a particular local recreational fishery on human actions in other sectors or even in the catchment, an ecosystem approach to aquatic ecosystem management is to be pursued whenever possible and technically and socially feasible. This demands integration across sectors and bureaucracies to work together on pertinent issues such as catchment-based management or coastal zone management.*

II. *The ecosystem approach emphasizes a holistic perspective rather than a focus on a single target species in a given water body, considering the interactions of land use, other non-fishery activities, access to resources, habitat diversity, water quality and ultimately recreational fishing quality.*

III. *The recreational fisheries sector needs to accept ecosystem-level impacts that need to be minimized. The results of these impacts on the ecological services valued by other stakeholders than fisheries stakeholders need to be considered and always carefully traded off against social and economic benefits accruing to recreational fisheries directly. Any ecosystem impacts supposedly being caused by recreational fisheries and resulting in constraints on recreational fisheries should preferable be backed up by objective data.*

IV. *Actions that protect and maintain habitat structure and diversity, ecosystem connectivity, water quality, food web structure, size structure, local gene pools and natural species diversity, as well as natural spatial and age structure of fish stocks are preferred in an ecosystem approach to recreational fisheries due to their usually positive impact on the resiliency and sustainability of recreational fisheries. Any impacts on these ecosystem features are to be traded off against social and economic benefits and be properly justified. In more artificial water bodies, the social and economic benefits may be weighed higher than in more natural water bodies, where conservation of natural communities may be considered of higher priority.*

V. *Management actions to benefit target species should be carefully evaluated and should not unduly jeopardize the conservation of other species or habitats in the ecosystem, and if so, the likely trade-offs, environmental and social risks and benefits should be properly evaluated prior to initiating action.*

VI. *If technically feasible, ecosystem-based indicator systems and performance systems are advisable to be developed, but focus is to be placed on managing critical slow variables and feedbacks in agreement with the Aquatic Stewardship Framework.*

Precautionary Approach

A second key management approach that is of utmost importance to sustainable recreational fisheries in general that is also inherent in the Aquatic Stewardship principle (Chapter 2) and needed to the implementation of an ecosystem approach in particular, is the precautionary approach (PA) to fisheries. The PA "exercises prudent foresight to avoid unacceptable or undesirable situations, taking into account that changes in fisheries systems are only slowly reversible, difficult to control, not well understood, and subject to change in the environment and human values" (FAO 1996). In the CCRF it is stated that one should apply the precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment and that the absence of adequate scientific information should not be used as a reason for postponing or failing to take cost effective conservation and management measures (FAO 1995). The rationale for the PA is the uncertainty that underlies much fisheries management in general, and the management of coupled social-ecological systems such as recreational fisheries, in particular. This uncertainty is pervasive across many levels and scales, including knowledge of productivity and size of stocks, importance of genetic diversity, impacts of alien species, behaviour of recreational fishers, stock condition in relation to management objectives and reference points, levels and distribution of fishing mortality, future climate and species invasions, and a range of social and economic drivers (e.g., social value change). Because some recreational fishing actions can have irreversible impacts on biota and the humans that depend on functioning aquatic ecosystems, e.g., establishment of a novel species or spread of a new disease through translocated fish, "erring on the side of caution" represents useful advice as a guiding norm of the precautionary approach in fisheries management. This is particularly so in leisure-based recreational fisheries because under these conditions fundamental, basic human needs (such as survival due to malnutrition) are not at stake when exploiting and developing a fishery, such that in discussion of environmental risks versus socio-economic benefits the risk may be highlighted more prominently in recreational fisheries compared to subsistence fisheries and maybe commercial fisheries. Put differently, in recreational fisheries erring on the side of caution is more affordable for individual recreational fisheries than is the case in subsistence fisheries, who often have limited alternative employment or food security options. Clearly, this also strongly depends on the type of ecosystem exploited and under consideration. The value judgements in favour or against certain management tools will differ strongly when comparing artificial stillwaters and natural streams and rivers for example. So ecological context will strongly impact on what is considered acceptable in an PA in one case or another.

Generally, taking account of the uncertainties in fisheries systems and the need to take action with incomplete knowledge, the PA to recreational fisheries management requires, inter alia (Garcia 1994; FAO 1996; Peterman 2004; Fenichel et al. 2008):

- Engagement in ways and measures that are precautionary, i.e. 'risk-averse' objectives and approaches using holistic, ecosystem-level perspectives (note the PA is not to be confused with the precautionary principle originally emanating from environmental law and policy, which emphasizes that any risk is "too much");
- consideration of the needs of future generations and avoidance of changes that are not potentially reversible within 2-3 decades;
- prior identification of undesirable outcomes and of measures that will avoid them or correct them promptly; one toolbox could involve the design of limit and reference points, as long as monitoring data and stock assessment are possible in the long-term.
- that any necessary corrective measures are initiated without delay, and that they should achieve their purpose promptly, on a timescale not exceeding two or three decades; i.e. impacts are reversible within 2-3 decades
- appropriate placement of the burden of proof to justify actions by adhering to the requirements above.

"A key point in the precautionary approach document is that, if faced with considerable uncertainty and risks, and if it is not clear which action to choose, actions should be chosen to give priority to conserving the biological productivity over the long term rather than satisfying short-term economic or social demands" (Peterman 2004). This can involve setting safety margins in terms of, say, how much fishing mortality or effort to tolerate, to take uncertainty in reference point estimation (e.g., MSY) or behaviour and impacts of fishers into account (e.g., implementation uncertainty in terms of unsure results of a given management action, Fulton et al. 2011). This perspective is related to the ecological economic concept of maintaining critical natural capital and the idea that healthy aquatic ecosystems are the basis for all the subsequent ecological services generated by them that are of value and use to humans, as conceptually inherent also in the aquatic stewardship framework (Chapter 2) and the ecosystem approach mentioned before. One important take home message is that the PA implies that very conservative management measures are required when a paucity of scientific information is available to underpin advice, which is often the case in many recreational fisheries (Arlinghaus et al. 2002). In such case, adaptively evaluating the results of certain actions and thereby "learn-as-you-do" is similarly recommended, which will be explained in the next subsection in more detail.

Guidelines - the precautionary approach

I. Because of large uncertainties inherent in recreational fisheries and the wide-spread lack of solid scientific data for many local fisheries, erring on the side of caution to avoid irreversibly altering important properties of the system, socially or ecologically, is advisable.

II. Application of the precautionary approach requires prudent foresight to protect the productive capacity of the resource in spite of uncertainty. When data are lacking, as it often the case in recreational fisheries, set-asides and safety margins should be employed to protect against unknown ecosystem effects.

III. The PA could be operationalized by a reference points system similar to industrial commercial fisheries, as long as funding and means are available for stock assessment and routine data collection. In the absence of these opportunities, precautionary objectives and measure should be guided by experiences elsewhere, e.g., related to the impact of introduction of new species, and in doubt the principle of "do nothing" should be guiding.

IV. The level of precaution exercised should be commensurate to the risk of long-lasting, undesirable outcomes and the benefits expected for a given action (e.g., stock enhancement).

V. Critical uncertainties in the system are to be resolved through monitoring and routine evaluation of past actions.

VI. It is wise to develop contingency plans that are taken when undesirable outcomes are noticed.

VII. For particular critical measures that very likely will have strong environmental impacts, the burden of the proof to justify the activity lies with those interested in conducting the activity.

VIII. The absence of data should not be a reason for postponing reasonable actions as long as these actions have a reasonable likelihood of success based on experience elsewhere, yet are to be chosen precautionarily and commensurate with the potential for ecological impact. The precautionary approach should not be misused as a tool against management.

Adaptive Management

A final key management approach that operationalizes and integrates the previously described ecosystem and precautionary approaches is adaptive management (AM). Such type of flexible management is often put forward as a strategic approach to sustainable fisheries management to confront uncertainty and social and ecological risk associated either with exploitation or management actions supporting recreational fisheries (or other natural resource use) (Fig. 3.1). Because of the focus on avoiding risk and acknowledging change and adaptation to novel situations, the AM approach of environmental management agrees well with the aquatic stewardship philosophy present in Chapter 2.

The conceptual underpinnings for AM are simple; there will always be inherent uncertainty and unpredictability in the dynamics and behavior of complex social-ecological systems, e.g., as a result nOnlinear interactions among fish and anglers and natural stochasticity in fish recruitment, yet management decisions must still be made, whose outcomes we cannot predict with certainty (Williams 2011a,b). Hence, the strength of AM is in the recognition and confrontation of uncertainties by emphasizing learning through management intervention and observing the fishery's (i.e., system's) reaction to the intervention (Walters and Hilborn 1978; Walters 1986). Because in the fisheries case one source of uncertainty is the impacts of fishing or management on the ecosystem and biodiversiry, the AM approach constitute a means to respond to the demands of the EAF and the PA. In fact, the need for precaution and risk-averseness is inherent in any all AM applications in fisheries when choosing which tools to test.

Adaptive management is often characterized as "learning by doing", "experimental management", or "informed trial-and-error" management. These are all variants of passive adaptive management (Fig. 3.2; Williams 2011a,b), where usually one management strategy is considered and tested for its effect in actual (recreational) fisheries. The core idea of AM (Walters 1986), however, involves deliberate testing of alternative methods and management interventions (i.e., hypotheses about the system, e.g., testing stocking versus harvest regulations). Due to its experimental focus, active AM therefore is different from passive AM, which means "try something, and if it doesn't work try something else" and involves an ad hoc revision of strategy through time when it is seen as failing (Fig. 3.1. Williams 2011). Passive AM may come in three variants, as outlined in Fig. 3.2 (corroborated, trial and error and step-wise). By contrast, active AM actively pursues the reduction of uncertainty through experimentally planned management interventions (i.e., using management as experiments for understanding of system behaviour), whereas passive AM focuses on fishery objectives, with learning a useful but unintended byproduct of decision making (Walters, 1986). Obviously, one will learn less from passive AM, i.e., the degree of information gain (or inference, Fig. 3.2.) is lower compared to active AM, and so are the needs for expertise, man power and resources.

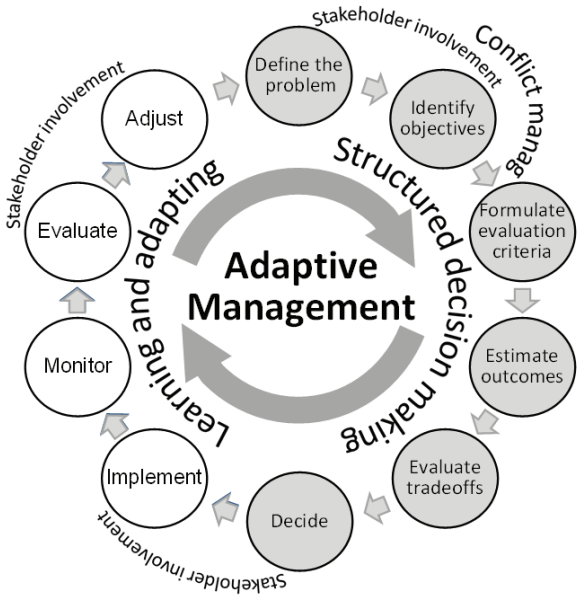

Fig. 3.1 Adaptive management of renewable natural resources such as fish, often characterized as 'learning by doing', is a formalized iterative process that acknowledges uncertainty and achieves management objectives by increasing system knowledge through monitoring, feedback and revision of objectives and means to achieve objectives. Integral is both a decision component and an opportunity to learn. Structured decision making (gray circles; Box 3.1), a term sometimes confused with adaptive management, is an organized and transparent approach to the decision process for identifying and evaluating alternatives and justifying complex decisions; however, structured decision making does not necessitate the iteration and consequential higher order learning (white circles) inherent in adaptive management (modified from Allen et al. 2011).

Active AM differs from trial and error-based passive adaptive management by the structure used in decision making, which involves the articulation of quantifiable objectives, identification of management alternatives, predictions of management consequences based on explicit recognition of key uncertainties, implementation of the most likely actions and monitoring of field data to find out what worked best in reality at the scale of entire fisheries or ecosystems (Walters 1986). Based on the outcome, the best management approach can then be identified and pursued further (Fig. 3.2). Thus, in active AM learning through ad hoc trial and error is replaced with learning by careful design and testing (Walters, 1997). For example, there might be discussion among stakeholders about the best way of managing a range of lakes for a given target species, and various toolboxes such as different stocking strategies (differing by size and density of stocked fish), different size-based harvest limits and other tools are hotly debated leading to conflict among stakeholders. Active adaptive management would then use a model-based analysis to built several hypothesis about how the system would likely react to certain variants and after identifying the most successful alternative (given previously defined objectives) allocate treatments (e.g., variants of stocking or size limits) to sampling units (e.g., lakes). Then, one would use intensive monitoring of system variables (e.g., catches, relative abundance) to test which variant performed best and what other expected or unexpected impacts occurred (e.g., biodiversity impacts). Monitoring of the system's response to the various actions then provides insight for revising the – quantitative or qualitative - models of the system (learning) and subsequent decision-making (adaptation) (Figs. 3.1 und 3.2).

Such active AM obviously increases the ability of managers and stakeholders to learn about the outcomes of various management regimes, but there are daunting tasks involved with successful projects (e.g., financial resources for long-term monitoring on large spatial scales). Moreover, there is a range of expertises (e.g., modelling, experimental design, field research) needed in active adaptive management projects, which usually limits its applicability in fisheries practice (Walters 1997, 2007). Nevertheless, engaging in some sort of flexible, adaptive strategy, including variants of the passive trial and error approaches in Fig. 3.2, is always advisable based on evaluation of actions against quantifiable objectives,

as this approach will promote approaching some locality-specific approach that works "pretty well" in the long term (in analogy to the "pretty good yield" perspective by Hilborn 2010 for commercial fisheries).

Adaptive management, no matter which variant, may be ideally combined with structured decision making (Box 3.1). Central to the success of the structured decision making process in recreational fisheries management (Irwin et al. 2011) is the requirement to clearly articulate fundamental and operational (i.e., quantifiable) objectives, explicitly acknowledge uncertainty, and respond transparently to all stakeholder interests in the decision process, even if this delays decision-making (Irwin et al. 2011) – the process thus also helps consensus building and conflict management. Structured decision making can be conducted using quantitative tools (e.g., models of fish populations and the interaction with anglers) or by qualitative means (e.g., concept maps) to identify plausible management alternatives in light of objectives. A structured approach to decision-making in recreational fisheries then promotes stakeholder involvement already in the setting of objectives, discussing of plausible alternative tools, evaluation criteria and evaluation of alternatives. The goal is to carefully identify suitable, agreed-upon management alternatives. Those may then be tested in the virtual world of a computer (which is then known as management strategy evaluation, see Mapstone et al. 2008 for an example in marine recreational-fisheries management) or be tested at the scale of real recreational fisheries using AM (Fig. 3.1). Obviously, the progress can be combined, and a subset of tools be implemented in reality as a proof of the modelling predictions. Generally, AM is enhanced when done in collaboration with the full spectrum of stakeholders. When stakeholders, e.g., anglers, are involved in the process of structured decision-making more knowledge of the system can be captured and the suite of potential management actions is richer (Irwin et al. 2011). Further, the process is transparent and stakeholders may be more supportive of management actions they had a hand in choosing (Irwin et al. 2011).

Adaptive management is particularly useful when the system to be managed exhibits high controllability (e.g., a close angling club with a limited set of water bodies that may self-determine a certain management action or a set of tools), but uncertainty about outcomes of particular actions is high (e.g., does stocking really enhance fisheries?) (see Allen and Gunderson 2011). Because this is usually the case in many of the world's recreational fisheries, AM can be considered an ideal approach because it also helps accounting for risk and thereby helps implement the EAF and the PA. However, any overly time consuming (and also financially challenging) approach of model building, model analysis and field testing of alternatives using structured decision making-based, active adaptive management will only be an viable option for selected well-funded and managerially well staffed recreational fisheries (e.g., Great Lakes in the U.S.A.). For many of the world's smaller recreational fisheries, the monitoring needs for active adaptive management would be prohibitive, in particular for individual fisheries in water rich-landscapes, or the range of waters to test various tools may simply not exist. Yet, in water rich landscapes where hundreds or thousands of lakes are to be managed, a region- or space-based monitoring scheme could be useful, in particular when wanting to manage fisheries from a "landscape" perspective where lakes and rivers are connected by mobile anglers. Here, an individual lakes and rivers approach may not be advisable (Lester et al. 2003; Hunt et al. in press).

To conclude, it is contented that for every recreational fishery appreciation of the general management philosophy of AM using a structured decision-making framework could be helpful and may indeed be implemented with a range of simple participatory (to identify objectives and strategy decisions) and monitoring (assessment of outcomes) tools. For example, in smaller angling clubs in central Europe that lack the scientific expertise or relationships to fisheries biologists and trained managers monitoring of actions may well be conducted using angler diaries, as long as anglers provide sound data about catches and sizes of catch. This can be promoted by good interpersonal communication skills and an inclusive management process based on mutual understanding about the need to monitor variables. Thus, even in the absence of expertise in modelling-based fisheries analyses, the approach of incorporating structured decision making (Box 3.1) in an AM framework is strongly advisable because it helps managers and stakeholders collaborate and choose management actions despite uncertainties about the system, with a view to agree on actions that reduce future uncertainties while maximizing learning, system knowledge

and benefits to the recreational fishers. Irwin et al. (2011) have tested model-based structured decision making in the context of various recreational fisheries in the U.S.A. in participatory frameworks, where the stakeholder-agreed management tools were found to be more strict than initially planned, which emanated out of the increasingly shared common understanding developed in the participatory model building process.

Box 3.1 Structured Decision Making

Recreational fisheries are complex social-ecological systems. Management options are usually multi-faceted and any given action will likely have environmental, social and economic implications. Stakeholders may have conflicting views about goals for the fishery and the means to achieve them. Thus, choosing a course of action can be a daunting task. Structured decision making (SDM) is a process well suited to complex environmental problems (Kendall 2001; Irwin et al. 2011). This process can help policy makers, managers, and stakeholders think clearly about the system, entertain multiple objectives, evaluate tradeoffs among actions, and decide what action to implement. When the process is combined with modelling and multiple sources of uncertainty, a management strategy evaluation framework can follow, which outlines a set of plausible management tools with their associated costs and benefits resulting in trade offs. Irwin et al. (2011) outlines a structured decision making approach applied to various freshwater and saltwater recreational fisheries in the U.S.A.

In most fishery management situations, decisions are made with considerable uncertainty. SDM explicitly captures uncertainty and allows for multiple working hypotheses (e.g., alternative models for the system and its response to management). Management strategies should evolve as knowledge and experience are gained. Thus, actions need to be adjusted as new information becomes available. Adaptive management is an iterative form of SDM that promotes learning to reduce uncertainty and improve management outcomes.

Structured decision making:

…is a rigorous framework for identifying and evaluating alternatives, and then making choices in complex situations (Hammond et al. 1999).

…can transform command and control structures from top-down designation of problems and imposition of management solutions to a more pluralistic approach in which stakeholders play a formal role.

…requires explicit, objective quantification of the problem and solutions but also provides a rigorous means to incorporate subjective information (e.g., stakeholder values, expert opinion).

…increases transparency of management knowledge and decision-making, recognizes alternative views of problems and solutions, and provides for accountability and learning when decisions do not produce desired outcomes.

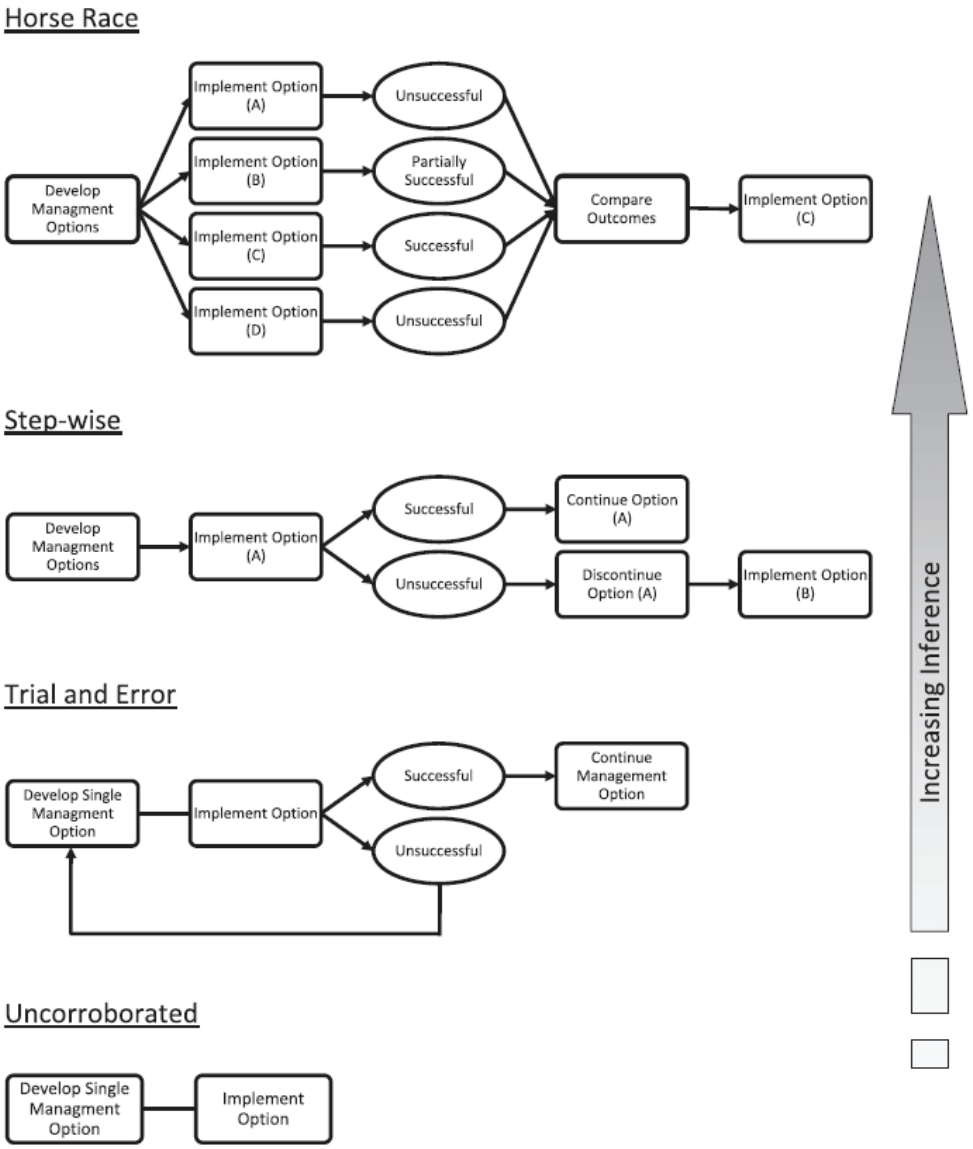

Fig. 3.2. The learning and degree of information gain (inference) possible among approaches to recreational fisheries management varies, increasing from little or none in passive adaptive management (three different variants are called uncorroborated, trial-and-error and step-wise) to much in the active adaptive management approach (called horse race) (from Allen et al. 2011).

Guidelines - Adaptive Management

I. *Adaptive management in its various forms, from loose passive to deliberate active adaptive management, where operationally and financially feasible, should always be followed. It is important to implement at least some rudimentary form of monitoring toolbox, e.g., using angler diaries that report all catches, sizes and effort.*

II. *Adaptive management can be enhanced using structured decision-making processes, which increases stakeholder buy-in and acceptability of regulations.*

III. *Where possible and feasible, testing of management approaches in the field may be combined with model-based analyses using an interative approach where model are modified in light of new information from field-based assessments.*

IV. *The highest degree of information gain about the effects of management actions on the coupled social-ecological systems of recreational fisheries to management can be generated from active adaptive management. Such approach is preferred when large uncertainties are to be reduced. However, in many smaller recreational fisheries this experimental approach is not practical due to expertise or financial limitations. In such cases, some variant of passive adaptive management should be pursued.*

V. *Sustainable recreational fisheries depend on continuous learning loops that emanate from evaluation of previously agreed upon and measurable objectives after implementation of action strategies. Therefore, identification of measurable objectives and continues revision of objectives should be conduced whenever possible and be the basis of adaptive management.*

VI. *To close learning loops, investment into an adequate monitoring capacity is essential. This involves capacity building for smaller recreational fisheries communities that are not linked to an overarching management body.*

VII. *In adaptive management applied to recreational fisheries both social and biological data and indicators are to be measured and monitored.*

POLICY AND INSTITUTIONAL FRAMEWORKS

Coherent and effective fishery management requires an appropriate policy and institutional framework that involves fisheries laws and regulations as well as organizations that fulfil important roles in governance of fisheries. Because recreational fisheries are complex social-ecological systems the purview of "management organizations" (those persons or organizations with the authority to make management decisions about the fishery) includes oversight of the ecological system and a variety of human interactions with the biota and the environment. The managers may be a) the State (e.g., government fisheries agencies), b) owners of private waters (not discussed further), c) organizations such as angling clubs in rights-based systems, or d) communities with strong ties to the fishery. In reality, management organizations of the latter three types cooperate with government managers to some degree. Stakeholders are diverse and may have conflicting interests so policy should provide the means for development of a framework of fishing-rights and management institutions. Moreover, appropriate mechanisms for gathering input and managing conflicts within and among user groups are needed if recreational fisheries management is to succeed (Chapter 5). Management organizaitons must have sufficient authority to enact regulations for the development, management and conservation of recreational fishery resources under their stewardship.

To encourage compliance with regulations, management organizations must also educate stakeholders and enforce regulations, and there must be adequate networks among organizations that link various managers affecting the ecosystem, e.g., water managers and fisheries managers. Management organizations require sufficient funding to execute their management, outreach, monitoring and enforcement responsibilities. Because recreational fishery management has societal benefits (e.g., economic value, environmental conservation) funding for management is often provided both by user groups and the general public. However, many management bodies are notoriously understaffed and thus can only fulfil their most rudimentary obligations related to monitoring of fish stocks and rule compliance (Arlinghaus 2006).

Governance structures

Structure and function of the governance framework must be clearly delineated to ensure transparency and to promote trust in decisions, and respect of authority among stakeholders. Three common approaches to governance of natural resources affect authority, access, and rights: 1) state control, 2) rights-based , and 3) community-based management (Table 7.1). Historically, inland recreational fisheries in many countries (e.g., USA, Canada, Australia) and most coastal and marine fisheries in developed countries

have been managed under the first model, with government assuming full management authority over the fish and fisheries. These organizations may use independent boards or commissions to review agency policy and act as arbiters of disputes between agencies and stakeholders. Many small-scale commercial and subsistence fisheries worldwide and some recreational fisheries in countries such as Germany (Daedlow et al. 2011) or Austria and The Netherlands (Arlinghaus et al. 2002) are managed under the second model, whereby a subset of users holds access and management rights to the resource. In these situations, private fisheries user groups (e.g., angling clubs) are responsible for managing their water bodies as long as actions agree with a general legal fisheries framework designed by the state fisheries agencies, who in turn enforce legal regulations. More recently, community-based management (Ostrom 1990) has been advocated, in which resource-based communities have primary responsibility for management. Organizational structure varies greatly across communities and many members and sub-groups may play a role in management so identifying "the manager" is difficult. Regardless of the governance structure and the fishing rights in place, some roles of state control may still be needed, such as setting overall environmental policy and regulations that apply to anglers and the rest of society. For this reason, rights-based and community-based management are forms of co-management, wherein the resource is managed cooperatively with the government.

Access, Rules, Compliance and Enforcement

A legal framework for recreational fisheries is usually needed to vest rights, identify parties holding rights, determine agents responsible for management, set fees and licensing requirements, and develop regulations governing the protection, promotion, management and use of the resource. The authorities responsible for enforcement of regulations and penalties for non-compliance must also be established. In the case of trans-boundary stocks, straddling stocks and highly migratory stocks that are fished by two or more management organizations the authorities should cooperate to develop consistent and effective policies for conservation and for management of the stocks and fishers

Fisheries management organizations require sufficient funding and authority to enact policy to ensure that the fundamental goals of fishery management are achieved: 1) conservation of biodiversity, 2) sustainable use of its components, and 3) equitable sharing of benefits among diverse stakeholders (Welcomme 2001). More specifically, management organizations should adopt policies to protect and promote access to recreational fisheries, and for the sustainable development, conservation and management of recreational fishing and fishery resources (EIFAC 2008, Article 6). Actions on the land (e.g., development, grazing, mining, agriculture) usually have direct impacts to aquatic ecosystems and yet fisheries management organizations in many countries have very limited power to control terrestrial factors. Further, other water interests (e.g., hydropower, irrigation, navigation) typically possess higher use priority than do recreational fisheries. Therefore, it is essential that recreational fishery managers cooperate with other authorities to insure that environmental regulations provide adequate protection for fished ecosystems. Cooperation also allows for coordination that reduces conflicting or duplicative regulations. Likewise, fishery management organizations should insure that their management practices are compatible with other uses of the environment. Policies must be regularly reviewed and updated with input from anglers and other stakeholders.

Fishing regulations should be developed with active participation of stakeholders. While stakeholder input is essential for setting goals and objectives for the fishery, it should be the management organization that has the knowledge to determine the appropriate strategy to achieve stated goals, and to identify the regulatory options to implement the strategy. Once these options are identified stakeholders can then provide input on their preferences. The management organization should provide a mechanism for managing conflicts between fishery or environmental policy and the interests of anglers and other stakeholders. Independent review boards and government officials can provide recourse when stakeholders believe their interests are not being considered fairly or management organizations believe their mandate is compromised by other governmental action.

Ideally, recreational fisheries would be managed on an individualized basis with the regulatory scheme tailored to system characteristics derived from creel surveys and stock assessments (Chapter 6). However,

government management organizations often lack the monitoring resources or the rationale to obtain detailed information on all the fisheries within their jurisdictions (Pereira and Hansen 2003). Instead, regulations may be applied categorically, with classes of waters receiving a given management regime based on shared fishing and ecological characteristics (Lester et al. 2003, Chapter 6). Because fishing regulations by their nature involve users, regulatory schemes must be a compromise of ecological and social objectives; ideally meeting social objectives also preserves the fish stock biologically (Johnston et al. 2010). Overly complex rules that change frequently are difficult to justify and may be disregarded. The management organization should promote compliance with fisheries and environmental regulations by involving stakeholders in rule development and making them aware of rules, their justification, and sanctions for violations (EIFAC 2008, Article 7). Management organizations should provide the mechanisms and the means for monitoring compliance and for enforcing regulations but regardless of the governance system, anglers themselves must share the responsibility for compliance by informing themselves and fellow anglers, and by self-policing (Ostrom 1990, 2005).

Internal policies and procedures

Managers should develop internal policies and procedures to insure the safety, efficiency, effectiveness and integrity of its members and the organization. Policies and procedures are needed to: establish roles and responsibilities of members; promote ethical behaviour, e.g., fiscal responsibility, ethical treatment of animals, responsible conduct of research; provide for safety and welfare of employees provide stakeholder involvement and conflict management procedures; establish employment and supervisory practices; recommend and standardize sampling methods; establish data collection and archival procedures; establish procedures for fishing rule development and promulgation; provide outreach and education policies; establish best practices for stocking, habitat, and other management approaches. The management organization should provide training to insure that members understand policies and procedures. The organization should regularly review and update policies and procedures to remain consistent with laws, regulations and prevailing public and professional attitudes.

Funding and Licensing

The management organization should base decisions on stakeholder input and the best available scientific information so the manager must have adequate funding to gather this information. In the U.S.A., where fishery management is a function of the government, funding for fish and wildlife management has come from a combination of license sales and user fees, sometimes supplemented by excise taxes on fishing- and hunting-related purchases and general fund revenue (Prukop and Regan 2005; Ballweber and Schramm 2010). Funding for management in rights-based systems could come from membership dues, user-fees, and in community-based systems from local taxes and user fees. Because fishery management can have societal benefits the use of some general tax revenue can probably be justified in all management systems.

Licensing of anglers has three important advantages: a) a funding stream to support management activities, b) a mechanism for limiting access or use of a fishery, and c) the means to account for, characterize and study the primary users of recreational fishery resources. In most jurisdictions, recreational fishing is considered a privilege and the license for which may be revoked for violation of fishing or other environmental regulations. For these reasons it can be advantageous to require licensing through the centralized government in all types of management systems, with the fee commensurate with functions provided by the State. Fees for licenses can also vary according to social considerations, with reduced costs for residents, children, elderly, and military personnel. Licenses are often available for daily, weekly and annual durations. Many State agencies have optional surcharges on licenses in the form of fees or stamps that allow special privileges; e.g., for harvest of restricted species, use of special gear, or access to limited entry fisheries. In the absence of licensing, in rights-based or community-based systems, user fees could be developed with similar considerations.

Design principles for sustainable management

Ostrom (1990) identifies eight principles for design of management institutions and governance of common pool resources, including fisheries. Meeting these principles increases the likelihood that the policy and institutional framework facilitates sustainable recreational fisheries, whether they are under state control, rights-based, or community-based management systems.

1) Clearly defined boundaries: the resource, users and their access rights are explicitly defined.

2) Equivalence of costs and benefits: benefits to users should be locally determined as a function of productivity of the resource and be proportional to costs required to produce the benefit.

3) Collective choice arrangements; stakeholders are involved in the decision-making process, promoting development of locally relevant policy that enhances legitimacy of the management authority and compliance by stakeholders.

4) Effective monitoring: the resource and its users are monitored, preferably by monitors that are stakeholders of the resource being monitored.

5) Graduated sanctions: users who violate rules and risk sustainability of the system receive sanctions proportional to the severity of the offense.

6) Mechanisms for conflict management: conflict is inevitable in fisheries, within management organizations, among stakeholders and between management organizations and stakeholders. The means to effectively and rapidly manage conflict is required.

7) Right to self-determination: the rights of stakeholders to organize and establish institutions for long-term sustainability are recognized by higher authorities.

8) Nested enterprises: common pool resources may transcend jurisdictional boundaries (e.g., coastal, highly migratory and straddling stocks). In these cases management activities should be organized in a nested set from the local to regional or international scale.

Table 4.1. Three common forms of governance of natural resources and some advantages and disadvantages of each. Note that in many cases the governance system possesses attributes of more than one form of governance.

	State control	Rights-based	Community-based
The manager	Government agencies and their employees	Rights holders (e.g., angling clubs, their members)	Community members, paid staff, councils, fishers, angling and tourism business representatives
		Sometimes in conjunction with State that protects public interests and enforces laws ("co-management")	
Access	Open (may require licensing)	Dictated by rights holder	Dictated by community
Strengths	Prevents conflicts of interest in management decisions	Should promote stewardship of resource	Captures local knowledge.
	Management and monitoring can be coordinated across management units	Better tailored to local conditions than broad-scale government control, potentially more economically efficient	Costs dispersed from agency to local communities
Weaknesses	"Blueprint approach" fails to tailor management to local context	Has not always resulted in better stewardship of resource	Can prioritize stakeholder opinions over objective data
	Users may become disenfranchised	Conservation of biodiversity or other societal goals potentially deemphasized	Delayed decision-making

Conclusions

A well-defined institutional framework that meets the design principles outlined above is needed for sustainable management of recreational fisheries to identify the resource, its users and their rights, and the manner in which the system will be managed. A variety of governance structures have been employed (state control, rights-based, and community-based management). All management organizations need to solicit stakeholder input in decision-making, adopt adequate policies and regulations to conserve the resource, protect and regulate users' rights, and effectively monitor and enforce policies and regulations. Funding mechanisms must be in place to support the duties of the management organization. Regardless of the exact governance system in place, sustainability of resource management should be enhanced if fundamental design principles are recognized and incorporated into the structure of the system.

i.Structure and function of the governance framework must be clearly delineated to ensure transparency and trust in decisions, and respect of authority.

ii. An appropriate legal framework should establish parties holding property rights, agents responsible for management, and regulations governing the use of the resource.

iii. Authorities responsible for enforcement of regulations and penalties for non-compliance must be established.

iv. Management organizations need the authority to ensure that the fundamental goals of fishery management are achieved.

v. Management organizations should promulgate regulations necessary to promote, conserve and enhance fishery resources and their environments.

vi. Regulations should be developed in consultation with stakeholders, including anglers and other interested parties.

vii. Mechanisms should be in place to manage conflicts among stakeholders, the fishery management organization and other management authorities.

viii. Regulations should be clear, uncomplicated, well publicized, and reviewed periodically.

ix. The management organization should develop policies and procedures to insure the safety, efficiency, effectiveness and integrity of its members and the organization.

x. The organization's policies and procedures should be reviewed and updated regularly.

xi. Management organizations should promote compliance with regulations through shared rule-making, outreach, monitoring and enforcement.

xii. Anglers should share the responsibility for compliance through self-policing

xiii. Funding mechanisms need to be identified to support management.

a. Licensing provides funding but is also a mechanism for limiting fishery access, and identifying primary stakeholders.

b. User fees (and surcharges on licenses) may be useful for managing special circumstances (restricted access, fishing methods, or species).

xiv. Recreational fishing should be considered a privilege; the management authority should be able to revoke the license of anglers who commit serious violations of fishing or other environmental regulations.

xv. Efficacy of recreational fishery management should be enhanced if the fundamental institutional design principles are recognized and incorporated into the structure of the governance system.

RECREATIONAL FISHERIES MANAGEMENT

Background

This chapter presents concepts, issues and approaches relevant to the management of recreational fisheries, regardless of the habitat (freshwater or marine) or geographic region. One objective is to assist developing nations that lack a history of recreational fisheries management because the importance of recreational fishing is growing in many such countries (Arlinghaus et al. 2002). Recreational fishery management shares some fundamental tenets with commercial, artisanal and subsistence fisheries so the reader should also consult other FAO guidance including: the Code of Conduct for Responsible Fisheries, Article 7 (FAO 1995), Technical Guidelines for Responsible Fisheries 4: Fisheries Management (FAO 1997),Technical Guidelines for Responsible Fisheries 6: Inland Fisheries (FAO 1997), A Fishery Manager's Guidebook (Cochrane and Garcia 2009). This chapter provides specific guidance to complement advice presented in Article 11, Fisheries Management, of the Code of Practice for Recreational Fisheries (EIFAC 2008).

Fisheries management is the process by which sound information is used to achieve management goals by directing actions at the three components of the fishery system: 1) the habitat, which usually transcends the aquatic-terrestrial interface, 2) the biota, including but not limited to the target fish population, and 3) the humans directly and indirectly involved in the fishery (Nielsen 1993). The primary goals of fisheries management should be consistent with those in the Convention on Biological Diversity (CBD 2011): 1) conservation of biodiversity, 2) sustainable use of its components, and 3) equitable sharing of benefits among diverse stakeholders (Welcomme 2001). Commercial, subsistence and recreational fisheries management share these fundamental goals but goals for recreational fisheries can be more diverse and more difficult to quantify than those associated with other types of fisheries. For example, benefits to be gained from recreational fisheries may include food but this is secondary to other outputs from the fishery such as psychological and physiological aspects of the fishing experience (Fedler and Ditton 1994; Weithman 1999). Indeed, even defining what constitutes a recreational fishery can vary considerably among societies and cultures (Arlinghaus et al. 2010). Thus, a challenge for the recreational fishery manager is to understand stakeholder attitudes and values and be able to explicitly define the goals and objectives of their management.

While overfishing of commercial fish stocks has been widely publicized (FAO 2009; Worm et al. 2009), recreational fishing clearly has the potential for detrimental impacts. Recreational fishing itself is becoming widely recognized as a potent ecological force, capable of imposing significant impacts to fish populations (Cooke and Cowx 2004; Post et al. 2006; Uusi-Heikkila et al. 2008), trophic interactions (Walters and Kitchell 2001), and ecosystem services (Crowder et al. 2008). Thus, the manager should recognize that the authority to manipulate and channel recreational fishing is also a potent ecological force that can be harnessed to achieve desirable ecological changes.

Management authorities in developing countries should anticipate that with industrialization and agricultural modernization the relative importance and value of recreational fishing will likely increase compared to other uses of aquatic ecosystems such as aquaculture and commercial fishing (Arlinghaus et al. 2002). Much of the advice in this chapter derives from experience in developed nations. Developing nations may have different management goals and stakeholder desires, particular to their own social and cultural context (Sanderson 1995). However, the natural science that underlies assessment and management is universal.

An important challenge to recreational fisheries management is achieving an appropriate balance between actions that provide for recreational angler desires without compromising the benefits that other stakeholders may wish to enjoy from the system, today and in the future. Because humans vary greatly in how they value recreational fisheries and the benefits they get from them involving stakeholders in goal setting and decision making is needed to insure legitimacy of management. The entire process of recreational fishery management should employ an objective, transparent, evidence-based approach to achieving management goals.

The Fishery Management Process

The process of recreational fishery management involves 1) defining the resource to be managed, the state of the system and constraints, 2) setting goals and objectives, 3) evaluating management options, 4) choosing and 5) implementing appropriate actions to achieve management objectives and monitoring outcomes, 6) evaluating success of management, and adjusting management in light of learning (Figure 5.1). Explicit specification and documentation is required at each step. The development of a fishery management plan (Table 5.1) can provide a framework for identifying problems, stakeholder desires, goals and objectives; and proposing management remedies and expected outcomes. The plan should be short and simple (Hindson et al. 2005) and well publicized. Publicizing the fishery management plan promotes transparency of decisions and trust among stakeholders. Because management is usually an ongoing, adaptive process, the fishery management plan should be revisited and updated regularly.

Fishery management is challenging because managers operate at the intersection of ecological and social-psychological, sociological, economic and political realms. Diverse human desires for the resource and uncertainty about the ecological system, both of which are dynamic, can make choosing a course of action difficult. Traditionally, agencies have used a variety of approaches to make management decisions emphasizing politics, conventional wisdom, or best available data (Johnson 1999). Managers of recreational fisheries need better tools for coping with diverse objectives, complexity and uncertainty in the decision making process. Structured decision making (Chapter 3) is a systematic process developed for finding optimal solutions in complex situations (Hammond et al. 1999; Kendall 2001). As such, SDM can be a very useful underlying framework for the fishery management process. The method provides a pluralistic approach in which stakeholders play a formal role, subjective information (values, opinions) is rigorously incorporated, and knowledge and decisions are transparent to all. While management provides an opportunity to learn about the system and how it responds to humans, many problems persist despite years of attention. Learning and improving management can be facilitated by following SDM with explicit evaluation of outcomes and adjustment of the management in a cyclic fashion, in a process called adaptive management (Chapter 3).

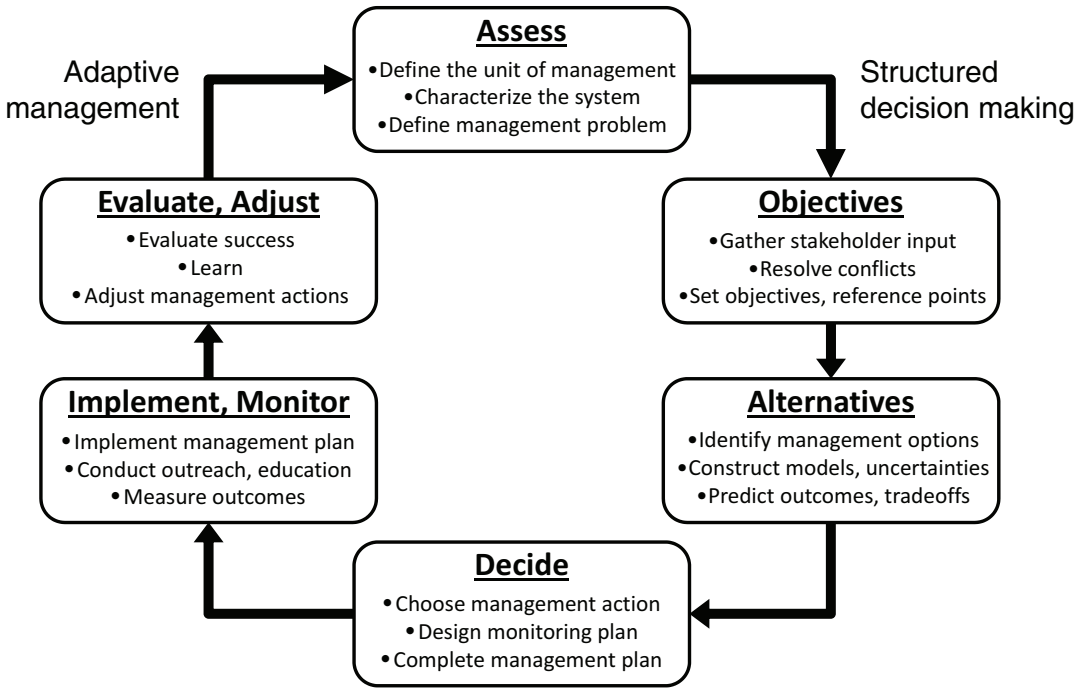

Figure 5.1. The recreational fishery management process formulated for structured decision making and adaptive management (Chapter 3).

Table 5.1. General elements of a recreational fishery management plan.

Plan element	Description
1.Characterize the system	Define the system to be managed. Characterize a) the fishery: background, history, status; b) the geographic setting: environmental characteristics, socio-economic and political factors; c) the ecosystem: food web, sensitive species, system productivity.
2.Identify threats, constraints	Identify threats to fishery and potential environmental degradation. Identify potential limiting factors (biological, physicochemical).
3.Goals and objectives	Gather stakeholder input, resolve conflicts, set measurable objectives, including establishment of reference points
4.Strategies	Management actions necessary to achieve goals and objectives. Timeline for implementation. Predicted outcomes.
5.Monitoring	Monitoring required and reference points, performance indicators. Enforcement plan.
6.Financial responsibilities	The cost of implementing the plan, including monitoring and enforcement. Methods for having users and beneficiaries pay a portion of management costs.

1. Defining the unit of management

The impact of fishing on a species cannot be determined without knowledge of stock (population) structure. Thus, explicitly defining the stock (Ihssen et al. 1981; Dizon et al. 1992; Hilborn and Walters 1992) or evolutionarily significant unit (ESU; Vogler and Desalle 1994) that is the target of the fishery and of management actions is an essential first step. In fisheries sustained by natural reproduction the management unit should usually be the population of interbreeding individuals. When ambiguous, as in mixed stock fisheries, tagging or marking can be used to discriminate stocks, or an eclectic approach to stock delineation employing genetic, morpho-meristic, behavioral, and ecological information (Behnke 1992; Vogler and DeSalle 1994).

Stock delineation can be challenging when the species being managed is highly migratory or has a trans-jurisdictional range, as is the case for many marine fisheries. In such cases stocks are often defined by pragmatic criteria (spatial distribution relative to jurisdictional boundaries). However, an eco-evolutionary (Carroll et al. 2007) perspective is required to ensure that fishing and its management preserve the integrity of the population and sustain benefits to humans. Protecting the genetic and functional diversity of fish populations, akin to a financial portfolio (Schindler et al. 2010), can stabilize their response to environmental change and thereby protect future yields to recreational fisheries.

Guidelines – the unit of management

i. The unit of management must be specified before status of the fishery can be assessed or management can be prescribed.

ii. Stocks should be defined by eco-evolutionary criteria (genetic, morpho-meristic, behavioral, and ecological traits) to ensure that fishing and its management preserve the integrity of the population and sustain benefits to humans.

iii. Managers should strive to maintain a diverse "portfolio" of fish stocks of a given species as insurance against unexpected environmental fluctuations.

2. Assessing the fishery

Knowledge of a fishery's present status is necessary before management goals and objectives can be chosen (Hilborn and Walters 1992; King 2007). In addition to information on the fish, recreational fishery managers require demographic (human), social and economic (stakeholders) and ecological (environment) information to evaluate the status of a fishery, and environmental constraints and opportunities for improvement. Managers can be informed about the state of a fishery by angler opinions and through their own sampling and observations. While local knowledge of anglers is essential to a complete understanding of the system and stakeholder attitudes and values, choosing and evaluating management actions also requires information obtained from scientifically valid sampling programs (Mackinson and Nottestad 1998).

Appropriate assessment methods will depend on the environment and species of interest, but in general 1) stock assessment seeks information on vital rates of populations and their eco-evolutionary characteristics (FAO 2006; King 2007; Guy and Brown 2007), 2) creel surveys seek information about angler catch, harvest and effort (Pollock et al. 1994; NRC 2006) and 3) ecosystem surveillance monitors status of the ecosystem.

Stock assessment can take various forms but the ultimate goal is to understand the processes that drive the stock's dynamics. In many cases direct measures of fish population vital rates (e.g., growth, mortality, recruitment) are not available and must be determined from inference or back-calculation approaches (e.g., modelling, virtual population analysis; Hilborn and Walters 1992). Creel surveys are primarily directed at quantifying angler-related factors but the manager may also obtain samples from the anglers' catch that contribute to stock assessment. For example, angler-caught fish can be sampled for growth and diet information. In fisheries subject to both recreational and commercial/artisanal fishing catch and harvest data must be available from each to provide for a full accounting of fishing mortality on the stock. Monitoring ecosystem status is an enormous task so managers may wish to develop a set of indicators that can inform them about condition of the ecosystem and the sustainability of their management actions (Rice 2003; Cury and Christensen 2005; Kwak and Freeman 2010). The Trophic State Index for lakes (TSI; Carlson 1977), the Index of Biotic Integrity for streams (IBI; Karr 1981), Biomass Ratios (Medley et al. 2009), and abundance of sentinel species (Beeby 2001) are examples of useful metrics for ecosystem surveillance.

Together, these information sources allow the manager to assess present status, and identify problems, constraints and opportunities for improvement through a management manipulation (Figure 5.2). Traditionally, stock assessment has been a single-species approach but there is widespread agreement that the indirect effects of manipulating the fisher-fish relationship should be considered in both freshwater and marine ecosystems (Cooke and Cowx 2004; Coleman et al. 2004; Crowder et al. 2008).

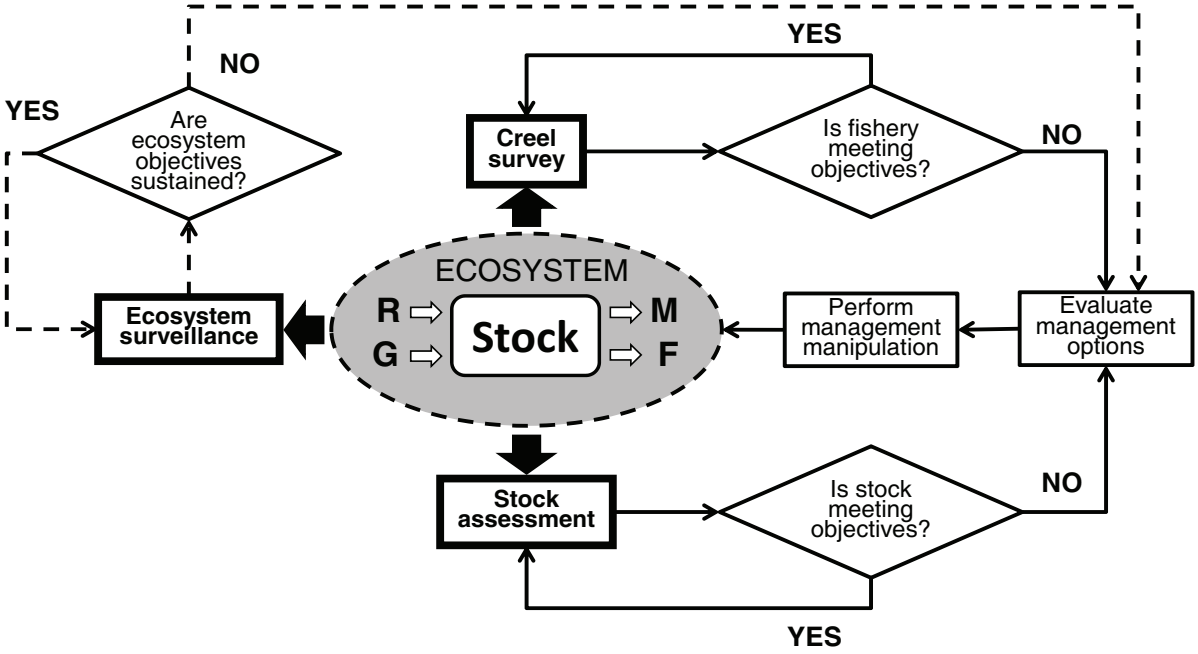

Figure 5.2. The traditional process by which fish and angler survey data are used to assess the status of a fishery and identify appropriate management prescriptions (solid lines) and the incorporation of ecosystem considerations in fishery management (dashed lines). Here, the "stock" is defined as the fish population of interest (Hilborn and Walters 1992); its dynamics are governed by inputs (recruitment (R), and growth (G)) and outputs (natural mortality (M), and fishing mortality (F).

Managers should be prepared for indirect effects of changes in angler effort and harvest brought about through management. Alteration of the target population can have implications for other trophic levels and even water quality (e.g., Lathrop et al. 2002). Moreover, anglers are likely to respond to changes in fishing conditions within a system (Johnson and Carpenter 1994) but also to alternative fisheries across the landscape (Lester \et al. 2003; Post et al. 2008; Hunt et al. 2011). Modeling may prove useful for predicting performance of a fishery under alternative management regimes, and expanding the purview beyond the target species. For example, understanding how fishing regulations might affect trophic relations can be evaluated using projections from a population model combined with a bioenergetics model to translate expected changes in the target population into predictions of consumptive demand and potential impacts to prey populations by the target population (Johnson et al. 1992; Johnson and Martinez 1995). More generally, Ecopath with Ecosim (Christensen and Walters 2004) can be used to explore the ecosystem effects of fishing and fishery management.

Integrating information from fish stocks, ecosystems and anglers provides for a more holistic conceptual model for fisheries and fishery management. This perspective also emphasizes that management actions are never final, but rather require periodic re-evaluation. Recreational fishery management is a continuous process with regular assessment of its objectives, methods, subjects, and outcomes. The frequency of repeat surveys is correlated with the intensity of management (+), value or importance of the resource (+), lifespan of fishes (-), time scale of environmental variation (-), and human demographic factors (+/-).

Guidelines – assessing the fishery

i. Present status of the fishery should be determined prior to choosing management goals and objectives.

ii. *Managers should integrate information from local knowledge, stock assessment surveys, creel surveys and ecosystem surveillance to characterize the present status of the fishery.*

iii. *Evaluation of present status should be used to identify potential problems or constraints and opportunities to improve the fishery.*

iv. *Modeling can be used to evaluate the relative status of the fishery compared to alternative system states that could be achieved through management.*

v. *Potential management actions should also be evaluated with respect to their effects on the ecosystem*

vi. *Modeling can be used to expand the management purview beyond the traditional single-species view.*

vii. *Integrating information from fish stocks, anglers and ecosystems provides for a more holistic and predictive conceptual model for fisheries and fishery management.*

viii. *Fisheries require periodic reassessment.*

3. Setting goals and objectives

Clear and explicit goals and objectives are essential for effective management and are required to evaluate management outcomes. While the manager may believe s/he knows what is best for the fishery, choosing from among competing objectives requires a value judgment that should be a societal choice, not an administrative one. Goals and objectives will be highly dependent upon stakeholder attitudes and values but the fundamental goals of fishery management should always apply: 1) conservation of biodiversity, 2) sustainable use of its components, and 3) equitable sharing of benefits among diverse stakeholders (Welcomme 2001). More specifically, goals of recreational fisheries management include 1) maintaining ecological integrity and protecting natural systems for present and future generations, and 2) maintaining and improving the quality of the fishing experience (Baker et al 1993). The recreational fishery manager should consider sociological, biological and ecological aspects when developing a management regime: what do stakeholders want, what can the target population provide, and what can the ecosystem sustain? Stakeholder desires must be compatible with demographic or environmental constraints on the target population and with ecosystem sustainability.

Unlike commercial fisheries where yield optimization is important, recreational fisheries generally strive to optimize relatively intangible benefits such as angler satisfaction. Recreational angler values and opinions about what constitutes a satisfying fishing experience vary widely across the sector (Fedler and Ditton 1994). Recreational anglers may wish to maximize catch rate, harvest, number and size of trophy fish, or ease and convenience of fishing while minimizing their exposure to contaminants in the fish they catch to eat. They may also desire a diversity of angling opportunities, including the chance to catch wild or unusual fish, use more challenging methods, or enjoy a relatively natural setting. In addition to striving to meet angler desires, managers may also manipulate fisheries in a fashion that affects water quality (e.g., biomanipulation, Lathrop et al. 2002) or otherwise emphasizes ecosystem services (e.g., increase predation on exotic species). Ultimately, managers must work cooperatively with a spectrum of stakeholders, not only anglers, to choose appropriate goals and objectives.

Given the diversity of goals that stakeholders and managers may have for recreational fisheries there is potential for disagreements about the goals and objectives for a particular fishery. Managers must recognize that 1) some activities are of higher social priority than recreational fishing, 2) values of recreational anglers and managers may differ from those of other stakeholders, and 3) the sector should respect values, customs and objectives of other stakeholders (EIFAC 2008, Article 10). When goal setting becomes contentious then conflict management techniques (FAO 1997; Daniels and Walker 2001; FAO 2005) should be applied to reach a mutually acceptable solution.

Guidelines – goals and objectives

i. Managers must explicitly state clear goals (e.g., increase satisfaction of coastal zone anglers) and quantifiable objectives (e.g., achieve X fish/angler-hr, mean size of catch ≥ Y mm) for the fishery.

ii. The fundamental goals of fisheries management apply to recreational fisheries: 1) conservation of biodiversity, 2) sustainable use of its components, and 3) equitable sharing of benefits.

iii. Recreational fishery management should also maintain and improve the quality of the fishing experience while maintaining ecological integrity and protecting natural systems for present and future generations.

iv. Selecting goals and objectives should be a societal choice, not an administrative one: goals and objectives should be developed cooperatively with a spectrum of stakeholders, not only anglers.

v. When goal and objective setting is contentious, conflict management techniques should be used to reach mutually acceptable solutions.

4. Choosing and implementing a course of action

Equipped with knowledge of the status, constraints and potential of the fishery, and stakeholder goals and objectives, the next task is to choose a course of action to achieve the specified desires for the fishery. In some instances, no management actions will occur but it should be recognized that this is in effect a management choice. Given increasing human domination of the biosphere, this choice can carry potentially irreversible consequences for the fish stock, ecosystem, and human welfare.

Whereas in most commercial fisheries (wild, capture fisheries) the primary means to maintain biomass and productivity of a stock is through regulation of harvest (FAO 1997) recreational fishery managers have a diverse array of tools and approaches to manipulate fisheries (Welcomme 2001; Hubert and Quist 2010). In general, these tools target the three primary components of the fishery system: habitat, biota, and anglers (Nielsen 1993; Cowx 2002). It is important for the manager to thoroughly understand the scientific basis for these tools before an appropriate course of action can be chosen. In many countries recreational fishery managers have university training, even college degrees in fishery biology and management. Where higher education coursework and degrees are not practical as job requirements shortcourses and workshops could provide managers with an understanding of the fundamentals. A detailed description and rationales for recreational fishery management tools are presented in Section 5.3.

Choice of a management action must be justifiable on technical grounds but it also must be sensible from an economic standpoint. What are the costs of a change in management (e.g., rule change and promulgation, outreach, monitoring, enforcement)? Who must bear these costs (The management agency? The anglers? Society at large?). What are the opportunity costs of the action? (If stocking in Lake A is to be increased, stocking may need to be reduced elsewhere). Do the expected benefits justify these costs? Are these benefits shared equitably among stakeholders? Economic analysis of recreational fishing can be more challenging than in commercial fishing where the benefits can be readily valued by markets, but methods such as contingent valuation (Loomis and Walsh 1997) are available. The ability to valuate recreational fishing may be particularly important where recreational and commercial fishers share the same resource and a basis for allocation between the two is needed.

When a management strategy has been selected then necessary regulation changes should be pursued and a plan for monitoring and enforcement of the program should be developed. At this stage the fishery management plan can be completed and disseminated to stakeholders. The success of many management initiatives and compliance with associated regulation changes can be improved by effective outreach such that stakeholders understand the rationale for a course of action.

Guidelines – implementation

i. *Managers should recognize that neglecting to manage is in fact a management choice that must be monitored and evaluated regularly.*

ii. *The manager must have an understanding of the fishery's status and constraints, combined with accurate knowledge of stakeholder goals and objectives before choosing a management strategy.*

iii. *Managers should know how the multitude of recreational fishery management tools and approaches operate and when to use them.*

iv. *When higher education coursework is impractical, shortcourses and workshops can provide the fundamentals.*

v. *An economic analysis (e.g., benefit-cost) should be conducted to compare management alternatives.*

vi. *After deciding on a course of action the manager should initiate regulation changes and develop a plan for monitoring and enforcement.*

vii. *When planning is completed the fishery management plan should be disseminated so stakeholders understand the project's goals and rationale.*

5. Monitoring and evaluation

The management of recreational fisheries offers many opportunities for learning about aquatic ecosystem dynamics and for devising better solutions to fishery problems. While conducting coordinated, jurisdiction-wide management experiments may be beyond the scope of some entities, steps should always be taken to maximize learning from individual management actions (Chapter 3). Managers should thoroughly document actions taken and the results obtained. Statistically valid sampling designs are required to obtain reliable information on fish population responses (Hansen et al. 2007; Noble et al. 2007), angler catch and effort (Pollock et al. 1994; NRC 2006), and angler attitudes and values (Ditton and Hunt 2001). In many cases, managers will need training to enhance their understanding of study design, sampling methods, data analysis and inference before they can be expected to conduct meaningful monitoring projects.

For findings of monitoring and evaluation studies to be most useful adherence to standardized sampling and database protocols is essential (Bonar and Hubert 2002; Kubečka et al. 2009). Fisheries may take years to respond to some management actions, necessitating consistent sampling methods over time to allow for a full evaluation of the action. In developing nations where an historical record of fisheries investigations is not available, managers must rely on contemporary surveys as their knowledge base. Standardization of sampling methods allows managers to immediately begin building a foundation of comparable data.

Globalization dictates that managers share data increasingly broadly. Standardization of routinely used sampling gear (e.g., gill nets, electrofishing) at a continental or global scale would improve communication among nations (Bonar et al. 2009) and would be useful for addressing management questions at large geographic scales (e.g., effects of climate change, invasive species). To assess the global impact of the recreational fishing sector and to elevate recreational fishing as a conservation concern, fundamental information on angling participation, compliance and harvest rates are needed. However, these data are currently scarce or unavailable for most recreational fisheries (Cooke and Cowx 2004). Thus, proper monitoring, evaluation and documentation of fisheries work serves needs at local and global scales (Chapter 3).

Evaluation of the outcome of a fishery management action is necessary to determine if goals and objectives have been achieved, and therefore, the success of the action. However, enforcement of regulations must accompany any change in management if outcomes are to be properly interpreted. Evaluation of effectiveness is required to learn about system behaviour and to allow managers to refine management strategies. Adaptive management (Chapter 3) provides a framework to maximize learning from management manipulations and thereby improve future management outcomes.

Because recreational anglers can have significant ecological impacts (Cooke and Cowx 2004; Lewin et al. 2006), it follows that fishery management actions that regulate effects of anglers are powerful ecological tools. Further, many fishery management actions manipulate environmental characteristics directly. To fully evaluate the effects of a management action it is important to assess effects of the change on the host ecosystem. Tracking ecosystem indicators provides a means to detect and understand the broader implications of management actions targeting a particular angler-fish interaction (Kwak and Freeman 2010). Managers should take care to limit their unintended impacts on the system by choosing monitoring methods that minimize adverse effects on the environment and the stock, and the bycatch of non-target organisms.

Guidelines – monitoring and evaluation

i. *Management authorities should strive to maximize learning from management actions.*

ii. *Management authorities should provide training for managers in the fundamentals of study design, basic data analysis and inference*

iii. *Survey and monitoring methods should be standardized to insure data comparability across projects and through time.*

iv. *Standardized methods should be as simple as possible to facilitate adoption and adherence to protocols, and field crews must be trained in the use of the methods.*

v. *Managers should be required to thoroughly document their management actions and results obtained. Standardization of data reporting is also required.*

vi. *Information gathered from monitoring and evaluation efforts should be validated, compiled into centralized databases and shared with other experts and interested stakeholders*

vii. *Evaluating the outcome of a management action is necessary to determine if goals and objectives are being achieved*

viii. *Enforcement of regulations is required if management outcomes are to be interpreted correctly.*

ix. *Evaluating the outcome of a management action is also required to learn about system behavior to promote more informed and effective management in the future.*

x. *Adaptive management, an iterative form of structured decision making , provides a method to maximize learning from management manipulations.*

xi. *Managers should monitor ecosystem indicators to detect and understand the broader implications of management actions*

xii. *Sampling methods should be chosen to minimize adverse effects on the environment and the stock, and bycatch of non-target organisms.*

Matching Management to Objectives

Collectively, anglers may desire conflicting, inappropriate or unattainable fishery attributes. For example, some anglers would like to maximize harvest of a desirable food fish while others would like to maximize the size structure of a piscivorous trophy fish that preys upon the other species (Johnson and Martinez 2000). Anglers may desire to have a popular recreational fish species that is not native or is unsuited to the local environmental conditions. A job for the responsible manager is to understand stakeholder desires and then optimize when possible and educate when not. Thus, an appropriate compromise for the first scenario could be to increase overall harvest rate of the piscivorous species to sustain the prey population but protect the largest, trophy size class with restrictive regulations (e.g., a maximum size limit). Angler wishes might also be accommodated by emphasizing trophy fish in some systems and emphasizing food fish in others. When angler wishes cannot be granted due to environmental constraints or eco-evolutionary considerations the manager needs to educate anglers and then provide a more sustainable alternative by enhancing the fishery by other means (Figure 5.3;Table 5.2).

Anglers commonly desire improvements in the catch rate, size of catch, and opportunity for harvest in a fishery. The manager must confirm and diagnose causes behind reported inadequacies in the fishery and choose an appropriate course of action to achieve objectives for the fishery (Table 5.2). In some cases there may be several approaches to achieve an end and others that would be contraindicated. Overall, the recreational fishery manager should accept and espouse three general principles: 1) recreational anglers are a multi-faceted clientele, 2) ecological constraints (e.g., evolutionary history, environmental conditions, existing fish assemblage) can dictate what management strategies can or should be applied, and 3) regardless of clientele desires, constraints preclude some management strategies.

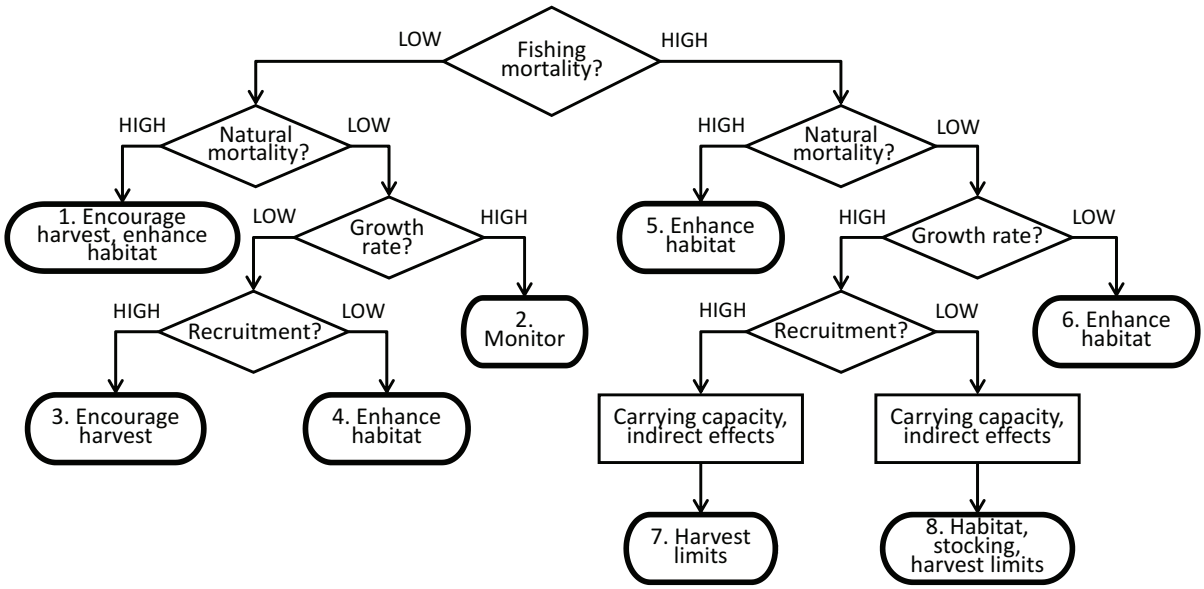

Figure 5.3. Generalized decision tree for recreational fishery managers. An implicit assumption is that the management objective is to increase size and abundance of the target species within ecological limits of the system. When fishing mortality is low (1-4) harvest regulations would be not be useful, rather, it may be advantageous to encourage harvest to alleviate problems with density-dependent growth or natural mortality (1, 3). When fishing mortality is high but natural mortality is also high (5) or growth is low (6) habitat improvements rather than harvest restrictions would be indicated. The manager stands to make the greatest improvements to the fishery with harvest regulations when fishing mortality is high, natural mortality is low, and growth is high (7, 8). Under these conditions harvest limits can increase biomass and size structure of the target population so an assessment of system carrying capacity and potential indirect effects of the change on non-target species should be performed.

Table 5.2. Common complaints of anglers about the fish stock and suggested management actions to remedy the situation. In some cases there will be multiple complaints caused by interacting factors; in these situations effective remedies may be more limited (Figure 5.3). It is possible that problems with a target species are such that the manager needs to emphasize other species and educate anglers about ecological constraints that preclude catering to some angler desires. Numbers in parentheses refer to tables with more detailed information about remedies.

Complaint	Evidence	Diagnosis	Suggested remedies (Tables)
Not enough fish	Creel survey: low CPE	Low catchability: temporary boom in prey of fished species Low catchability: fish dispersed	Educate anglers: catch rate not always indicative of fish abundance Install fish aggregating devices
	Sampling: low CPE, abundance	Low abundance: insufficient recruitment	Improve habitat (5.3),
			Protect spawners,
			Stock target species (5.6)
		Low abundance: excessive natural mortality	Improve habitat (5.3), Suppress predators (5.5), Alternative target species (5.6)
		Low abundance: excessive fishing mortality/too many anglers	Size, bag, and effort limits (5.7, 5.8),
			Stock target species
Fish too small	Creel survey: size in catch Sampling: size in catch	Slow growth	Improve habitat (5.3), Enhance prey (5.5), Suppress competitors (5.5), Encourage harvest (5.7, 5.8)
		Excessive natural mortality	Improve habitat (5.3), Alternative target species(5.6)
		Growth overfishing	Size, bag, and effort limits (5.7, 5.8), Stock target species
Fish too thin	Creel survey: body condition Sampling: body condition	Slow growth	Improve habitat (5.3), Enhance prey (5.5), Encourage harvest (5.7, 5.8)
		Unsuitable environment	Improve habitat (5.3),
			Alternative target species (5.6)
Any of the above	Historical record	Unrealistic expectations, inaccurate recollection of past fishing success	Educate anglers: provide access to historical data
Not the right kind of fish	Species not present in catch	Species not native to locale	Educate anglers, Alternative target species (5.6)
		Environmental constraints	Improve habitat (5.3) and Stock target species (5.6), Alternative target species (5.6)

Guidelines – matching management to objectives

i. *Three general principles apply to the selection of a management strategy: 1) recreational anglers are a multi-faceted clientele, 2) ecological constraints (e.g., evolutionary history, environmental conditions, existing fish assemblage) can dictate what management strategies can or should be applied, and 3) regardless of clientele desires, constraints preclude some management strategies.*

ii. *The duty of the responsible manager is to understand stakeholder desires and then optimize when*

it is possible and educate when it is not.

iii. *The manager must confirm and diagnose causes behind reported inadequacies in the fishery and choose an appropriate course of action to achieve objectives for the fishery*

Habitat management. Habitat management focuses on protecting, modifying, mitigating and restoring aspects of the biological, chemical and physical. Managers conduct a wide range of habitat manipulations with goals ranging from enhancement of habitat to increase the abundance of a particular recreational fish species to actions aimed at protecting or restoring ecological integrity of the system (Table 5.2). Managers should also be alert for potential environmental problems created or aggravated by recreational fishers and their activities (Table 5.3). Fostering environmentally responsible behaviour among anglers is ethical and serves to reduce societal objections to recreational fishing.

Habitat protection may be the most powerful tool for promoting healthy fisheries but it is not always practical. Likewise, habitat restoration can have widespread benefits for fished populations and the ecosystem, but in many cases complete restoration is not feasible either. Human impacts to watersheds, and hence to inland and coastal waters, are pervasive. The fishery manager rarely has authority to control potentially harmful activities on the land such as unsustainable logging, mining, agriculture and development. The manager's task is then to be an advocate for the aquatic environment, protect to the extent possible and then find ways to mitigate or compensate for habitat degradation. This may lead the manager to pursue various means of directly manipulating recreational fish populations and other aquatic organisms.

Guidelines – habitat

i. *Habitat protection may be the most powerful tool for promoting healthy fisheries and should be employed whenever possible*

ii. *Managers should be alert for potential environmental problems created or aggravated by recreational fishers and their activities.*

iii. *Managers should foster environmentally responsible behaviour among anglers to protect the environment and reduce societal objections to recreational fishing.*

Biotic manipulations. Manipulations of the biota often involve the enhancement of desirable fishes and the suppression of undesirable ones (Table 5.4). Managers may conduct the manipulations themselves, through stocking (the deliberate release of aquatic organisms), or physical removal using conventional sampling gear (e.g., gill nets in lakes and reservoirs, electrofishing in streams and rivers). Or, managers may enlist the aid of anglers by implementing mandatory kill regulations to suppress undesirable or overabundant fish. In North America and elsewhere, the desirability of species has undergone a gradual evolution from a highly utilitarian position of favouring species based primarily on their recreational value and gastronomic appeal to criteria related to the maintenance of biodiversity and ecosystem function (Eby et al. 2006). Regardless, insuring that recreational fishery management practices are ecologically sustainable is essential to achieving the fundamental goals of fishery management and sustaining benefits from the fishery.

Stocking plays a prominent role in recreational fishery management worldwide (Cowx 1998; Nickum et al. 2004). The practice includes the transfer of wild fish between water bodies, the release of cultured fishes from aquacultural facilities, and the introduction of non-native species. Managers have many objectives for stocking (Table 5.5). They may wish to stock cultured fish to restore a wild population decimated by an environmental catastrophe (restoration). Or, they may perpetually maintain or supplement a population to mitigate for an unresolved habitat limitation on natural recruitment (maintenance/mitigation) or in an attempt to increase the fishable stock above natural levels (enhancement). Managers may introduce

non-native fish to establish them with a goal of diversifying the fishery. In some cases cultured fish are stocked for the express purpose of contributing to the catch. These fish may be native or non-native to the stocked system but they are not expected to be self-sustaining (e.g., put-and-take or put-grow-take stocking, sea ranching; stocked fish may be sterile or otherwise unlikely to reproduce). Finally, managers may stock piscivores or prey to manipulate a food web for the benefit of the recreational fishery.

Table 5.3. Examples of management actions targeting habitat that benefit recreational fish populations and their ecosystems (see also Table 5.4).

Strategy/goal	**Explanation**
Protect habitat	Mitigation and restoration are costly; preventing degradation by education, regulations and enforcement should be a high priority.
Restore connectivity	Install fish passage structures or remove dams to alleviate barriers to fish movement and restore metapopulation dynamics.
Nutrient abatement	Contain point and non-point sources of nutrients in the watershed (often phosphorus and nitrogen)
Nutrient supplementation	Phosphorus and nitrogen additions to enhance fish production or to compensate for cultural oligotrophication
Reduce contaminants	Contain point and non-point sources of contaminants in the watershed (e.g., nitrates, metals, pesticides)
Liming	Addition of calcium carbonate (limestone, calcite) to neutralize acidified waters
Aeration	Increase dissolved oxygen concentration through physical means to prevent dieoffs and undesirable chemical dynamics in hypoxic waters (e.g., dissolution of phosphorus and manganese, and mercury methylation)
Mitigate thermal pollution	Cooling water effluent from power plants can cause harmful abrupt temperature changes when discharged into water bodies
Manage turbidity	Soil runoff from the watershed, mixing by boats, and bioturbation by fish can all increase turbidity, limiting photosynthesis and increasing surface temperature.
Manipulate flow/water level	Mimic natural water level/flow fluctuations in regulated waters; reservoir drawdowns can reduce reproduction of undesirable species
Restore wetlands/estuaries	Inland and coastal wetlands provide many ecosystem services including water purification and fish production
Restore shoreline/riparian zones	Fish benefit from large woody debris in littoral zones of lentic systems; excluding livestock protects riparian areas and reduces bank erosion of lotic systems
Improve spawning habitat	Spawning substrates, spawning channels, river channel modification for fish and shellfish reproduction
Supplement structure	Fish aggregating devices, artificial reefs

Table 5.4. Examples of regulations that can be used to target environmental problems that may be aggravated by recreational fishers and their activities.

Target	Regulation purpose
Anchoring	Prohibit anchoring over sensitive substrates (e.g., coral reefs); provide permanent mooring buoys for anglers
Baiting	Regulate use of chum, groundbait and other recreational fish attractants with potential to pollute water bodies
Biosecurity rules	Implement regulations and protocols to prevent the intentional and accidental introduction of invasive, pathogenic or parasitic organisms.
Boat noise and wake	Engine horsepower and speed limits to minimize conflicts with other water users
Boat discharge	Regulate emissions from boat motors, release of grey and black water into waterways
Boat strike	Restrict boat operations when potential for collisions to have significant effects on fish and wildlife populations
Bycatch and discards	Regulate fishing to minimize incidental catch and mortality of nontarget species, undersized fish, and sensitive species
Disposal of fish waste	Prohibit in waterways to reduce aesthetic concerns and disease transmission
Disposal of garbage, tackle	Prohibit littering and provide trash collection receptacles; encourage recycling of fishing line and other fishing related materials
Disturbance to wildlife	Restrict shore and boat angling when there is potential for disturbance of breeding, nesting or rearing of wildlife
Habitat disturbance	Regulate recreational use of disruptive fishing gear (e.g., shellfish dredges, rakes; trawls) to protect benthic habitats
Harvest of bait	Regulate to prevent depletion of bait organism populations, habitat damage
Release of bait	Prohibit to prevent introductions of nonnative species, diseases or parasites
Stocking	Require permits for importation, transportation and stocking of aquatic organisms
Introduction of nonnatives	Prohibit introduction of invasive species; conduct risk analysis and thorough review before considering any introduction
Tackle and methods	Prohibit toxic tackle (e.g., lead weights and lures) harmful to fish or other wildlife
Transport of live fish	Prohibit transport without a permit to discourage illegal transfer of fish and aquatic hitch-hikers among waters
Trophic cascades	Prevent overharvest of keystone species, apical predators to prevent undesirable food web consequences

Table 5.5. Examples of management actions targeting the biota (recreational fishes, and other components of their ecosystem).

Biotic manipulation	**Purpose**
Stocking	Release of cultured or translocated fish to create or supplement populations of desirable fishes (see Table 5.6).
Biomanipulation	Stock, protect fishes as agents of biomanipulation to improve water clarity; compromises between angling and water quality goals are required
Enhance prey	Release of aquatic organisms or otherwise supplement prey resources and enhance growth of recreational fishes.
Suppress detrimental fishes	Physical removal by managers (e.g., netting, electrofishing) or anglers (e.g., with liberal harvest regulations, bounties, contests); targets may or may not be recreational fish species
Selective removal	Reduce biomass of overabundant cohorts of recreational fish to reduce inter- and intraspecific competition
Renovation/reclamation	Chemical piscicides to remove all fish from a water body when undesirable species cannot be removed by other means
Manage aquatic plants	Physical removal, biological control (e.g., grass carp, milfoil weevil), herbicides; often directed at invasive species; introduce beneficial plants, e.g. kelp.

Table 5.6. Major types of stocking programs (Cowx 1998, Bell et al. 2008) used in recreational fishery management. The first three types involve stocking cultured fish on top of a natural (indigenous) population of the same species.

Type	Definition/objectives	Duration	Origin of stocking material
1.Restoration	Release of cultured fish to restore a population after a limiting factor has been ameliorated	Temporary	Indigenous
2.Mitigation	Release of cultured fish to compensate for reductions in wild stock caused by unresolved environmental inadequacy (includes maintenance)	Permanent	Indigenous
3.Enhancement	Release of cultured fish to augment a population's natural supply of recruits	Temporary, permanent	Indigenous
4. Introduction	Release of non-native fish to create a new, self-sustaining fishery	Temporary	Nonindigenous
5.Put-take	Release of cultured juveniles for immediate catch or catch at a larger size (includes sea ranching, put-grow-take)	Permanent	Indigenous, nonindigenous
6.Trophic	Release of predators or prey to manipulate food web for the benefit of recreational fish stocks	Temporary, permanent	Indigenous, nonindigenous

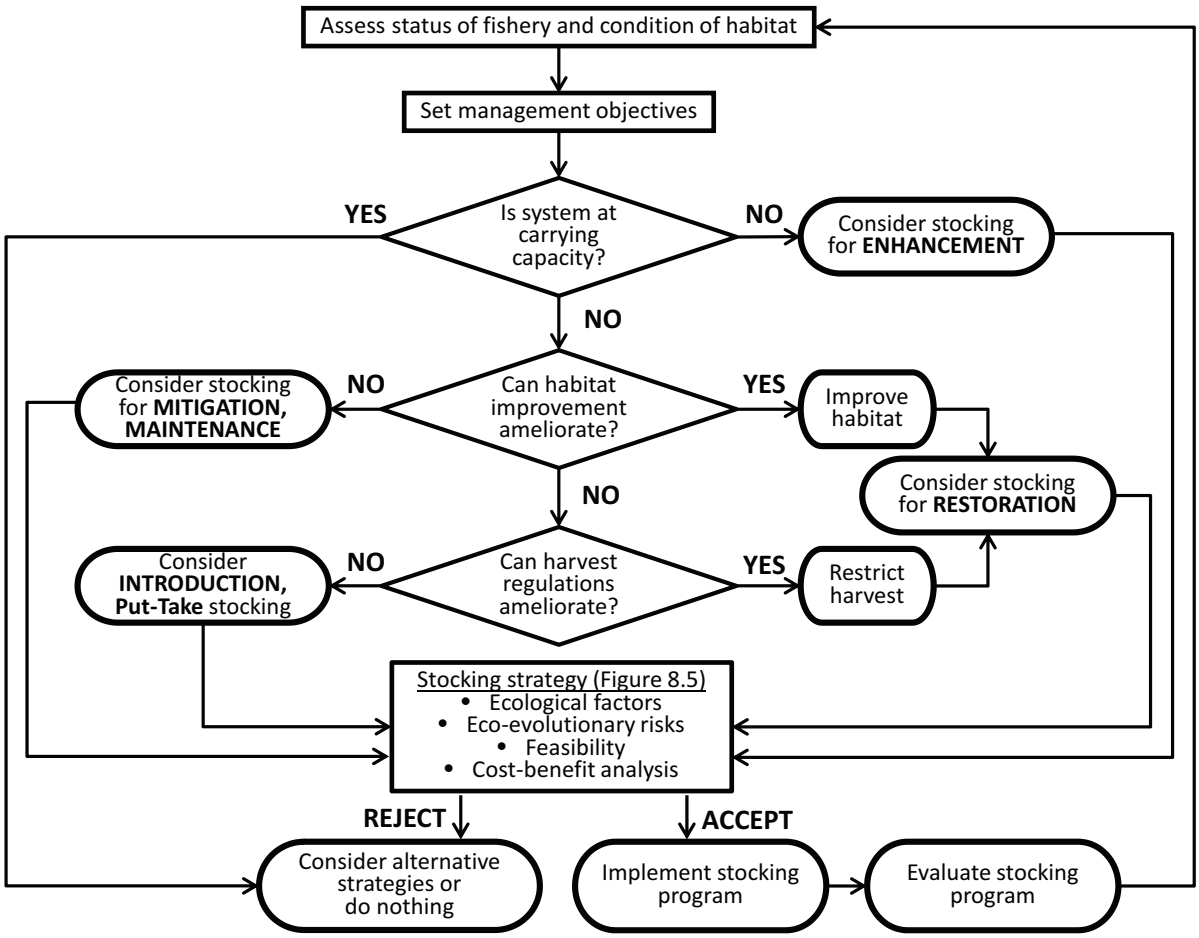

Figure 5.4. Decision tree for selecting an appropriate stocking strategy (modified from Cowx 1994). See Figure 5.5 for procedures for planning and implementing a stocking program.

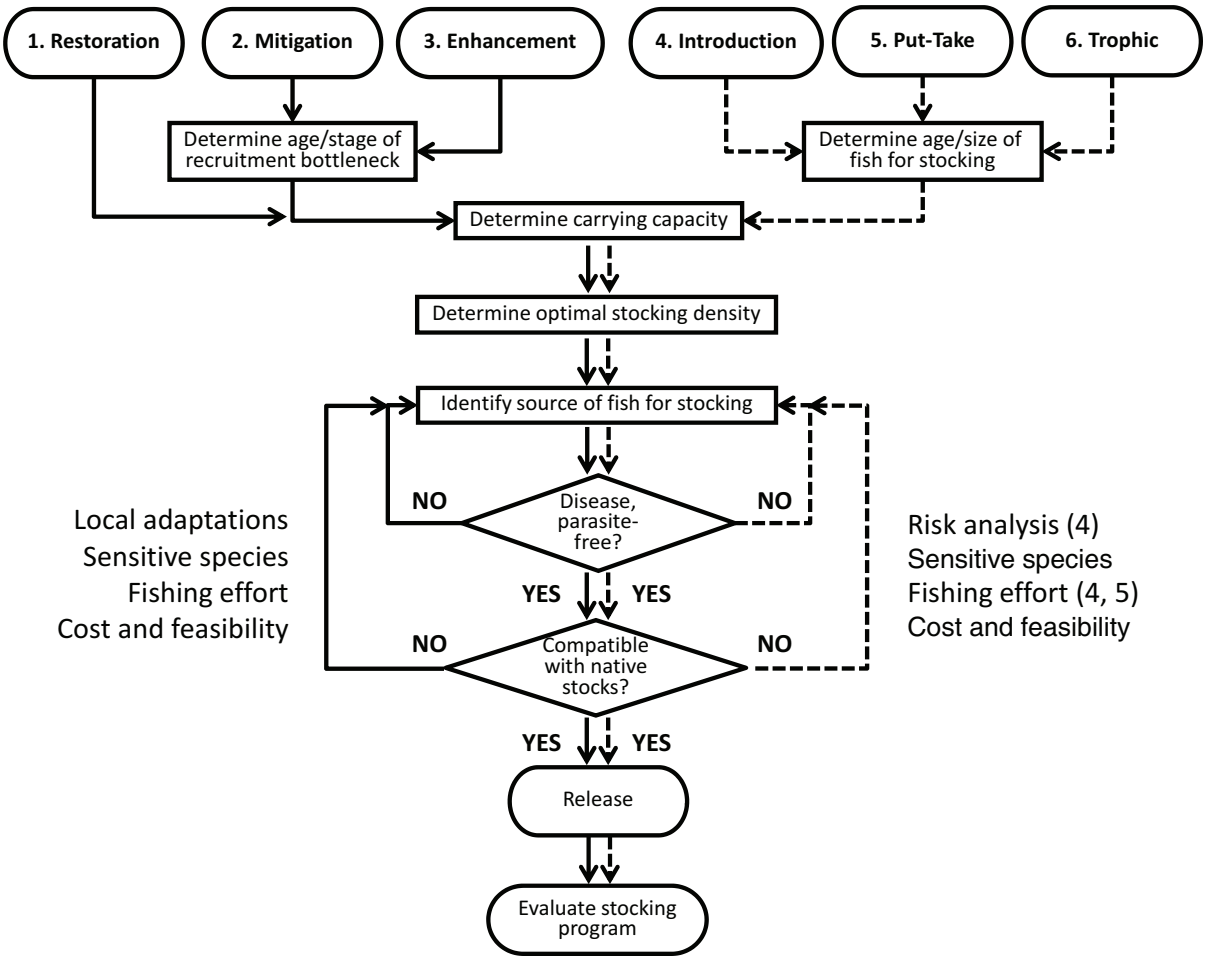

Figure 5.5. Procedures for planning and implementing a stocking program once objectives (1-6) have been identified. Solid arrows represent considerations relevant to stocking cultured fish on top of a natural population of the same species (restoration, mitigation, or enhancement). Dashed arrows represent considerations for stocking that may involve non-native species (after risk analysis) and does not involve rehabilitation of a native fish population, per se. The manager should anticipate angler response to stocking and its potential collateral effects on native fish populations.

Managers considering a stocking program should first evaluate whether stocking would be an effective remedy for fishery ills (Figure 5.4), and then decide if stocking is feasible and appropriate on eco-evolutionary and fiscal grounds (Figure 5.5). It must be recognized that stocking does not alleviate biological limits on the productivity of the ecosystem. Habitat improvement or appropriate harvest regulations could be more cost-effective and less risky to ecological integrity of the system than stocking. When these approaches fail, stocking may be a suitable alternative for improving the fishery. For any stocking program to be successful it is essential that the manager:

1. understands the status of the fishery and the condition of the habitat,
2. has clear management objectives,
3. selects a stocking strategy appropriate to the objectives,
4. considers ecological factors controlling survival of stocked fish,
5. evaluates eco-evolutionary risks to resident species,
6. anticipates angler response to stocking and its potential collateral effects on native fish populations,
7. predicts the benefit-cost ratio and feasibility of the program, and
8. evaluates outcomes of the stocking program.

Historically, items 3-5 and 8 have proven most neglected and problematic. Stocking unquestionably supports substantial recreational fishing opportunity worldwide. However, the practice is commonly seen as a panacea for a multitude of fishery inadequacies, often is unsuccessful, and it can be ecologically harmful. Further, fish culture technology is advancing rapidly, providing the means to produce enormous numbers of fish for stocking. Understanding and preventing the deleterious effects of stocking on fisheries and ecosystems is becoming increasingly important.

Stocking hatchery reared fish is often viewed as an efficient means of restoring extirpated populations. A common management response to large-scale environmental damage that impairs or prevents recruitment of wild populations is to build hatcheries (e.g., 2010 Gulf of Mexico oil spill). When the stocking objective is restoration, managers should very carefully consider the genetic implications of using cultured fish as founders of populations. Even when cultured progeny of wild broodstock are used the genetic composition and fitness of hatchery-reared juveniles can be quite different than that of wild juveniles. Managers should insure that best practices (FAO 2008b) are adhered to when hatchery reared fish are produced for restoration stocking.

Stocking to supplement a wild population (enhancement or mitigation) has some particular risks and challenges. When natural reproduction is present but deemed inadequate stocking may be harmful to the wild population. For example, large scale hatchery supplementation of Pacific salmon on the west coast of North America attracted fishing effort that increased exploitation rate on natural stocks and compromised local adaptations (Hilborn 1992). Stocked fish may compete with wild fish reducing growth and size structure of the population as a whole, diminishing the benefits of stocking. The cumulative effect of stocked and wild fish could also be harmful to sensitive species in the ecosystem (e.g., excessive predation). Similarly, managers stocking piscivorous recreational fish to reduce abundance of undesirable prey species should consider collateral predation on desirable recreational species or sensitive species.

Practically speaking, stocked fish could be constrained by the same life history bottleneck that may be limiting the wild population. Unless this aspect of the ecosystem is understood and the stocked fish are raised to a size that is beyond this bottleneck the manager should not expect stocking to be effective. Raising hatchery fish to a size that is large enough to survive after stocking can be very expensive (Johnson and Martinez 2000). Maintaining a population entirely with stocking (maintenance, put-take) should be viewed as a long-term commitment because anglers will expect such a fishery to be perpetuated. Likewise, when stocking to manipulate food webs, benefits may be transitory unless stocking is continued.

Introducing non-native fishes or prey has a long history in recreational fishery management but these practices are now widely recognized as environmentally risky and have been discontinued by most management agencies in North America (Rahel 2004). Many fishery managers today are devoting considerable time and resources to the removal, containment and suppression of non-native fishes stocked to create new recreational fisheries (Johnson et al. 2009). Thus, managers contemplating the introduction of a non-native species should consider the option carefully. Managers should adhere to professional codes of practice (AFS 1986; Turner 1989; Bartley 2005; ICES 2005) because effects of fish introductions can be catastrophic (Eby et al. 2006) and eradication of established non-natives may be unfeasible (Vander Zanden et al. 2010).

Many managers experience pressure from anglers to introduce species. When this stocking strategy is found to be inadvisable, the manager must educate anglers about the need for environmental sustainability of management practices, and provide more sustainable options with existing species whenever possible. Given the ease with which non-native fish may be introduced without management approval or oversight, and the potential for permanent, unmitigable harm to recreational fisheries and ecosystems, deterring unauthorized stocking should be a management priority (Johnson et al. 2009).

Managers should evaluate success of stocking programs. Surprisingly, given the pervasiveness and costs of the tool, there is a paucity of studies carefully evaluating the outcomes of stocking projects. At a minimum, managers should know if stocking objectives are being achieved and therefore, whether continued stocking is justified. A critical need for such evaluations is the ability to distinguish stocked fish from wild ones. Managers may believe that stocking is enhancing a fishery but in cases where wild fish are present this is not an obvious conclusion. Fortunately, there are a variety of methods to distinguish hatchery and wild fish. Fin-clipping, tagging, chemical marking, stable isotope ratios, and genetic analysis all can be used to identify hatchery fish.

Guidelines – stocking

i. *Stocking is not a panacea, often is unsuccessful, and can be ecologically harmful.*

ii. *Managers considering a stocking program should first evaluate whether stocking would be an effective remedy for fishery ills and then decide if stocking is feasible and appropriate on eco-evolutionary and fiscal grounds.*

iii. *Habitat improvement or appropriate harvest regulations could be more cost-effective and less risky to ecological integrity of the system than stocking.*

iv. *For any stocking program to be successful it is essential that the manager:*

- *understand the status of the fishery and the condition of the habitat,*
- *have clear management objectives,*
- *select a stocking strategy appropriate to the objectives,*
- *consider ecological factors controlling survival of stocked fish,*
- *evaluate eco-evolutionary risks to resident species,*
- *anticipate angler response to stocking and its potential collateral effects on native fish populations, and*
- *predict the benefit-cost ratio and feasibility of the program, and*
- *evaluate outcomes of the stocking program.*

v. *The manager should minimize inadvertent impacts to fitness by adhering to best practices when hatchery reared fish are produced for restoration or enhancement stocking.*

vi. *The manager should be cognizant of trophic considerations that affect success and acceptability of stocking: predation on recruits, increased consumptive demand, competition for food, depletion of prey, and effects on sensitive species.*

vii. *Managers contemplating the introduction of a non-native species should consider the option carefully and adhere to professional codes of practice (AFS 1986; Turner 1989; Bartley 2005; ICES 2005) because effects of fish introductions can be catastrophic (Eby et al. 2006) and eradication of established non-natives may be unfeasible (Vander Zanden et al. 2010).*

viii. *When introducing a non-native is inadvisable, the manager must educate anglers about the need for environmental sustainability of management practices, and provide more sustainable options.*

ix. *Given the ease with which non-native fish may be introduced without management approval and the potential for permanent, unmitigable harm, deterring unauthorized stocking should be a management priority.*

x. *Managers should evaluate success of stocking programs, with respect to achievement of management objectives, cost-effectiveness, and undesirable consequences.*

Harvest regulations. A plethora of techniques are used to manage anglers and the fish-angler interaction (Table 5.7). Regulations are often categorized as either input controls (regulating the amount and manner of fishing) or output controls (regulating the fate of the catch). While effort restrictions (e.g., limited entry) are relatively rare in recreational fisheries as compared to commercial fisheries, recreational fishery managers can use a variety of indirect methods of manipulating the intensity of fishing. For example, requiring licenses and fees may prevent some from participating and gear restrictions are frequently used to reduce the efficiency of anglers without controlling the amount of fishing effort. While the provision of user conveniences such as boat landings and fish cleaning stations may please anglers the manager should anticipate impacts from the resulting increase in angler use of the fishery.

Bag and size limits have several purposes but generally they are used to limit fishing mortality. Bag limits are the most common output control in recreational fisheries (Isermann and Paukert 2010). These rules affect the per capita (angler) harvest rate, but because access to many recreational fisheries is unlimited, not the total harvest from the fishery. In many cases, unless bag limits are very restrictive they will not reduce harvest mortality because few anglers actually catch the daily limit, but in aggregate their harvest can remain excessive. In these situations effort controls may be more effective for reducing fishing mortality and bag limits would then allow more anglers to participate. Effort can be controlled by limiting license sales and harvest quotas can be implemented with season-long bag limits (e.g., punch cards or harvest tags).Catch and release rules can increase angler use without depleting the fish population but the manager should assess hooking mortality and may need to restrict tackle or fishing methods to maximize survival of released fish.

Size limits are another common form of output control, dictating sizes of fish that may be harvested and those that must be released (Table 5.8). By carefully tailoring size restrictions to match fish population characteristics and level of angling effort, the manager can use angling as a means to manipulate fish population structure. Growth and productivity can be enhanced by targeting fishing mortality on overabundant size-classes and recruitment can be improved by protecting age- and size-classes with the most successful progeny (Arlinghaus et al. 2010). Alternatively, inappropriate size limits, e.g., based on stakeholder desires without regard to fish population demographics and ecosystem characteristics can be counterproductive (Johnson and Martinez 1995).

Many anglers are unclear about the conditions under which various harvest regulations would be applicable and effective. Operating under the implicit assumption that anglers would like more fish and larger fish, the particular regulation(s) that can best achieve these goals is constrained by the characteristics of the fishery. That is, the level of size-specific fishing mortality interacts with the natural mortality, growth rate and recruitment rate of the fished population to determine an effective regulatory regime (Figure 5.6, Table 5.8, Table 5.9).

When fishing mortality rate is low limiting it further will not be beneficial. Protective size limits that defer harvest will have little benefit if growth is low and natural mortality is high: few fish will survive to reach the harvestable size. When growth is slow, size limits may be useful for reducing density-dependent growth depression by channeling harvest onto overabundant size classes. In general, the manager can expect size and bag limits to have the greatest impact on the number of large fish when fishing pressure is high, fish grow quickly and experience low natural mortality. Thus, when regulations defer harvest to a larger size the abundance of fish in that size class will be higher than if natural mortality and growth were less favourable. When natural mortality and growth favour deferred harvest strategies, the recruitment dynamics of the stock can dictate the particular size regulation to apply. For instance, when recruitment is high a closed slot limit would be appropriate but if recruitment is low and driven by maternal effects then an open slot limit or total catch-and-release might be called for to protect the most influential spawners.

Application of harvest regulations provides the means to improve the fishery for anglers but it is also an opportunity to learn about the system and improve management in the future. In some cases regulations may not produce the desired effects or are detrimental to the fishery due to effects of environmental perturbations, compensatory responses in fish populations or changing behaviour of anglers. Therefore, it is important for managers to follow up regulation changes with evaluation, including methods such as stock assessment, creel surveys, and ecosystem surveillance (Figure 5.2).

Guidelines – harvest regulations

i. *Effective use of harvest regulations allows the manager to use angling as a tool to manipulate fish population structure, increasing its productivity and desirability to anglers.*

ii. *Size and bag limits can improve recreational fisheries but only when consistent with the fish population's demography, angler desires and level of exploitation.*

iii. *The recreational fishery manager should acquire the necessary biological and fishery information before appropriate harvest regulations can be identified:*

    a. *Fishing mortality rate (or exploitation rate or fishing effort)*

    b. *Natural mortality rate (catch curve, maximum age, von Bertalanffy approaches)*

    c. *Size specific growth rate (hard parts, tagging, size-frequency methods)*

    d. *Recruitment (catch curve, population age structure, CPE of juveniles)*

    e. *Angler desires and willingness to harvest fish of various sizes*

iv. *Managers should follow up regulation changes with evaluation, including methods such as stock assessment, creel surveys, and ecosystem surveillance.*

Table 5.7. Management actions and regulations targeting recreational anglers and fish-angler interactions. In general, input controls regulate the amount and manner of fishing and output controls regulate the fate of the catch.

Control type	**Explanation**
Input	
Licensing, fees	Fees based on duration of license, species, angler residency, angler status (e.g., youth, aged, military, student, native)
Gear restrictions	Hook and line, hook type, artificial vs. bait
Method restrictions	Motor trolling; attractants: ground baiting, artificial light, scents
Closed seasons	Spawning period, aggregations, stressful environmental conditions
Closed areas	Spawning areas, aggregations, refuges, marine protected areas
Fishing contests	Minimize conflicts with other users; employ to encourage harvest of overabundant or undesirable species
User conveniences	Provision of boat landings, fishing piers, fish cleaning stations may attract anglers
Effort restrictions	Limited entry, number of rods/lures/lines
Output	
Length limits	Limit size of fish retained (Minimum, maximum, “slot” limits, “one over X” limits)
Bag limits	Limit number of fish retained; daily and in possession
Sale of fish	Prohibit commercialization of recreational fish species
Harvest restrictions	Restrict based on wild vs. hatchery, conservation status
Fish holding	Prohibit to reduce sorting, stress, translocation
Harvest mandates, bounties	Encourage harvest of overabundant or undesirable species

Table 5.8. Five commonly applied size-based (total length, TL) harvest regulations used to manage recreational fisheries, and the associated vulnerability to harvest, management objectives and demographic conditions necessary for the tool to be effective (F=fishing mortality, M=natural mortality, CPE= catch per unit effort). For example, the minimum size limit protects fish less than that threshold (TLmin) from harvest and allows larger fish (≥ TLmin) to be harvested. A common management objective for minimum size limits is to conserve young fish which are relatively rare due to low recruitment (or in stocked populations). In order for a minimum size limit to be effective it is necessary that protected fish have rapid growth and low natural mortality to allow them to recruit to the vulnerable population. The manager may also wish to set the minimum size limit above the size at maturity to allow fish to spawn prior to being vulnerable to harvest.

Size limit type	Segment of population	Vulnerability to harvest	Management objectives	Demographic conditions
Minimum	$TL < TL_{min}$	Protected	Conserve recruits	Low recruitment, rapid growth, low M
	$TL > TL_{min}$	Harvestable	Produce bigger fish for reproduction and harvest	Fish mature at size $< TL_{min}$
Maximum	$TL < TL_{max}$	Harvestable	Reduce abundance and competition	High recruitment, slow growth, moderate M
	$TL > TL_{max}$	Protected	Catch & release of trophies	No stockpiling above TL_{max}
Open slot	$TL < TL_{min}$	Protected	Protect recruits, increase CPE,	Low recruitment, high growth, low M
	$TL_{min} < TL < TL_{max}$	Harvestable	Optimize growth and mortality	Moderate F
	$TL > TL_{max}$	Protected	Protect best spawners, catch & release of trophies	Maternal effects (bigger fish better spawners)
Closed slot	$TL < TL_{min}$	Harvestable	Reduce abundance and competition	High recruitment, slow growth, high M
	$TL_{min} < TL < TL_{max}$	Protected	Protect during high growth	High growth, low M
	$TL > TL_{max}$	Harvestable	Allow harvest of big fish	Ample spawners for reproduction
Catch and release	All fish	Protected	Improve CPE and size, consumption prohibitions	High F, high contamination, sensitive stock

Table 5.9. Demographic characteristics of some commonly encountered fish population "types" and examples of appropriate harvest regulations associated with each.

Fish population "types"	Suggested regulation and rationale
1. High recruitment, density-limited growth, density-dependent natural mortality (population exhibiting classic logistic growth)	Closed Slot. Lower limit set at size/age when density begins to decline, or when fish reach a new "growth stanza" based on prey resources or dietary ontogeny. Upper limit set at size when growth declines. Harvest overabundance small fish to "thin out", chance to harvest large fish.
2. Low but sustained recruitment, modest growth, low natural mortality, long lifespan in absence of fishing (e.g., large, remote, temperate oligotrophic lake)	Minimum Size Limit with one fish over X. Minimum set to protect first time spawners, X set to maintain size structure of larger fish for anglers and maternal effects.
3. Moderate recruitment, moderate growth, low to moderate natural mortality (e.g., "healthy" mesotrophic lakes), no evidence of maternal effects	Minimum Size Limit. Minimum set to protect first time spawners and sustain recruitment.
4. Low recruitment, moderate growth, low to moderate natural mortality. High mercury or other contaminant bioaccumulation.	Open Slot, reduced bag. Upper limit set by contaminant concentrations (usually positively correlated with size).
5. Low and spotty recruitment, low to moderate natural mortality, high growth (spawning habitat is limiting)	High Minimum Size Limits, reduced bag limits. Minimum set above size at first spawning (biological goal) or much higher ("quality" goal).
6. Low recruitment, poor growth, high natural mortality (e.g., environmental problem or unsuitable waters)	No size or bag limits; no stocking. Habitat improvement if demography tied to degraded habitat.

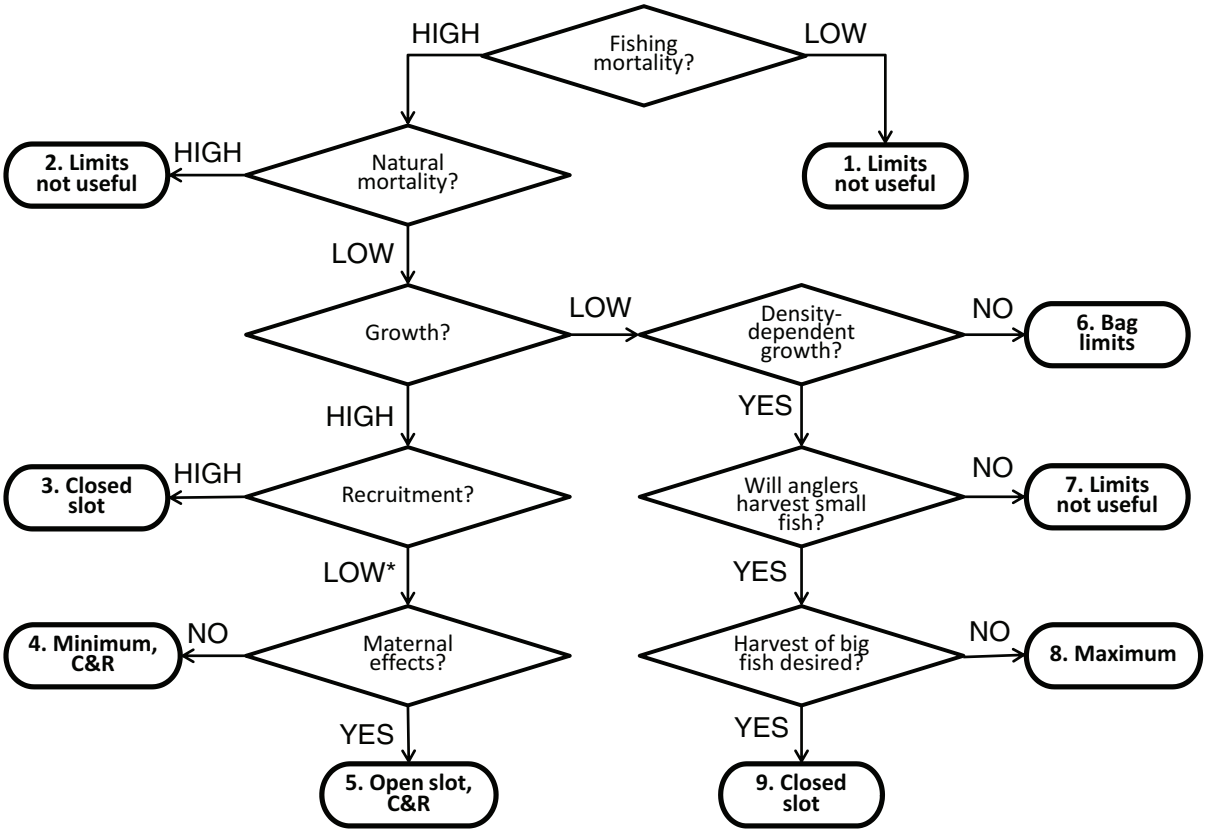

Figure 5.6. Decision tree for selecting appropriate size and bag limits based on the intensity of fishing, target fish population's demographic characteristics and angler desires. When fishing mortality is low (1), harvest restrictions would not provide any benefit. If natural mortality is high (2) then deferring harvest will not result in more large fish. The manager can expect size and bag limits to have the greatest impact on the number of large fish when fishing pressure is high, fish grow quickly and experience low natural mortality (3, 4, 5). When growth is slow, size limits may be useful for reducing density-dependent growth depression by channeling harvest onto overabundant size classes (8, 9).

RECREATIONAL FISHING PRACTICES

The behaviour of individual recreational fishers (hereafter called anglers for simplicity) plays a pivotal role in the impacts fishing induces on habitats, fish stocks or individual. This section about recreational fishing practices is thus about angler behaviour and how those behaviours or choices have the potential to influence the environment. In some cases these decisions are voluntary and it is up to the angler to decide whether he or she will act in a certain way to minimize impacts on habitats or individual fish. In other cases, there are policies or laws that exist but the angler still has to decide the extent to which they comply with such regulations. There can be a number of potential negative consequences of recreational fishing including direct impacts on fish populations and both aquatic and terrestrial ecosystems. However, by following a number of rather simple guidelines related to recreational fishing as outlined below, the potential negative consequences of recreational fishing can be minimized or even eliminated. Material is presented as the issue, scientific basis and context for generation of recommendations and then the guidelines themselves. All the guidelines are related to individual behaviour by the fisher or angler, to be implemented into practice via official regulation and promoted by voluntary behaviour, which may be stimulated by guidance, outreach and sometimes education from NGOs, recreational fishing clubs and associations or fisheries management bodies and agencies.

Safety

The safety of the angling community, other stakeholders and their property is of tantamount importance and to that end, many jurisdictions have developed a suite of regulations deemed to protect recreational anglers. Although not specific to recreational fishing, most of these regulations and safety issues pertain to boat safety. Regulations can dictate the need for certain pieces of safety gear including signaling devices, paddles, anchor, buoyant heaving lines, first aid kit, fire extinguisher, and life jackets. There is also a growing trend towards the licensing of pleasure craft operators. Being that recreational fishing occurs outside, there is also potential for exposure to harmful ultraviolet radiation. Commercial fishing is regarded as one of the most dangerous occupations in the world and there is a large body of literature detailing with aspects of occupational health and safety (e.g., Jin et al. 2001). A similar body of literature does not exist for recreational fishing, possibly due to its leisure time focus that reduces governmental and industry-based safety regulations.

Each year hundreds if not thousands of recreational fishers die while participating in recreational fishing, with almost all deaths directly attributable to drowning. Following regulations or best practices for boat safety and working on or around water have the potential to reduce safety concerns. The single biggest factor that could minimize deaths associated with recreational fishing is use of life jackets. Other recreational anglers will be injured by recreational fishing gear (e.g., hooks in eyes). Wearing sun glasses can help to shield the eyes from hook injuries. Similarly, having a well-stocked first aid kit as well as a pair of side cutters sharp enough to cut through a hook can be useful for addressing hooks embedded in other body parts. Learning how to handle fish that are likely to encountered while fishing and ensuring that adequate gear for landing and hook removal is available can also help with angler safety while also helping to also maintain the welfare status of fish as a side-product (see below). Wearing clothes and a hat to cover up from the sun and/or use of sunscreen is also necessary to reduce risk of skin cancer. Finally, in some regions choice of appropriate clothing is critical to either stay warm (e.g., ice fishing) or to minimize exposure to biting insects. Consumption of angled fish can also be a safety concern in some locations. For example, biotoxins such as ciguatera exist in some coastal marine regions in recreationally-harvested species which can cause gastro-intestinal and neurological issues (Ting and Brown 2001). Other toxic substances associated heavy metals, PCBs, etc. can enter the aquatic food chain so fish consumption advisories exist in some regions (Fiore et al. 1989). Research has revealed that many anglers are unaware of fish consumption advisories or tend to ignore them which is a significant concern (Ramos and Crain 2001), in particular in urban fisheries. In developing countries such advisories do not exist which does not mean that angled fish are safe to eat, but simply that there is no research or monitoring.

Guidelines – Safety

I. *Each recreational angler should be aware of, and comply with, local and national safety rules, health advisories and regulations and where such directives do not exist, consider voluntary actions that will increase safety of all participants*

II. *Governments and NGOs should develop safety guidelines and material to educate recreational anglers about safety practices related to this activity including safe consumption*

Sale and Trade of Fish

A tenet of recreational fishing by definition is that fisheries protein is generally not sold or otherwise traded on domestic, export or black markets. Doing so bridges the divide between commercial, subsistence and recreational fishing. In many jurisdictions it is illegal to do so as fish that is sold following capture in commercial fisheries is subject to a variety of inspections and rules intended to protect consumer health or fisheries-management including stock assessment. Similar protections usually do not exist for fish that are captured by recreational anglers and then sold or traded. There is no scientific basis per se related to the sale and trade of recreational fish other than if allowed it could lead to the "industrialization" of recreational fishing and thus lead to overharvest. Clearly, for legal reasons in many countries there is prohibition to trade fish for recreational fishers so as to avoid competition with those that make a living out of fishing.

Guidelines – Sale and Trade of Fish

I. *Selling or otherwise trading fish or other aquatic products harvested during the pursuit of recreational fishing is not recommended, unless explicitly allowed in a given country and as long as this does not interfere with interests of commercial or subsistence fisheries.*

II. *It is recommended to develop indicators systems to distinguish fish captured from the recreational sector and commercial sector for means of evaluating and ensuring compliance with regulations.*

Use of Harvested Aquatic Animals, Particularly Fish

When fishing, anglers have the potential to either release or harvest the fish that they capture. Although there is certainly a strong emphasis on catch-and-release among a large segment of the more specialized and avid recreational fishing community (Arlinghaus et al. 2007), most anglers practice selective harvest where they evaluate their catch and based on a variety of factors (e.g., fish size, species, food value, amount of food at home, conservation concerns, management regulations) decide whether they will release or harvest an individual fish. Cultural and legal norms vary widely such that in some regions voluntary release rates are very low (e.g., Germany where voluntary release of legal-sized fish is not widely tolerated) while in other regions release rates are quite high and many approach 100% of captured fish in some specialized fisheries (Arlinghaus and Cooke 2009). Anglers, like commercial fishers, do have the potential to overharvest fish and lead to population declines (Post et al. 2002). As such, independent of whether harvest regulations exist, it is only sensible that anglers harvest only as many fish are immediately needed. This is particularly sensible in a practice conducted during leisure time that supplements households diets with fish protein but is not essential for survival. Likewise for ethical reaons, when a fish is harvested, it should be used effficienty and not wasted, and similarly one should do everything possible to minimize by-catch mortality (e.g. hooking mortality) for ethical reasons (Coggins et al. 1997). Some jurisdictions have "flesh cannot be wasted" regulations such that if a fish is harvested it must be used and not wasted. Fish that are to be kept should be handled and stored in such a way that preserves the quality of the flesh. When fish are cleaned it should be done at a proper fish cleaning station and entrails or whole dead fish should not be left in the environment due to potential for unpleasant odours, disease and attraction of potentially problematic wildlife. Many jurisdictions require that dead fish or their parts are disposed of via burial away from water sources.

Guidelines – Use of Harvested Aquatic Animals

I. *Each recreational fisher should not take more fish or other aquatic organisms than immediately needed to supplement diets of the person's household.*

II. *Each recreational fish should only keep fish or other aquatic organisms that will be eaten within the family or within the network of relatives and friends; other fish should be released alive in agreement with national and regional legislation, needs and local customs, while maximizing the opportunity for survival.*

III. *Each recreational fish should preserve the quality of fish that are removed for consumption such as by putting them on ice, immediate removing and disposing of the entrails, quick storage in freezers or early consumption; dead fish should not be left in the environment.*

Tackle and Fishing Techniques

Recreational fishers have a large array of fishing gear and techniques to choose from. Indeed, although most people think of rod-and-reel as the primary tool of recreational fishers, others use a spear, rifle or gill-net (Arlinghaus and Cooke 2009). Whatever gear and method is used, it is important to ensure that it is consistent with various regulatory requirements and also minimizes welfare impacts on individual fish (see for more details below).

Guidelines – tackle

I. *Each recreational fish should always use fishing tackle and methods that comply with national regulations or where regulations fail to exist, use no more than can be tended and observed simultaneously by the fisher.*

II. *Fishing gear should not be left unattended with the exception of techniques that are designed to be fished passively without continuous oversight (e.g. gill netting, traps).*

Litter and Pollution

Similar to commercial fisheries, the recreational sector can be responsible for the generation of litter and pollution. Litter from bait containers, tackle packaging, etc. does not directly affect fish, but is generally not compatible with natural environments. Areas frequented by anglers can have more litter compared to low-intensity angling sites (O'Toole et al. 2009). Anthropogenic debris along shorelines and in adjacent water bodies can have a negative impact on the environment (Cryer et al. 1987; Radomski et al. 2006). Loss of fishing gear (e.g., line, lures, hooks, lead weights) along shorelines can affect both the substrate in which it is deposited as well as the wildlife present in the area (Forbes 1986; Cryer et al. 1987; Lewin et al. 2006; Radomski et al. 2006). Although rarely quantified, fishing line and hooks can become entangled in a variety of wildlife species including birds, marine mammals, and turtles (e.g., Nemoz et al. 2004). When line is ingested or when animals become entangled, it can result in injury or mortality (e.g., Franson et al. 2003). Cryer et al. (1987) estimated that up to 13.7 m of fishing line was lost per angler, and Forbes (1986) found that the average length of line discarded around a small, coarse fishery lake to be 56 cm. Although most research on the effects of lost fishing gear have occurred in freshwater systems, fishing hooks and line can also result in damage to sensitive sessile marine invertebrates (i.e., coral habitats). In the Florida Keys National Marine Sanctuary, lost hook-and-line fishing gear accounted for 87% of all fishing debris encountered and was responsible for 84% of impacts (i.e., tissue abrasion, partial individual mortality, colony mortality) to sponges and benthic cnidarians (Chiappone et al. 2005). In Asia, coral colonies entangled with fishing line were consistently in poorer condition, had higher rates of mortality, and larger proportions of dead or damaged coral (Yoshikawa and Asoh 2004). Similar recreational fishing impacts were reported for cauliflower coral (Pocillopora meandrina) by Asoh et al. (2004).

Lead deposition can also pose a hazard to wildlife, especially to birds that ingest small stones and grit in order to aid digestion, although the effects tend to be quite localized (Scheuhammer et al. 2003). Lost lead fishing tackle is not readily released into aquatic and terrestrial systems under most environmental conditions, although some environmental conditions lead can weather and be mobilized from such artifacts, yielding free dissolved lead, precipitates, and chemical species that complex with inorganic and organic matter (reviewed in Rattner et al. 2008). Lead has a very slow dissolution rate and a high stability in sediment leading to ingestion by waterfowl, which subsequently suffer the effects of lead poisoning (Cryer et al. 1987; Scheuhammer et al. 2003). Jacks et al. (2001) estimated that in Swedish Atlantic salmon fisheries, up to 200 t of lead fishing sinkers are lost in river mouths. In littoral regions of the waters of South Wales, United Kingdom, between 24 to 190 sinkers/m² were found (Cryer et al. 1987a). Lead poisoning in birds may result in lethal and sublethal effects including decreases in body weight, reproductive stress, and anemia (Scheuhammer and Norris 1995; Kendall et al. 1996). Educational efforts by governments and environmental organisations have been successful in promoting the use of alternatives to lead sinkers. In the long-term, it is probably desirable to move away from lead fishing tackle although it has been suggested that this should be driven by consumer demand and the industry rather than regulatory agencies (Rattner et al. 2008).

An emerging issue is relates to the accidental loss or intentional discarding of soft plastic lures into waterbodies. Research has revealed that soft plastic lures often swell in water and can be consumed by fish. The fish are unable to digest the lures and they block the digestive tract, acting as a bezoar. There are a number of forthcoming research projects but the only published study on the topic to date reveals that the presence of the soft plastic lures leads to starvation (Danner et al. 2009).

Combustion motorboat traffic in rivers, lakes, and along the coastline results in the emission of inorganic and organic compounds (mostly hydrocarbons) into the water and into the air near the surface, which are toxic to zooplankton (Juttner et al. 1995) and fishes (Tarnlund et al. 1995). Also in marine ecosystems, the engine emissions from outboard motors can contribute to the surface microlayer, and the toxic substances on the air-water interface can significantly affect the survival and development of early life history stages of marine fishes and other surface-dwelling organisms (Hardy et al. 1987; Kocan et al. 1987). Even if it is not possible to quantify the effects of boat traffic linked exclusively to angling, Lewin et al. (2006) conclude that given a substantial level of boating activity, there could be some negative effects on the aquatic environment or fish stocks, with the effect dependent upon motor type, traveling speed, bottom structure of the ecosystem, or slope of the shoreline

Guidelines – Litter and Pollution

I. *Each recreational fisher should not litter the environment; it is best not to bring material to the water that could litter the environment and to pack all equipment, bait and food in recycling boxes.*

II. *Each recreational fish should if feasible, remove litter left by other people and leave the fishing location litter-free; always bring a container to collect litter at the fishing site.*

III. *Each recreational fisher should minimize the use of lead weights on the fishing line and use alternatives to lead where possible and when appropriate.*

IV. *The tackle industry should explore the development of biodegradeable fishing tackle and lines made from materials that do not cause potential negative consequences to human or aquatic ecosystem health.*

V. *Governments should work collaboratively with the fishing industry and provide incentives to develop environmentally-benign fishing gears.*

VI. *Governments or bodies that own or manage lands used for recreational fishing (e.g., boat ramps, parking lots, harbours) should provide refuse facilities for the disposal of fishing-related litter.*

Environmental and Wildlife Disturbance

Areas that experience high fishing effort may also be subjected to considerable shoreline changes as a result of human activity, which can lead to a cascade of deleterious changes in both the terrestrial and aquatic environments. Increased boot traffic into angling access points could potentially lead to removal of vegetation (Müller et al.2003), loss of plant diversity (Ros et al. 2004), soil compaction (Andrés-Abellán et al. 2005), and erosion - factors that have rarely been studied in the context of recreational fishing (Cooke and Cowx 2006; Lewin et al. 2006) but are known in terms of hiking and camping impacts. In turn, as riparian vegetation is important in providing overhead cover and shade for fish and also in anchoring soil, riparian disturbance may lead to increased shoreline erosion as well as decreased habitat complexity (Delong and Brusven 1991; Schindler and Scheuerell 2002). Soil compaction increases bulk density and reduces soil porosity (Lei 2004), further contributing to erosional processes, surface runoff into nearby watersheds, and water quality degradation (Kozlowski 1999). O'Toole et al. (2009) found that the percentage of barren area and soil compaction were greater in areas of high angling activity compared to areas that experienced relatively low angling activity. In addition, terrestrial and aquatic macrophyte density, height and diversity were lower at high angling activity sites.

Angling, although essentially a quiet and often solitary activity, can disturb wildlife. Commonly, waterfowl, and coastal and wetland birds, many of which are now rare, are liable to disturbance if access to waters or shoreline is uncontrolled (Cryer et al. 1987b). Most damage is done at the nesting time when birds are disrupted or prevented from gaining access to their nests (Maitland 1995). There are also many mammals commonly found associated with the rivers and lakes, most of which are shy and sensitive to disturbance, e.g. otters (Lutra lutra), and prefer secure places to rear their young (Jefferies 1987). Closed seasons or protected areas, are designed to minimise these impacts, but problems still persist. Anglers wading in streams can also damage aquatic habitats. For example, Roberts and White (1992) reported that anglers wading on trout eggs and pre-emergent fry resulted in mortality as high as 96%. In addition, recreational angler activity can also affect the production of invertebrates that can serve as important food sources for fish. For example, Mueller et al. (2003) reported that dragonfly fauna were negatively affected by bank trampling caused by recreational fishing activity in a Hungarian river. This problem is exacerbated when anglers modify bankside and littoral zone vegetation to gain access to fishing sites. Smith and Murray (2005) reported that angler foot traffic combined with the collection of mussels (Mytilus californianus) for bait may reduce cover for mussels and create mussel-free gaps.

The intense, but spatially restricted, nature of recreational fisheries can result in degradation of localised habitats from increased boat traffic, particularly in near-shore and inland environments (Bellan and Bellan-Santini 2001). Sargent et al. (1995) documented that over 6% of seagrass beds in Florida exhibited damage caused by propellers, representing some 70,000 ha. Although both commercial and recreational fishery boats can scar seagrass, 95% of boats registered in Florida are recreational (not that all engage in recreational fishing) and it is those boats that typically operate in shallow, near-shore environments. Noise from recreational fishing vessels can also disturb fish. In the Adriatic Sea, noise from the passage of outboard boat engines resulted in behavioural alterations in gobies (Gobidae; Costantini and Spoto 2002). In small inland waterways or near-shore areas vessels can also generate waves that erode shorelines, suspend sediment, and may disturb fish, especially where movements are excessive and uncontrolled (Pygott et al. 1990; Mosisch and Arthington 1998). This leads to collapse of banks, loss of riparian vegetation, and on a more subtle level, change of littoral water temperatures that directly affects juvenile growth and recruitment (Hodgson and Eaton 2000).

Guidelines – Disturbance of Environment and Wildlife

I. Each recreational fish should avoid damage to riparian vegetation caused by accessing the fishing location, construction of fishing sites, piers, removal of woody debris, trampling or felling of firewood.

II. *Each recreational fish should avoid disturbance or possible disturbance to wildlife and waterfowl, in particular avoid fishing near nesting birds and avoid using hook bait that might be ingested by waterfowl.*

III. *Each recreational fisher should minimize boat travel, speed, noise and boat wash when these may disturb and potentially damage fish, riparian vegetation, sea grass beds, waterfowl and other water users.*

IV. *Each recreational fisher should anchor boats only in areas that are not environmentally sensitive.*

V. *Each recreational fisher should avoid wading in streams, lakes and coastal habitats during fish and other aquatic wildlife's reproductive periods.*

VI. *Government agencies and NGOs should educate recreational anglers about the sources of disturbance to the environment and wildlife including the provision of best practices to avoid or minimize negative consequences.*

Environmental Monitoring and Reporting

Most natural resource agencies lack sufficient staff to be able to provide the level of monitoring and surveillance needed to identify "real time" problems with aquatic ecosystems. Given the number of anglers or other recreational fishers, they serve as an important group of front line observers when it comes to documenting fish kills, instances of pollution, and presence of non-native species. Indeed, this is regarded as one of the benefits of recreational fishing. Of course, anglers must not only observe but also report relevant observations to relevant authorities in a timely manner. As key resource stakeholders, anglers are well positioned to do so and have the potential to benefit from participation in environmental monitoring and reporting.

Guidelines – Reporting of Environmental Observations

I. *Each recreational fisher should immediately report pollution incidences, distressed or dead fish, the presence of unusual species, non-native species and other environmental impacts/observations to the relevant authorities.*

II. *Government agencies and other entities responsible for aquatic environments should provide clear mechanisms by which anglers are able to. report environmental problems or infractions*

Baiting and collection and transfer of live bait organisms

Use of organic baits in recreational fishing has the potential to generate a number of environmental problems ranging from the intentional deposition of various organic materials in the water to attract fish to the harvest of various vertebrates and invertebrates that are used for bait as well as the potential consequences of those animals being introduced into a new environment. In some recreational fisheries, ground-baiting (with cereals, maggots or other bait) or chumming, the process of distributing bait in water to attract fish, is common in both freshwater and marine environments. When used excessively, it can lead to a deterioration in water quality (Cryer and Edwards 1987), increased phosphorus loading (Edwards and Fouracre 1983; Niesar et al. 2004), and substantial reduction in benthic fauna (Cryer and Edwards 1987). Comparatively, there is much more known about groundbaiting in freshwater systems than chumming in marine systems.

Collection of bait for use by recreational fishing can also cause problems and as the absolute number of anglers worldwide increases, so will the demand for live bait. Some studies on marine coastal habitats have shown that bait digging can influence the littoral fauna (Beukema 1995; Beukema et al. 2002)

as well as the abundance and size structure of harvested benthic organisms (e.g., Cryer et al. 1987b; Keough et al. 1993; Roy et al. 2003). Some of the harvested bait species play an important role in structuring the bottom communities that there can be systems level consequences (e.g., Wynberg and Branch 1997; Shepherd and Boates, 1999). The bait digging or pumping and the associated trampling can involve a considerable disturbance to the sediment and affect taxa that are sensitive to disturbance of the sediment (Brown and Wilson 1997; Wynberg and Branch 1997; Skilleter et al. 2005). Litvak and Mandrak (1993) provided a comprehensive review of the baitfish industry in Canada and the United States which was conservatively estimated to be worth US $1 billion annually. The authors identified a number of problems experienced by the systems where baitfish harvest occurred. In Ontario, they revealed that 15 baitfish species were listed as vulnerable or threatened.

A significant concern associated with use of live bait is the potential for introduction of non-native species. A survey of the characteristics of the bait industry in 1992 in six north-central US state revealed that all retail dealers purchased bait, and 16% reported harvesting some bait (Meroneka et al. 1997). Most bait came from within the state of sale but 15% of retail dealers and 34% of wholesale dealers reported purchasing bait outside the state. In another study (Ludwig and Leitch 1996), a survey of bait vendors, bait samples from retail locations, vendor interviews, a creel survey, and a literature review, were used to estimate the potential for anglers in North Dakota and Minnesota to contribute to the dispersal of nonindigenous fish from the Mississippi River basin into the Hudson Bay basin. They estimated the probability of a single angler on a single angling day in the Hudson Bay basin releasing live bait from the Mississippi River basin to be 1.2/100. The authors suggest that drastic policy measures would have to be undertaken to reduce anglers' potential for contributing to the dispersal of aquatic species. Litvak and Mandrak (1993) examined bait dealer tanks in Ontario and found that 18 of the 28 fish species found in the tanks were potentially used outside their known ranges. Freshwater crayfish are also believed to be introduced by anglers. In a 2008 survey of U.S. and Canadian fisheries agencies, 49% of respondents reported aquatic resource problems that were believed to have been caused by bait-bucket introductions of alien crayfishes (DiStefano et al. 2009). Visits to bait shops revealed sales of illegal and invasive alien crayfishes by bait shop proprietors who could not identify the species they were selling. Non-native earthworm populations are often found near lakes, and it has been suggested that anglers discarding unwanted bait are a vector for the establishment of new populations. Based on a survey of the bait trade and anglers (i.e., Keller et al. 2007), it was determined that all bait stores surveyed sold known invasive species and 44% of anglers who purchase bait dispose of unwanted bait on land or in trash thus suggesting that the bait trade and disposal of worms by anglers is a major source of earthworm introductions (Keller et al. 2007). Font and Lloret (2011) studied recreational shore fishing along the coast of the marine reserve of Cap de Creus (NW Mediterranean) and determined that 43% of the baits used by the shore anglers were live, non-native species (mostly polychaetes), emphasizing the increasing environmental risks arising from the use of exotic marine baits, which constitute a potential and unregulated vector of introduction of non-native species in the Mediterranean.

In recognition of the problems identified above, particularly with respect to bait bucket transfers, regulatory agencies, particularly in North America, have enacted regulations to better limit the season and quantity of baitfish harvest, to limit species that can be harvested, to minimize inter-state and inter-watershed transport, and to require that anglers do not release bait alive. These regulatory actions have been coupled with outreach and education activities that have targeted bait harvesters, dealers and anglers to maximize compliance.

Guidelines – Baiting and Collection of Bait

I. *Each recreational fisher should moderate the amount of chum and groundbait introduced to water bodies and do not use potentially toxic chemicals (e.g. preservatives, colouring agents) in ground bait and hook bait.*

II. *Each recreational fisher should use bait, particularly live bait, only in agreement with local or*

national regulation, and use aquatic organisms only in the water body from which these were collected; never transfer aquatic live bait from one water body to another.

III. *Each fisher as well as the bait harvest industry should when collecting bait adopt environmentally friendly practices to minimise disturbance to habitats and the environment (e.g. backfill holes on the foreshore that are dug in the process of bait collection).*

IV. *Bait harvesters or growers, dealers and where bait regulations exist, governments should ensure that species being sold are legal and appropriate for use in a given area.*

V. *Governments and NGOs should develop outreach and education materials related to sustainable bait harvest and use for anglers and the bait industry,*

Illegal release and transfer of fish

Related to the what has been discussed above about the transfer of non-teleost organisms via bait used by anglers, the angler-induced introduction or transfer of alien species or non-native genotypes and associated pathogens has the potential to fundamentally alter the structure and function of fish populations, and potentially entire aquatic ecosystems (reviewed in Cowx, 1994, 1999; Lewin et al. 2008; Johnson et al. 2009; Gozlan et al. 2010). While the issue of management-decided introductions have been covered in Chapter 5, the issue extends to each individual recreational fisher that transfers baits or fish among water bodies in the process of fishing, as bait or intentionally, yet illegally to establish populations of desired species. This can have devastating impacts on local fish communities, e.g., the establishment of European wels catfish (Silurus glanis) in Spain was driven by an illegal introduction by laypeople (likely anglers) to establish this fish to be exploited recreationally. Many more examples exist world-wide (Cambray 2003). Although agency-authorized stocking of sport and forage fishes is a common reason for fish introductions, unauthorized (and thus illegal) introductions by individual fishers are now a major reason for the spread of nonnative fishes (Cambray 2003; Rahel 2005). Other introductions occur indirectly through angler activities, for example, the introduction of non-native invertebrates as bait, such as worms to terrestrial ecosystems (Hendrix et al., 2008) as mentioned above, aquatic zooplankton through attachment to fishing lines (Jacobs and MacIssac 2007) or fishes when released from bait buckets.

Guideline – Illegal transfer of fish by recreational fishers

I. *Individual recreational fisher shall never not stock, introduce or transfer live fish or other aquatic organisms within or between catchments without permission from the authorities. This applies particularly to non-native organisms or genotypes.*

II. *Incidences of illegal transfer of fish should be immediately report to the relevant authorities.*

III. *Governments should establish rigorous and very visible penalties (e.g.,100 000 US $) to combat illegal transfer of non-native fish or non-native genotypes by recreational fishers.*

IV. *Governments should work together, develop outreach materials and popularize successful condemnations of illegal stocking across countries and regions. A zero tolerance policy is advisable given the ecological impacts that may be associate with the successful establishment of one just one fish species illegally introduced by recreational fishers.*

Fish welfare in relation to capture, retention, kill and catch-and-release

A contentious issue within contemporary recreational fisheries in some countries is the well-being (or welfare) of individual fish and how this welfare might be compromised in the process of recreational fishing (Huntingford et al. 2006; Arlinghaus et al. 2007a, 2009b). The concept of fish welfare is relevant independent of the question whether fish can suffer or feel pain in the process of being captured by anglers, as it is doubtless that a fish will experience a stress reaction to any form of capture, fight and

handling (Rose 2007). Therefore, from a fish welfare perspective any actions that minimizes or even avoid stressful situations for a fish in the process of capture, kill or catch-and-release is to be preferred (Cooke and Sneddon 2007). Obviously, for many the discomfort associated with recreational fishing would increase if one would unambiguously prove that fish are able to feel pain in a mammalian sense, however, such evidence is not existent with opposing views expressed in the literature (see Arlinghaus et al. 2009 for a summary). Here the stance is taken that from a pragmatic fish welfare perspective the question whether fish feel pain or not and if so to which degree is entirely irrelevant. Instead, good welfare practices can and should be applied to minimize stress induced by angling on fish, and it is this concept that can yield the most constructive recommendations as it is amendable to objective science and study (Arlinghaus et al. 2009).

Fish welfare perspectives always deal with the individual fish, not with impacts resulting from recreational fishing at the population level (Arlinghaus et al. 2007, 2009). By the very nature of the activity, hooking or otherwise catching a fish with recreational fishing gears causes stress and induces some injury to an individual fish that cannot be avoided – i.e., a fish cannot be hooked without inducing injury and fought/handled without some level of stress (Cooke and Sneddon 2007). Indeed, during the entire angling process from when the fish is hooked to when it is either killed or released it has the potential to experience a variety of outcomes that may range from rapid death to impacts being measurable for weeks after release and resulting in fitness depression even if the fish survives (Fig. 6.1). Judgment how strongly fishing practices, including catching and holding in keep nets or other devices, impact the welfare of individual fish is contingent on how fish welfare is defined and what a given stakeholder group tolerates. Irrespective of the definition of impaired fish welfare, appropriate (i.e. fish-friendly) behaviours of anglers is critical for all because it reflects a high moral attitude of recreational fishers towards their quarry and by aggregate, these decisions and behaviours have the potential to benefit the image of anglers, increase flesh quality (e.g., when fish are rapidly killed after capture) and maintain entire fish populations, for example when released fish survive unharmed and resume normal behaviours rapidly with no fitness impacts. Indeed, although consideration of fish welfare is somewhat abstract to some anglers and fisheries managers and may be perceived as threatening, ultimately accounting for it benefits the individual fish, fisher (flesh quality, image) and potentially the entire fish population and fishery (Cooke and Sneddon 2007).

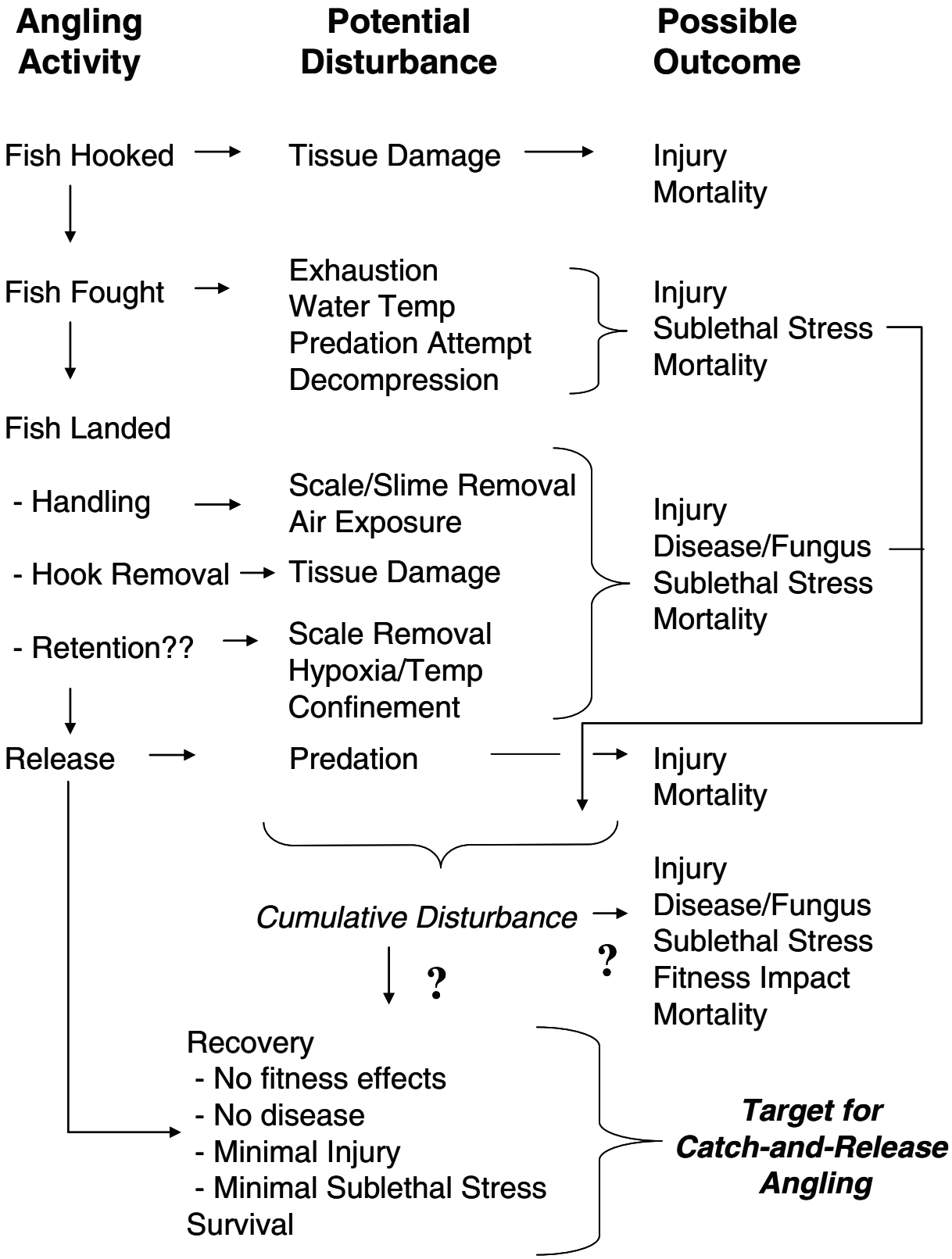

Fig. 6.1. Overview of various sources of impacts on fish in the context of catch-and-release (from Arlinghaus et al. 2007a). Welfare is not explicitly listed as an impact as all of the potential impacts can be considered to be related to fish welfare.

Defining fish welfare in a manner that is objective, useful and not threatening to recreational fisheries on moral grounds has proved elusive and has generated considerable disagreement (Arlinghaus et al. 2007a). In the EIFAC Code of Practice for Recreational Fisheries (EIFAC 2008) a feelings-based approach to fish welfare that focuses on currently unmeasurable "unpleasant mental states" of fish (Huntingford et al. 2006) was found to be unsuitable based on arguments presented in detail in Arlinghaus et al. (2007a, 2009b). As a consequence, a function-based definition of fish welfare based on objectively measurable indicators of impaired fish welfare (e.g., physiology, behaviour) is recommended preferred (Arlinghaus et al. 2007a, 2009b). Indeed, compared with feelings-based definitions of fish welfare, most function-based definitions allow a greater variety of such objective indicators to be derived (Huntingford & Kadri 2008). Thus, a function-based definition of fish welfare was found more appropriate than a feelings-based approach and is also adopted in this document. Consequently, the definition is that "good welfare means an individual fish is in good health, with its biological systems functioning properly and with no impairment of fitness" (EIFAC 2008. Against this, one can judge how recreational fishing may reduce impacts in terms of fish welfare, acknowledging that some impacts need to be accepted (e.g., hooking a fish).

A number of techniques and handling practices promote improved welfare of recreationally captured fish (Arlinghaus et al. 2007a), while other practices potentially aggravate fish welfare impairment. To address these issues and provide guidance, some detailed recommendations (i.e., best practices) for appropriate behaviour and techniques for minimising fish welfare impairments are provided below. Most anglers are interested in adopting gear choices and behaviours that facilitate survival of fish that are to be released or that maintains flesh quality in fish that are to be harvested so there is ample room to combine education with regulation. One of the inherent challenges in attempting to generate best practices for maintaining the welfare status of angled fish is the fact that there is substantial variation in how different species and even stocks respond to capture and handling.

Cooke and Suski (2005) provided an extensive overview of this challenge in the context of catch-and-release and essentially asked the question as to the extent to which we can develop generalizations that apply across a broad range of recreational fisheries. Substantial inter-specific variation in behaviour, physiology, ecology, and morphology exist within fishes (Helfman et al. 1997). Similarly, species of fish vary in terms of sensitivity to different stressors including those associated with catch-and-release angling (Muoneke and Childress 1994). Interestingly, similar levels of variation in response to catch-and-release angling are also evident among congenerics. Finally, within species, some researchers have revealed that fish respond differently to stressors (and experience differential release mortality) at different life-history stages (e.g., Brobbel et al. 1995), among stocks (Nelson et al. 1994), by fish size (within the same species; Meals and Miranda 1994; Thorstad et al. 2003) and by sex (Hanson et al. 2009). These simple examples illustrate how a guideline that is appropriate for one species will not always be appropriate for others. And indeed, what is appropriate for an individual species in one location or at a particular life-stage, may also be inappropriate for the same species at other times. The generalities that are provided in this document represent the extent to which we can rely on deriving generic information from the catch-and-release studies conducted to date and applying it to other fish and fisheries. The ultimate goal for catch-and-release research is to develop and refine general guidelines for the successful release of all fish, and then develop a suite of specific guidelines for individual species or types of catch-and-release activities (e.g., tournaments, deep water fishes). The findings below are based on the best available information and there are certainly exceptions. Those interested in this topic are directed to a number of syntheses including Muoneke and Childress (1991), Bartholomew and Bohnsack (2005), Cooke and Suski (2005), Cooke and Sneddon (2007), Cooke and Wilde (2007), and Arlinghaus et al. (2007). For the purposes of brevity, a table has been constructed that summarizes the scientific basis and context for the guidelines (Table 6.1). The below table is focused on catch-and-release as this is a standard practice in all recreational fisheries, either being a by-product of harvest regulations or due to voluntary choice. In addition, some information on holding effects is included as this practice is also common in many recreational fisheries, either in keep-net or live-wells or other devices.

Table 6.1. Factors that influence fish welfare (including stress, injury and survival) during catch-and-release recreational fishing. For the purposes of the document the factors are presented in terms of gear, practices and environment.

Factors	Brief Summary of Scientific Literature	Generalization
Gear		
- Barbed vs Barbless Hook	-There are few examples in the literature where barbless hooks reduce mortality (reviewed in Schill and Scarpella 1997; Cooke and Wilde 2008) -Use of barbless hooks has been shown to reduce the amount of time required for the angler to remove the hook by increasing the ease of removal (Diggles and Ernst, 1997; Schaeffer and Hoffman, 2002; Cooke et al. 2001; Meka, 2004) - Use of barbless hooks reduces tissue damage at the point of hook entry (e.g., Cooke et al. 2001; Meka 2004) -Barbless hooks required in some jurisdictions	Barbless hooks reduce injury and the time required to remove a hook so are therefore preferable to barbed hooks
-J Hook vs Circle Hook	-For J hooks the point is parallel to the shank whereas for circle hooks the point is typically at least at a 45% angle to the shank (Fig. 6.2) -A review of circle hooks revealed that mortality rates are on average 50% less when circle hooks are used (Cooke and Suski 2004) -Circle hooks favour shallow hooking and relatively few instances of deep hooking (Cooke and Suski 2004) -Anglers may have to modify their behaviour when using circle hooks given that they do not tend to work well with a hook set -In general circle hooks tend to perform best when organic baits are fished passively (Cooke and Suski 2004) -Small differences in circle hook configuration (e.g., degree of off-set) can obfuscate the benefits of circle hooks (Prince et al. 2002)	When fishing passively with organic baits, circle hooks are favourable because of the reduced instances of deep hooking

-Single vs Treble Hook	- Muoneke and Childress (1994) reported that single hooks tend to be more deeply ingested than treble hooks -If treble hooks become deeply hooked, they almost certainly result in massive injury or mortality (Muoneke and Childress 1994) - In a meta-analysis of salmonids, Taylor and White (1992) failed to demonstrate a difference in mortality between these two hook types -There are a number of jurisdictions that restrict the use of treble hooks	-Does not appear to be an important factor aside from the fact that one hook point theoretically should be easier to remove and result in less injury
-Hook Size	-Among conventional hook types, the relationship between hook size, fish size, and hook performance has varied widely among studies (Muoneke and Childress, 1994) -Taylor and White (1992) conducted a meta-analysis on factors associated with hooking mortality in non-anadromous salmonids and concluded that hook size did not influence mortality rate -There are relatively few examples of regulations that require the recreational sector to use a specific hook size	-Not an important factor in most cases
-Bait/Lure Type	-Artificial lures or flies are highly regarded for superficially hooking fish, with minimal opportunity for damage to vital organs or tissue (Muoneke and Childress 1994) -Organic baits including live bait, (but excluding artificial flies), are typically ingested deeper than artificial lures- resulting in more time required to remove hooks and a greater potential for mortality (Siewert and Cave 1990; Cooke et al. 2001) -Studies of flies versus lures and baits have been consistent in that flies tend to be less injurious and have a lower chance of causing mortality (Schisler et al. 1996; Meka 2004)	-Lures and flies tend to be less superficial and have less likelihood of deep hooking
Practices		
-Fighting Time	- There is a general consensus among the current body of catch-and-release research that the duration of an actual angling event experienced by a fish correlates positively with the magnitude of physiological disturbance (Gustaveson et al. 1991; Kieffer et al. 1995; Gallman et al. 1999; reviewed in Cooke and Suski 2005) - Beyond the magnitude of disturbance, the time needed for recovery can also be prolonged with longer angling durations (Schreer et al. 2001) - Larger individuals within a species may require longer periods of time to land (Thorstad et al. 2003) - Meka (2004) determined that experienced anglers took longer to land fish than novices because they tended to capture larger individuals and thus factors such as fish size and angler experience can affect the duration of angling and subsequent physiological responses (Meka and McCormick 2005) -These effects appear to be pronounced when combined with multiple stressors such as high water temperatures	-Based on this evidence, it is recommended that anglers should attempt to land fish as rapidly as possible to minimize the duration of exercise and the concomitant physiological disturbances

-Landing Methods	-Use of landing nets can cause scale loss and other injuries but this seems to depend on the species and this issue has been poorly studied -In general, more abrasive net materials tend to cause more damage than softer knotless or rubber materials (e.g., Barthel et al. 2003) -Anything that reduces slime loss or injury to the fish is useful such as using wet hands -Lip gripping devices work well on some species but on others they can cause severe injury (Danylchuk et al. 2009)	-When landing fish it is preferable to minimize dermal injury by using wet hands and if a net is required, it should be made of a fish-friendly material
-Air Exposure	-Among all species of fishes examined with respect to C&R thus far, exposure to air is harmful (reviewed in Cooke and Suski 2005) - In recreational fisheries, air exposure occurs after capture when anglers remove hooks, weigh and measure fish, and/or hold fish for photographs. -During exposure to air, gill lamellae collapse leading to adhesion of the gill filaments (Boutilier 1990) which cause several major physiological changes. -Fish exposed to air typically experience greater acid/base disturbance than those fish that were exercised but not exposed to air (Ferguson and Tufts 1992) -Extended exposure to air eventually results in permanent tissue damage beyond some timing threshold -Mortality rates can also be increased by exposing fish to air (Ferguson and Tufts 1992) -Based on these studies, it appears that air exposure, especially in fish that have experienced physiological disturbances associated with angling, can be extremely harmful	-Although different fish species will vary in their sensitivity to air exposure, it is recommended that whenever possible, anglers attempt to eliminate air exposure by handling fish that are to be released in the water -When fish must be exposed to air, we urge that anglers do everything possible to minimize the air exposure duration.
-Hook Removal	-Fish hooked deep in the esophagus or stomach have an increased chance of mortality (as discussed above) -Consequently, there has been some discussion as to whether it is better to remove, or leave in place, hooks in deeply-hooked fish -There is a growing body of literature that suggests that survival rates are higher for deeply hooked fish when the line is cut and the hook left in place than when the hook is removed (e.g., Diggles and Ernst 1997; Hulbert and Engstrom-Heg 1980; Jordan and Woodward 1994) -There are still negative consequences of leaving hooks in place (Borucinska et al. 2001, 2001) so the optimal strategy is to avoid deep hooking in the first place (see discussion on circle hooks)	-Anglers should use their judgement but when the hook is deep it is typically best to cut the line
-Retention	-Catch-and-release angling sometimes involves the retention of fish for a period of time (usually hours) prior to release as anglers assess whether they will harvest individuals or in competitive events when fish are retained for later enumeration at a weigh-in -Professional anglers often hold fish in aerated live-wells, whereas recreational anglers commonly use more affordable, readily available and convenient methods, including stringers, fish baskets and keep nets -Studies suggest that retention is stressful to fish, but if provided with adequate water quality, mortality and sublethal disturbances are minimized (reviewed in Cooke and Wilde 2008) -Artificially cooling water or super-saturating holding environments with oxygen is counter-productive (Suski et al. 2006) -Some forms of retention including wire fish baskets and stringers cause severe injuries and should not be used (Cooke and Hogle 2000) -Nylon keepnets seem to cause little injury and fish tend to recover during retention	-If fish are to be retained it should be for as short a period as possible and should be in ample water that is similar to ambient conditions -Retention gear should not be abrasive

Environment		
-Water temperature	-In species for which data exists across a gradient of water temperatures, angling at extreme water temperatures (especially high) is correlated with increased physiological disturbances and the probability of mortality (reviewed in Cooke and Suski 2005) -Underlying the mortality of fish at high temperatures are limitations in maximal cardiovascular performance as fish approach their maximal metabolic rate (Anderson et al. 1998) and extreme biochemical alterations (Wilkie et al. 1996) -Catch-and-release angling at extremely cold water temperatures has also been suggested as potentially challenging to fish but there is little research on this topic -Because water temperature exerts important control over almost all physiological processes in fish (Fry 1971), extreme water temperatures are undoubtedly one of the periods where fish are particularly susceptible to mortality	-Caution should be exercised when angling for fish during extreme temperature conditions -Where possible other stressors (e.g., air exposure, fight duration) should be minimized
-Depth and Barotrauma	-When brought to the surface rapidly, the gasses in swimbladders of physoclistous fish rapidly expand to the point that the fish are unable to achieve neutral buoyancy, maintain equilibrium, and may even have their stomachs protruding from their mouths or anus (because of the expanded swimbladder pushing out the viscera; Burns and Restrepo 2002) -Fish may also experience embolisms and blood-gas disturbances (Morrissey et al. 2005) -Different species respond to capture at depth differently and each also has their own threshold regarding which depths are problematic -One obvious, but draconian, option for anglers to avoid these problems is to not fish in deep waters -An alternative solution can involve anglers venting the swimbladder with a needle to release the gas and enable the fish to swim back to depth (Keniry et al. 1996; Collins et al. 1999; Kerr 2001, Burns and Restrepo 2002), however, some research has revealed that venting does not reduce mortality (St John and Moran 2001)	-When fish are observed to be exhibiting barotraumas it is prudent to relocate to shallower habitats -There are a number of tools available to anglers to recompress fish with barotraumas
-Predators	-The habitat where fish are released influences exposure to predators and can result in mortality during the fight and after release (e.g., Cooke and Philipp 2004) -Attempts to release fish closer to cover failed to reduce mortality in one study (Danylchuk et al. 2007) -Fish that lose equilibrium have been shown to be more likely to be attacked by predators post-release (Danylchuk et al. 2007)	-If predators are abundant it may be prudent to relocate to other locations

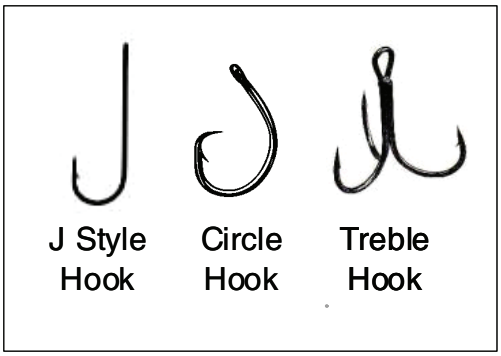

Fig. 6.2. Overview on general hook types in recreational fisheries

In many situations the fish is not released but harvested. Clearly, the welfare of fish is better off if the fight time is kept minimal and the fish is rapidly killed after capture, if possible prior to dehooking. Davie and Kopf (2006) summarized the most important aspects related to killing fish rapidly, which is legal norm in some countries such as Germany. In particular, it is recommended to rapidly anaesthetize a fish that is to be retained, e.g., by a sharp blow on the head (percussive stunning), and then bleed out the fish. Such rapid kill will also reduce the stress level of the fish and increase flesh quality (reviewed in Arlinghaus et al. 2009). In fact, the ability to take individual care of each captured fish in recreational fishing, also in the process of rapid kill, provides a major difference to commercial fisheries (e.g., relative to fish dying slowly due to hypoxia after trawling or in gill nets) and allows recreational fisheries to minimize greatly the amount of harm induced on a fish to the absolute minimum. It is therefore recommended to educate all anglers and work towards behaviours that make people engage in rapid kill procedures rather than letting fish flop around on the floor (or in boxes or plastic bags) until the suffocate slowly.

Guidelines – Fish Welfare-Oriented Recreational Fishing Practices

I. *Each participant in recreational fishing and the recreational fishing sector as a whole should recognize that their behaviours and gear choices have the potential to influence the outcome of a fishing event and the extent to which welfare will be compromised thus they should adopt behaviours/gears that are most likely to yield positive outcomes for fish.*

II. *Each participant should use tackle and gear that is appropriate for the size and type of fish or other aquatic organism that is targeted. In recreational angling, chose tackle and gear in a way that:*

    a. *minimizes landing duration where possible, recognizing that landing a fish prematurely can also lead to fish injury,*

    b. *minimizes air exposure,*

    c. *minimizes injury,*

    d. *avoids hooking outside the mouth region if technically possible,*

    e. *allows safe landing, while avoiding deep-hooking whenever possible;*

III. *after landing a fish, restrain it gently but firmly to control it during unhooking; kill the fish that is to be taken immediately after landing, by an appropriate method such as a sharp blow to the cranium and then exsanguinations (bleeding-out)*

IV. *if fish are to be held alive after capture, use devices that provide sufficient space and water quality and keep the fish for the shortest time possible. Suitable devices include keepnets, livewells and similar fish-retention equipment; stringers or very small metal cages should not be used.*

V. *develop and promote practices that cause the least physical, physiological and behavioural impact on fish if they are to be assessed (e.g. weighed) and released after capture, as in some recreational fishing competitions and tournaments. If the fish are to be brought to a central weighing station, reducing weigh-in stress by minimizing air exposure and crowding/compromised water quality at the weigh-in facility. Afterwards, release the fish as close as possible to the original capture site. Encourage use of alternative fishing success criteria that do not depend on bringing live fish to a central weighing station*

VI. *release fish and other aquatic organisms after capture in the best condition possible and only if legal according to national and regional legislation. Specifically, in recreational angling this entails:*

   a. *obtaining, reading and observing regionally-available best practice catch-and-release guidelines;*

   b. *using appropriate landing devices to avoid mucus loss and damage to the skin and other fish organs;*

   c. *carrying and using appropriate unhooking devices such as pliers, forceps, side cutters;*

   d. *assessing the size of fish and taking photos while keeping it under water, if possible;*

   e. *avoiding extended periods of air exposure, preferably unhooking the fish in the water and touching fish only with wet hands;*

   f. *avoiding touching the fish's gills and eyes while unhooking;*

   g. *never squeezing a fish or using unnecessary force while unhooking;*

   h. *releasing deeply-hooked fish by cutting the line and only if survival is likely;*

   i. *not releasing fish that show signs of impaired function or severe injury;*

   j. *using validated and legal techniques to increase chances of survival when fish show signs of barotraumas;*

   k. *avoiding fishing when the intention is to catch-and-release fish in situations that are known to substantially reduce the chances of post-release survival (e.g., for some species, a particularly high/low water temperature);*

   l. *avoiding catching-and-releasing fish during their reproductive period;*

   m. *reviving fish before release by moving water over the fish's gills if necessary;*

   n. *releasing fish as quickly as possible by placing them gently into the water*

INFORMATION, KNOWLEDGE SHARING AND RESEARCH

Information, knowledge sharing and research are essential elements of fisheries management independent of fishing sector. Particularly relevant here is the idea of education and capacity building within the recreational fishing community and among recreational fisheries managers to be prepared to solve past and future sustainability issues as outlined through these guidelines. This is particularly important given the many community-based management systems that exist world-wide in recreational fisheries, where limited expert assistance by trained personnel exists (e.g., central Europe, Arlinghaus 2006). Moving such systems towards sustainability depend on aquatic stewardship by stakeholders and solid networks of knowledge, which in turn is affected by proper information sharing within networks of fishing clubs and recreational fisheries, and among agencies and fishing bodies locally and regionally. In this section,

we first discuss information and knowledge sharing and then identify specific research needs and priorities for recreational fisheries.

Information and Knowledge Sharing

Information must be exchanged and shared among various actors within and external to the recreational fishing sector in order to reduce conflict, promote sustainable fishing practices and obtain the information needed to adequately assess the state of fisheries and implement strategies intended to maintain or rehabilitate them. Indeed, many of the problems facing fisheries are multisectoral and problem-solving necessitates formal and informal alliances and coalitions. Moreover, it is becoming increasingly important for resource managers to involve most, if not all, stakeholders in discussions about management policies, as a way to solicit constituency support and facilitate rule compliance and to effectively conserve and manage the resource base (Krueger and Decker 1999; Plummer and Fitzgibbon 2004). Unlike in many fields of scientific endeavor, stakeholder and traditional knowledge (STK) are essential sources of information and regarded as relevant for both recreational fisheries research and management (Fraser et al. 2006). Nonetheless, there are still challenges with respect to how to balance different forms of information. In particular, fisheries managers face complex situations in which policy may be viewed and accepted differently by multiple stakeholder groups, such as anglers, commercial fishers, fisheries researchers, and the local community itself. Each group can have contrasting attitudes and opinions regarding the accepted future use and development of aquatic resources. The resulting disconnects among the stakeholder groups can lead to inappropriate implementation of management activities (Miranda and Frese 1991) and lack of compliance with policy (and in some cases deceit; Sullivan 2002) and can come across as weaknesses within the sector, leaving it vulnerable to attack from outside groups (e.g., the animal right movement, Arlinghaus et al. 2007). Conversely, information sharing and communication within and among stakeholder groups has the potential to further understanding and alleviate conflict. To effectively incorporate stakeholder information it is essential to understand the biases associated with different information sources and its reliability. Sound management should always be based on the best available information, and if possible, scientific methods should be used to generate this knowledge, which can then be supplemented and complemented by STK and local experiences.

At the international level, the FAO Technical Guidelines on Information and Knowledge Sharing (FAO 2009) aim to foster a better understanding of the issues involved in all types of fisheries to ensure that stakeholders obtain the essential information that they need. That strategy is based on six key components of information exchange that are highly relevant to the recreational fisheries sector and focus on the most salient information needs:

- sustainability of a fishery
- best scientific evidence on current topics
- participation and cooperation
- objectivity and transparency
- timeliness and
- flexibility.

The present guidelines provide ones means to achieve this for recreational fisheries, but more local and regional advice is needed, e.g., on species of interest in a given locality.

Important more specific information activities associated with the FAO strategy are not specific to the recreational sector but are equally relevant here and include:

- *capacity-building in developing countries;* Recreational fisheries occur around the globe and there is a need for capacity building in developing countries to enable fisheries managers to ensure sustainable recreational fisheries and the interaction of subsistence and a growing recreational

fishing sector. Moreover, as developing countries become more industrialized it is expected that recreational fishing activity will increase (Arlinghaus et al. 2002), further emphasizing the need for capacity within the management community. NGOs, government agencies in developed countries and international bodies (e.g., FAO) all have the potential to play a role in developing capacity for recreational fisheries assessment and management in the developing world.

- *development of long-term stable and peer-reviewed arrangements for the provision and exchange of information within and among countries;* There are currently very few formal mechanisms for the global dissemination and exchange of recreational fisheries information. Most information sharing from government and the scientific community at present is based on the scientific literature and is largely restricted to developed countries. Angling-related NGOs have the potential to play an important role in establishing mechanisms for the exchange of information. The World Recreational Fisheries Conference is an example of an international venue for knowledge sharing although the content is decidedly directed towards those that deal with research and management as opposed to all stakeholders. The angling media also is a powerful mechanism and they already operate Online, television and print sources, some of which are particularly good at generating dialogue between the anglers and the scientific and management community.

- *sustaining data collection and global information systems;* As with any data collection and information system, it is essential that mechanisms and safeguards exist to ensure that data are available and archived for use. The FAO has the potential to serve as a repository for statistical information but currently there is minimal inclusion of recreational fishing data in FAO statistical databases. The FAO solicits such information from member countries on an annual basis but not all countries collect such information. Therefore, there is a pertinent information need within countries to invest into routine data collection systems for recreational fisheries (Beard et al. 2011). In addition, there is simply not a culture or history of considering recreational fisheries data as important as commercial fishing data. There is a need for greater emphasis on both the collection of recreational fisheries data and its sharing with bodies such as the FAO. In the short-term, the most prudent approach would be for the FAO to emphasize the need for data on recreational fisheries while the FAO and other bodies explore strategies for collecting reliable data on recreational fisheries that can be achieved in developing and developed countries (see Beard et al. 2011).

- *expanding the scope of information on status and trends of regional or national fisheries,* including the need to incorporate ecosystem considerations into fisheries management; Clearly there is ample room for increasing the monitoring and reporting on the status and trends in recreational fisheries. Also needed are success stories illustrating how ecosystem management can be operationalized when most harvest regulations tend to focus on single species.

- *greater participation in working groups in assessing the status and trends of fisheries and greater international visibility of recreational fisheries;* Working group models are used to address recreational fishing issues and have the potential to play a strong role in that they have the potential to involve multiple stakeholders. The IUCN has recently used a working group model to explore the status of several key recreational species (i.e., bonefish and tarpon) and in some jurisdictions (particularly North America), regional fisheries management councils exist that are able to seek stakeholder perspectives on management priorities and strategies related to the recreational sector. In Ontario (Canada), over 20 such councils (called Fisheries Management Zone Councils) are operated by the provincial natural resource agency and include 12 to 15 members of the community including fishing guides, anglers, tourist operators, baitfishers, commercial fishers and academics. The councils provide advice and input to the government on management priorities and strategies. Although only initiated in 2007, the councils have already successfully addressed a number of controversial issues related to recreational fisheries. Similar multi-stakeholder advisory groups certainly exist elsewhere (although not at that scale) but where they do not exist, their implementation would be a useful means of engaging anglers in fisheries management. Also, FAO

has started to increase recreational fisheries involvement in global workshops, e.g., the December 2010 workshop on implementation an ecosystem approach in inland fisheries, where commercial, subsistence and recreational fisheries were jointly tackled and discussed (see Beard et al. 2010).

Another major challenge to be overcome is the exchange and translation of knowledge into action nationally or regionally. It is well documented that transitions in angler behavior can often be facilitated through education, outreach and awareness (Arlinghaus et al. 2007). As such, effective communication is critical for regulatory agencies or NGOs to encourage behavioral change (Gray and Jordan 2010). However, in many areas of the world there is a disconnect among science, management and practioners, and this holds true for recreational fisheries as well. Moreover, the science capacity in many areas is not enough to fulfill the information needs to tackle recreational fisheries management issues, not the least, because explosive development of recreational fisheries is a relatively recent in some countries (Beard et al. 2011). However, even in this situation recreational fisheries research results or other forms of knowledge (e.g., practical experiences) should and must be shared with stakeholders using clear language and concise communication approaches that match the needs of the stakeholders. Equally relevant is knowledge sharing among agencies within countries, among countries, among fishing clubs and among anglers because each local experience can be relevant in solving pertinent issues elsewhere. The fishing media and outreach by fisheries agencies or NGOs (e.g., angler associations) play a critical role in that they have the ability to effectively disseminate information to a variety of stakeholders.

Figuring out the best way to use these existing communication sources to disseminate information to anglers remains a challenge. Some media outlets such as In-Fisherman Inc. in the U.S.A. employ editors with scientific training and also routinely solicit/co-author content from fisheries scientists and summarize findings from relevant peer reviewed sources. New forms of knowledge dissemination are needed such as forms offered through the internet and social networking sites. Angling-related websites are common and there are a variety of discussion boards, blogs and Facebook pages related to recreational fisheries and responsible fishing. The majority of such sites are operated independent of governments (either by individuals, NGOs or fishing clubs). Members of industry maintain websites but they are typically oriented towards marketing. One means for international exchange are the World Recreational Fishing Series, but they tend to tailor towards science, and country-level managers have issues with travel to overcome to attend this more formal meetings. Generally, there is way too little international exchange of knowledge in recreational fisheries, despite sometimes the same species are managed (e.g., pike are present both in North American and Europe), and the exchange is even smaller when it comes to management-science interfaces. A global communication platform on the internet to improve information on recreational fisheries would be highly advisable.

But what approaches are the best for interacting with and sharing information within the recreational fishing community? Some jurisdictions have developed angler education programmes that are institutionalized as part of the licensing process (Andrews 2007), in others, such as Germany, anglers need to take a 30-h course to even get a license (Arlinghasu 2007). However, more commonly education of anglers (e.g., regarding fish welfare-friendly angling practices) is done via outreach by government agencies, angling organizations and angling clubs (Siemer and Knuth 2001; Andrews 2007), or by worth to mouth within anglers. In some jurisdictions there is increasing interest in promoting awareness and educating anglers on different aspects of fish capture and handling rather than imposing regulations to restrict fishing access or gear. To do so requires a fundamental understanding of how best to educate anglers and knowledge of the barriers that would impede uptake of information and its resultant impact on angler practices. Here is a major research need. Recreational anglers have diverse preferences and attitudes (Arlinghaus et al. 2007), so it is not surprising that anglers also have heterogeneous communication and learning preferences and behaviors. Understanding how and where anglers (and frankly all stakeholders) acquire and use information about responsible fishing will play a central role in crafting effective conservation and management strategies for recreational fisheries.

Information and knowledge sharing among various stakeholders in fisheries is covered in detail in FAO (2009) and the COFI-approved “Strategy for improving information on status and trends of capture

fisheries". These technical guidelines were developed in response to the recognition that all too often a lack of essential information is a major constraint to implementation of responsible fisheries. Although not developed explicitly for the recreational fishing sector, the content of those documents is as similar constraints exist when implementing the present guidelines for recreational fisheries. For example, knowing how to effectively engage stakeholders and exchange information among relevant actors is needed given the fact that recreational fisheries represent coupled social-ecological systems. However, to date there has been relatively little work on evaluating the means by which recreational anglers obtain or prefer to obtain information on responsible fisheries. A survey of recreational fishers that target Pacific salmon in the lower Fraser River, Canada (Vivian Nguyen, Unpublished data), revealed that their most common source of information on responsible fishing practices was the Internet and personal interaction while at fishing sites. These did not necessarily align with their preferred information sources. Latent-class cluster analysis identified three distinct patterns of anglers current and preferred information sourcing. They found traditional (35% of sample), independent (33%), and interactive (42%) anglers, who were particularly differentiated by their preferences for obtaining information via in-person communication, regulation handbooks, media, and the Internet. Heterogeneous learning preferences imply that fishery managers need a mix of outreach approaches to effectively engage all anglers in responsible fishing practices, even when fishers are targeting the same species in a reasonably discrete geographic location. Without the essential information upon which to pursue research, make informed decisions and benefit from the lessons learned by stakeholders in similar situations, implementation of the documents such as CCRF or the present guidelines will continue to be constrained.

Guidelines - Information and Knowledge Sharing Guidelines

I. *Improve information on recreational fishing by collecting data on catch, species, type of gear, etc. and have member countries submit these data to FAO. Relatedly, the FAO should revisit minimum data standards for recreational fisheries and provide an explicit template for the provision of recreational fisheries data.*

II. *Improve ability to assign recreationally-related fish production (e.g., baitfish production, fish for stocking) to the recreational fisheries sector in global fisheries assessment and routinely include recreational fisheries assessments alongside production estimate at the global scale.*

III. *Promote awareness of various documents and guidelines including the TG for Recreational Fisheries to encourage responsible recreational fisheries through targeted information, education, and training of recreational fishers, managers, policy-makers and other stakeholders and facilitate translations.*

IV. *Increase international exchange of knowledge and the information transfer from science to management by developing international platforms for exchange of knowledge and international conferences, meeting and working groups on recreational fisheries. Some of these exist, e.g. at ICES on methods of recreational fishing surveys that involve international membership*

V. *Governments should facilitate their management staff to attend international conferences on recreational fisheries*

VI. *Publicize recreational fishing information and salient conservation and management measures and ensure that laws, regulations and policies governing their implementation are effectively disseminated and explained in layman's language;*

VII. *Ensure that local fishing communities and individual fishers are involved and are aware of policy formulation and the associated implementation, enforcement and evaluation process, while facilitating awareness and implementation of the CoP;*

VIII. *Make effort towards and invest in recruiting new recreational fishers and anglers, especially young people and children, instilling a sense of environmental stewardship with new recruits;*

IX. *Invest funds and manpower into development of education and training programs for fishers and managers to be informed about recent developments in recreational fisheries science, management and policy;*

X. *Collaborate with relevant experts in developing awareness and education programmes aimed at improving attitudes towards recreational anglers and further promoting resource stewardship within the sector;*

XI. *Objectively and routinely communicate recent advances in recreational fisheries science, management and conservation both within the sector and with external actors. In the long term, objective communication of both the economic and ecological benefits, as well as the negative impacts of recreational fisheries practices, strengthens the sector and encourages critical debate which will further benefit the fish and the environment, those that enjoy recreational fishing and dependant commercial activities.*

Research

Contemporary models of fisheries management require information from a variety of sources (e.g., STK, research, monitoring and stock assessment) to support decision making (See Chapters 3 and 5). In particular, research efforts supporting effective management of recreation fisheries requires an understanding of the features and the dynamics of targeted fish stocks and the associated social-ecological system dynamics (Arlinghaus et al. 2002). In some cases, research on recreational fisheries has adopted a multidisciplinary, interdisciplinary and transdisciplinary approach, motivated by the insight that incorporation of the social and economic sciences is needed to fully embrace the dynamics and features characterizing recreational fisheries as social-ecological systems. Quite simply, recreational fisheries research today has to extend the traditional fisheries biology research domain and explicitly integrate social and economic sciences (Ditton 2004; Arlinghaus 2005). Nonetheless, studies of basic focus that explore biological or social science phenomena in isolation are still essential building blocks for more integrated understanding. One needs a basis for rapid biological assessments about the biological sustainability of recreational fisheries (Beard et al. 2011) because it is an illusion that given the multitude of recreationally exploited stock any country will have the necessary resources to invest into stock assessment similar to effort into high profile marine fisheries such as cod *(Gadus morhua)*. Also, the research capacities in many countries is slim or only developing, partly because studies on recreational fisheries were often considered of low social priority given its leisure focus. This, of course, need to change if the sectors want to develop sustainably.

Specific research needs certainly vary regionally and through time but there are some general guiding principles and research foci that are relevant. These include general descriptive information to judge the developments of the sector, such as monitoring participation and landings, and more analytical tasks such as developing integrative fisheries models that incorporate salient social–ecological feedbacks, biological parameters of exploited stocks and angler behaviour, including social and economic objectives. In many areas of the world, a basic research need relates to better understanding human behavioural responses and objectives of those involved in recreational fisheries alongside economic cost-benefit analyses (Parkkila et al. 2010). An improved understanding of the long-term benefits and costs of stocking compared to other options is also needed (Beard et al. 2011). Generally, all recreational fisheries research should adhere to the standards of science and withstand the scrutiny of peer review as the foundation for modern dissemination of scientific knowledge. It is preferred to not do a study than to violate standards of science.

In addition to novel research, there are more classical needs that apply research methods to monitor trends and developments of fisheries. This starts with descriptive work that assists in characterizing the scope and magnitude of recreational fisheries on a global and national scale. In addition, most jurisdictions do not adequately monitor or report recreational fisheries participation, catch and harvest which impedes the ability to generate accurate fisheries statistics such as those routinely reported by FAO. A recent international workshop on the status of inland fisheries (Beard et al. 2011) generated

some research priorities that have much relevance to recreational fisheries and specifically to addressing gaps in our ability to characterize the global status of recreational fisheries. One of the priorities focused on the use of a landscape approach that estimates production using characteristics of water bodies would be an important first step towards a broad indication of potential catches from each region. There was also the suggestion that longitudinal, panel research may provide an improvement over expensive creel surveys in order to monitor catches, effort and harvest for the recreational sector.

Because recreational fisheries do not operate in isolation, it is also necessary for each jurisdiction to have fisheries organizations and agencies that monitor and assess the stocks under their jurisdiction, including effects of multiple stressors such as land use change, climate change, habitat alteration, invasive species, and over-exploitation. Indeed, managing recreational fisheries without understanding the other factors that influence population dynamics and community assemblages is problematic and could result in misguided management initiatives (Lester et al. 2003). For example, human behaviour must be linked to the fisheries dynamics in order to predict how systems will potentially react to various management interventions (Hunt et al. in press).

Another research topic relates to fish welfare, fish population consequences of exploitation and research on sustainable harvest regulations. It is essential to know the fate of fish that are angled and released as well as the evolutionary consequences of selective harvest. As discussed in the section on fishing practices, it is unreasonable to assume that catch-and-release studies can be conducted on every species so there is a need to develop generalized tools/strategies that are effective across a wide range of species/systems (Cooke and Suski 2005). There is also opportunity for collaborative research with the commercial sector given that many of the stressors and injuries arising from fishing are similar in both sectors (Cooke and Cowx 2006).

In terms to knowledge generation in academia, recreational fisheries research is, by definition, applied research, and therefore must not be conducted in isolation from the real world. There are a number of challenges inherent with applied research models where there are attempts to involve stakeholders in identifying research priorities, in executing partnership research and in transferring knowledge among members of the recreational fishing community. Engaging recreational anglers and other stakeholders in collaborative structured research (e.g., angler diary programmes, citizen science with respect to monitoring fish habitat [see Granek et al. 2008; Silvertown 2009; Danylchuk et al. 2011]) is important provided that it is collected in a standardized manner (Lester et al. 2003). Other engagement of stakeholders in research is important. For example, who is responsible for formulating research questions and are research priorities consistent among managers, anglers and researchers? Only by interaction between researchers and managers can these answers be provided. Several studies have identified that typically there are inconsistencies with respect to research priorities which reflects different perceived goals for recreational fisheries (Connelly et al. 2000; Hasler et al. 2011). Connelly et al. (2000) reported that opinions of fisheries managers and anglers were similar on a number of management-related issues, although differing attitudes among managers and anglers were found for a range of issues, including agency performance, fish consumption advisories, necessity to protect endangered fish species, and access issues. Differences in opinions and attitudes also occur among fisheries researchers and among managers within an organization's staff (Knuth et al. 1995; Connelly et al. 2000). Clearly it is important that at some level research maintains a degree of independence from stakeholders but there is no doubt that many questions need to be guided by stakeholder desires. There is therefore a need to both characterize the level of heterogeneity within and among actor groups and to evaluate different strategies for incorporating different perspectives and building consensus where possible. Understanding how to "market" different management scenarios, fishing opportunities or best practices/gear innovations could also benefit from structured research activity.

Guidelines - Research

I. *Given the data poor situation in terms of recreational fisheries there is a need for research to support policy decision making as regards the aquatic environment (e.g., economic evaluation of recreational fisheries), to reduce the risk of negative effects on recreational fisheries and to support and improve recreational fisheries management.*

II. *Recreational fisheries will need to adopt a multidisciplinary, interdisciplinary and transdisciplinary approach to problem solving. In particular, there is a need to adopt an ecosystem approach which considers stakeholders and other users of resources such as water. Research programmes should promote study designs that will succeed across research disciplines. Modern recreational fisheries research extends the traditional fisheries biology research domain and explicitly integrates the social and economic sciences.*

III. *Research programmes should work across multilevel governance systems at local, regional, national, and international levels, as well as involving various bodies with management and research responsibilities, such as universities, consulting and private sector organizations, local agencies, national institutes, and international fisheries organisations.*

IV. *Adequate resources, including research facilities and trained staff should be provided for recreational fishery research programs. These programmes should be provided financial support from public sources and from a variety of self-sustaining funding mechanisms, such as user-pay initiatives and cost-recovery mechanisms. Needed are alternative funding models to assist with supporting fisheries research, particularly in developing countries.*

V. *Capacity building is essential to ensure that fishery research programmes are effective. States and relevant international organisations that have the ability to provide capacity-building support should work towards provision of resources to developing countries' fishery research programmes, such as technical training.*

VI. *Research must use robust and accurate data collection and analysis strategies that incorporate appropriate standardized methods. Completed analyses should be published in a timely fashion and data made available subject to intellectual property and confidentiality being respected. If possible, results should be published to allow dissemination of the information internationally, but local and regional research reports are equally important for information of local end-users. Fishery research results should be shared with stakeholders using clear language and concise communication approaches that match the needs of the stakeholders.*

VII. *Recreational fisheries research should further explore the factors that influence the outcome of an angling event from the perspective of the fish. Specifically, when a fish is to be released, what gears or angler behaviours promote survival and minimize welfare impacts? Relatedly, to what extent can we generalize across species and systems or is it necessary to develop species-specific catch-and-release guidelines.*

VIII. *Recreational fisheries organizations and agencies should monitor and assess the stocks under their responsibilities, including the impact of ecosystem changes resulting from land use, urbanization, climate change, habitat alteration, and other anthropogenic sources. Successful implementation of fisheries management programmes rely on development of broad-based monitoring schemes. These should collect pertinent data on the habitat, fishery and fish stocks to assure that progress towards management goals and objectives can be documented.*

IX. *Researchers should encourage the fishers to contribute actively to the monitoring of fish populations by reporting relevant data and other observations to fisheries managers and researchers. Relatedly, it is necessary to study different approaches to various data collection methods and to fully understand the biases and limitations in angler reported data.*

X. *Recreational fisheries research should include an understanding of the social, economic, marketing, and institutional factors affecting recreational fishers and fisheries.*

XI. *Recreational fisheries research results should be used to establish management objectives, reference points, performance criteria and to formulate and update management plans. Fisheries research results should be used as the baseline for development of adaptive management approaches, and outputs of research are essential for evaluation of management effectiveness.*

XII. *Given the limited financial and human resources available, recreational fisheries research efforts may need to focus on a subset of fisheries. Where recreational and commercial fisheries co-exploit the same fish stocks collaborative research should be established.*

IMPLEMENTATION OF THESE TECHNICAL GUIDELINES

The present technical guidelines for responsible recreational fisheries is mainly targeted at policy makers, representatives of angler associations, unions and clubs, recreational fishers, the recreational fishing industry at large, local and regional fisheries managers and fisheries scientists. Because the guidelines were not developed for a specific user group the implementation strategies will vary. Moreover, given cultural, social, political, governance and economic differences around the globe, the implementation strategies will need to be congnisant of such diversity and flexible with its application. For example, many inland European fisheries are subject to private property rights whereas in North America fisheries tend to be public. Clearly, it will be easier to reach most North American fisheries agencies than the thousands of independent management bodies (usually angling clubs) in central Europ.e Transboundary fisheries issues, management structures, institutions and instruments further complicate the implementation of the technical guidelines. There is the need to translate it into various languages to improve the implementation.

To be viable, the TG for recreational fisheries must be adopted by the international community and be further developed as the new issues and conflicts arise. Failure for adoption at the international level would mean that the TG would likely only be received and implemented on a regional or local basis. In reality, the TG needs to be adopted by a variety of bodies ranging from local to international. One means to increase its impact is to use an abbreviated tool of the most salient guidelines summarized in the appendix and lablled Code of Practice for Recreational Fisheries. That provides a summary of the most important aspects.

Beyond governments, the TG would ideally be ued by regional and international angler and industry alliances such as the European Anglers Association, RecFish Australia, International Game Fish Association, and the American Sportfishing Association. This will give the TG for recreational fishing the recognition it deserves and a focal point for governments, agencies and international policy makers. It will also provide the necessary infrastructure for development and updating on a timely basis. In addition, there are certainly some activities that can take place more immediately. For example, agencies and governmental and non-governmental organizations, angling bodies, and in fact any stakeholder responsible for governance or management of local, regional or national recreational fishing, can consider voluntarily endorsing the TG and/or modifying the TG to suit local and regional needs. To overcome language barriers, various translations of the TG or its abbreviated form in the appendix should be made available. Moreover, the TG should be actively “marketed” and promoted to increase the extent and speed of uptake.

The Role of Different Bodies and Stakeholder Groups in Implementation

National States and Related State/Provincial Agencies – The primary fisheries management and regulatory agencies are a combination of national (e.g., Bahamas Division of Marine Resources, Fisheries and Oceans Canada, UK Environment Agency) or state/provincial governments (e.g., Illinois

Department of Natural Resources). These types of agencies are typically responsible for enacting policy, ensuring compliance, managing fisheries and collecting data and conducting research in support of their missions. Given that in some regions such agencies are supported largely by fishing licence sales, some agencies also expend resources on encouraging participation in recreational fisheries (e.g., take a kid fishing events, public service announcements) and in providing/enhancing fishing opportunities (e.g., put-grow-take fisheries, installation of fishing piers). In many regions, there is jurisdictional overlap between state/provincial and federal agencies. In such cases, there are typically agreements in place to specify which aspects of recreational fisheries research and management fall under their purview. In that respect, often federal agencies focus on broad legislation (e.g., habitat protection) and broad-scale research while state/provincial agencies tend to focus more on day-to-day management activities (e.g., fisheries assessment, enforcement, outreach). Federal agencies also typically become involved when it is necessary to participate in regional fishery bodies (RFB) including Regional Fisheries Management Organizations (RFMO) and other international cooperative mechanisms. The range of capacity and responsibility within agencies varies widely, particularly between developed and developing countries. Indeed, in some jurisdictions, there is little in the way of recreational fisheries management, resource monitoring or research. Many natural resource agencies employ education and communication experts that are able to develop outreach materials and deliver programming related to fisheries and natural resources. Specific examples of the role of RFBs and RFMOs in the implementation of the TG include:

- Using the TG to craft a code-of-conduct for their organization and then adopting and embracing the content
- Working to further the practices that will strengthen and sustain recreational fisheries by ensuring that their core mission is aligned with the TG
- Seeking input from a diverse range of recreational fisheries stakeholders to incorporate into decision making
- Development of outreach, education and awareness materials of various formats that can be used to disseminate information within and beyond their agency
- Recognize that they are important players in recreational fisheries management and science
- Cooperating with other organizations and entities to further the TG

Regional Fishery Bodies (RFBs) – Given that many fisheries and fisheries management issues transcend jurisdictional boundaries (either state/province or federal), regional fisheries bodies are often established. They also typically address issues in international waters although in a recreational fisheries context, those habitats are rarely accessed by recreational anglers which tend to fish close to shore. RFBs are typically comprised of government appointees from member jurisdictions. In a commercial context and where an RFMO, is established, these bodies may have the mandate to set and allocate quotas for the fish stocks under their management within the boundaries set out in their conventions. They are also responsible for enforce their quotas through control, monitoring and surveillance activities. RFBS related to recreational fishing are no different in that they work largely on the development of coordinated management policies. Some RFBs directly manage fisheries while others serve in more of an advisory capacity. The responsibilities of RFBs have been outlined in various international agreements such as FAO's Code of Conduct for Responsible Fisheries. RFBs often also engage in, fund, and/or coordinate research activities. Outreach and education activities are used by RFBs to engage other stakeholders, in particular fishers (recreational and otherwise). RFBs in marine environments are typically more focused on commercial fisheries issues and management mandates (e.g., the Northwest Atlantic Fisheries Organization, Inter-American Tropical Tuna Commission, International Commission for the Conservation of Atlantic Tuna, North Atlantic Salmon Conservation Organization, etc – see FAO Website for complete list of international RFMOs - http://www.fao.org/fishery/rfb/search/en) and given the challenges with international fisheries management, these RFMOs are quite large and common. RFBs can also be established by two countries (e.g., the Pacific Salmon Commission and the Great

Lakes Fishery Commission between Canada and the United States) or across states/provinces within a country (e.g., the Atlantic States Marine Fisheries Council in the United States). RFBs that deal with inland fisheries such as the Mekong River Fisheries Commission often have mandates that can extend to include water management. Like national states and related state/provincial governments, RFBs have the potential to play a strong role in the implementation of the TG and given the fact that many of the marine RFBs have already adopted the CCRF there is a strong likelihood that the TG for recreational fisheries could be rather easily embraced and incorporated into how they operate. Specific examples of the role of RFBs in the implementation of the TG include:

- Using the TG to craft a code-of-conduct for their organization and then adopting and embracing the content
- Working with member states/provinces/countries to further the practices that with strengthen and sustain recreational fisheries
- Seeking input from a diverse range of recreational fisheries stakeholders to incorporate into decision making
- Development of outreach, education and awareness materials of various formats that can be used to disseminate information within and beyond their organization
- Recognize that they are important players in recreational fisheries management and science and that in some cases (e.g., International Commission for the Conservation of Atlantic Tuna) the traditional focus on commercial fisheries must be revised to incorporate emerging or growing recreational fisheries
- Supporting research and management activities financially

Non-governmental Organizations – There are a broad range of non-governmental organizations involved with the recreational fisheries sectors including clubs, associations and special interest groups that act at a variety of spatial scales (e.g., a specific waterbody, region, watershed) and with diverse foci (e.g., species-specific, gear specific). The mission of these organizations vary widely and usually include several different foci including the improvement of fishing success, exchange of information on gears, fish biology or techniques, socializing, conservation and restoration, citizen science and monitoring, fundraising to support research activities, and advocacy for access to fish and fisheries management activities. Some organizations are rooted in business (i.e., industry associations that are interested in ensuring the future of fishing and fishing opportunities) while others are charitable organizations where the fish and fishing serve as a backdrop for conservation (e.g., Trout Unlimited). In Europe there are clubs that are responsible for the day-to-day management of inland fisheries. What is common across these groups is that they each have a role to play in the implementation of the TG on recreational fisheries. Specific examples of their potential role in the implementation include:

- Using the TG to craft a code-of-conduct for their organization and then adopting and embracing the content
- Industry associations can work with their members to ensure that innovations in gear and services are consistent with TG principles
- Debating within their own organizations the research needs for recreational fisheries and sharing information with other entities and stakeholders
- Development of outreach, education and awareness materials of various formats that can be used to disseminate information within and beyond their group
- Advocacy activities needed to ensure that government agencies responsible for fisheries management are aware of the TG and embrace the contents
- Recognize that they are important players in recreational fisheries management and science and

that there are opportunities for ensuring that their voice is heard and that they have the ability to contribute to formulating fisheries objectives and developing strategies to achieve them.

- Fundraising to support various initiatives including those listed above.

Individual Anglers – At the core of the recreational fishing community is "the angler" – to be more specific, probably around 400-600 million recreational fishers worldwide. Given that it is the angler is the actor that often interacts directly with the fish, they certainly have a strong role to play in the implementation of the TG. Some components of the guidelines such as those that focus on responsible fishing practices are really directed towards the angler. Nonetheless, there is immense variation in angler perspectives, motivations and expertise which is an inherent challenge with implementation. Some anglers operate very much as individuals whereas others are part of organized groups or clubs (see above). Specific examples of the potential role of anglers in the implementation include:

- Reading and embracing the TG and relevant codes-of-conduct that deal with recreational fisheries
- Adopting responsible and ethical fishing practices consistent with the TG
- Working with other anglers to form organized groups to share information, educate other anglers (and non-anglers) and to lobby, advocate and engage management bodies on topics related to recreational fishing
- Embrace and accept outreach, education and awareness materials
- Recognize that they are important players in recreational fisheries management and science and that there are opportunities for ensuring that their voice is heard and that they have the ability to contribute to formulating fisheries objectives and developing strategies to achieve them.
- Recognize that they have the ability to contribute to the generation of new knowledge and collection of fisheries data that will be essential for understanding global trends in fisheries

SPECIAL REQUIREMENTS OF DEVELOPING COUNTRIES

The decline in commercial capture fisheries with increasing industrialization and the increasing dominance of recreational exploitation constitutes a natural "life-cycle" (Smith 1986) development caused by changed market demands and economic and social forces associated with industrialization, and the rise of alternative employment opportunities. Under such situation, the only pervasive conflict that may emerge between two sectors is one related to allocation of fishing grounds and stocks among recreational fisheries and the few commercial fisheries that maintain their operations despite increasing economic hardship. Such allocation decisions are contested and very difficult even in industrialized countries and they involve multiple dimensions, including social, economic and cultural aspects. However, when looked from a pure welfare economic perspective that is interested in maximizing the welfare of societies independent of any particular sector, a fish captured by recreational fisheries in the developed world usually tend to generate more welfare than a fish traded on commercial food markets (Parkkila et al. 2010). Under such situation, the shift towards recreational fisheries would only be reinforced when decided on pure economic grounds. Parkkila et al. (2010) provide detailed methodological guidelines on how such analyses are to be done.

The situation is less clear in developing countries, where according to the life-cyle of fisheries subsistence and commercial fisheries tend to constitute the dominant fisheries forms, inter alia, to combat poverty and hunger. Because societies usually do not have the alternative employment opportunities, fisheries constitutes a safe-net and a major source of animal protein. Under these situations, the economic development is usually not high enough to facilitate significant resident recreational fisheries, and the only notable forms of recreational fisheries may involve tourist fishing as in some African countries. Under these situations, recreational fisheries usually provide additional income and also indirectly

facilitate resource conservation activities (e.g., Mike and Cowx 1986; Everard and Kataria 2011). From an ethical perspective, such development and use of selected fishing grounds or stocks in the developing countries is always to be promoted as long as the local and regional fishing communities are economically better of than prior to angling tourism and injustice and access to resources is not constrained to the poorest. In fact, FAO has clear articulation of favouring interests of subsistence and possibly commercial fisheries in developing countries over additional uses of fish stocks. For example, the CCRF (FAO 1995) acknowledges "the important contributions of artisanal and small-scale fisheries to employment, income and food security" and therefore "States should appropriately protect the rights of fishers and fishworkers, particularly those engaged in subsistence, small-scale and artisanal fisheries, to a secure and just livelihood, as well as preferential access, where appropriate, to traditional fishing grounds and resources in the waters under their national jurisdiction. Indeed a major component of ethical fisheries according to FAO (2005) is to acknowledge basic (i.e., essential) human interests related to three main categories: (i) *Welfare:* People need basic goods to survive and care for their offspring, and these are usually fish protein based in many developing countries; (ii) *Freedom:* People seek to regulate their own affairs and realize their life plans in accordance with their own or culturally defined values, and development of recreational fisheries may strongly interfere with this desire; (iii) *Justice:* People need to find ways to share social benefits and burdens and facilitate peaceful coexistence, which maybe come important when angling tourism operators are developed using investments and funds external to the developing country where the tourism is developed. Decisions-makers are thus asked to carefully value the basic interests of subsistence fisheries with more prosperous resident and non-resident recreational fisheries, and maintain access to resources and work for equal distribution of economic benefits associated with local recreational fisheries.

The economies in transition can be classified as intermediate between developing countries and the more industrialized world. It is these countries, which experience the greatest rise in recreational fisheries as subsistence fisheries transform into more leisure-type fisheries with increasing prosperity, e.g., in South America and Asia. Decision-makers need to pay careful attention that this development is sustainable, and that the errors that have happened in the more industrialized world are properly managed, e.g., establishment of recreational fisheries based on exotics. Moreover, there is a need for development of appropriate governance and policy frameworks that integrate recreational fisheries in the overall fisheries policy and carefully balances recreational, subsistence and commercial fisheries. Economic analysis maybe useful to balance allocation aspects, and it is contented that a welfare economics perspective may be supplemented by an economic impact based analysis of the "hard job effects" that development of recreational fisheries may create in a given economy in transition (Parkkila et al. 2010). It is then important to consider whether revenue will be accrued locally in the community or whether development will result in economic gains elsewhere, e.g., in the tourism sector abroad. Obviously, decisions should be taken that result in a net gain for a given region when fish resources are allocated towards recreational fisheries and taken away from subsistence and commercial fisheries. This may involve investments into infrastructure to host a significant angling tourism, and potentially changes to fishing practices may be needed so as to justify the aspirations of foreign angling tourism (e.g., large fish used on a catch-and-release basis). In this context, commercial fishers in economies in transition may develop into service providers, e.g., accommodation, guiding etc. To facilitate a potential shift, developing nations and economies in transition should pay particular attention to develop institutions and governance structures that are able to deal with the variety of recreational fisheries, both in inland and saltwater, in particular in light of the potential for co-exploitation. Because anglers may place a premium on large fish, while subsistence and commercial fisheries may be equally well off by exploiting intermediate or small size fish, differential regulations to protect certain size classes and species from commercial exploitation may be needed.

Given the lack of experience with recreational fisheries management in many developing countries creating appropriate institutions and governance might be a particularly high challenge to overcome, also in light of higher societal priorities faced by people in these countries. Solving this challenge may demand close collaboration between actors and stakeholders, potentially with involvement of expertise from countries with larger experience in managing aquatic ecosystems and recreational fisheries. This

expertise could be brought into the developing countries through capacity building of fisheries managers trained in the more developed worked to help establish and organize the organizational and institutional frameworks for managing "evolving" recreational fisheries. Development of recreational fisheries may in turn provide environmental benefits by establishment of a political force interested in habitat and fish stock protection, reduction of destructive fishing practices etc. However, the environmental risks associated with recreational fisheries development, e.g., spread of non-native fish introduced illegally, should be properly weighed, and ideally, an economic feasibility study looking at current state of recreational fisheries, growth potential, likely economic impacts and within-country sectoral effects as well as social impacts on subsistence fisheries and their alternative employment opportunities should be conducted prior to initiating action to increase recreational fisheries at the expense of other fisheries forms.

There are other particular challenges developing nations are facing to guide the development of recreational fisheries. Given the long history of combating hunger and poverty is it is easily imaginable that developing nations will experience potentially pervasive cultural and value conflicts between a growing, usually more wealthy segment of society that likes to fish for recreation, and segments of society traditionally engaged in small-scale commercial or subsistence fisheries. It is clear that combating hunger and poverty should always be a priority, and thus commercial and subsistence fishing might receive priority in any allocation decisions surrounding fish in the very poor countries where poverty and food security are dominant societal issues. However, what should drive decisions for fish stocks allocation in the long-term should be the combined societal welfare created by certain decisions in light of economic, social and environmental trade-offs. This might also favor the development of recreational fishing, particularly if this involves tourist activists that result in new revenue and job effects that are larger than the within-country welfare created by traditional uses of fisheries. For example, in some coastal areas of the U.S.A., it has been realized that the economic gains by allocating of stocks to recreational fisheries are higher than the economic benefits created by using the stocks commercially (Ihde et al. 2011). States, nations and regions should therefore properly value, using modern methods of cost-benefit analyses (Parkkrila et al. 2010), the benefits and costs of various uses of fish stocks, such that economically and socially acceptable decisions can be taken that involve recreational fisheries interest in waters with joint exploitation of stocks with other fisheries forms. However, if recreational fisheries development is uncertain, priority should generally be given to subsistence or other small-scale fisheries due to the importance of these fisheries for food security, hunger prevention and as a"safety-net" for developing nations (Berkes et al. 2001). Moreover, in such situations recreational fisheries may be jointly developed based on total catch-and-release policies so as to maintain stocks for harvest by small-scale commercial and subsistence fisheries. Possibly, these fisheries may in turn reduce harvest of particularly charismatic species that are then preferentially targeted by, for example, tourist anglers.

There are two final issues associated with promotion of angling tourisms in development nations. First, such tourism might create alternative employment opportunities and development of an important service sector that provide economic benefits for local communities and help increase welfare and income. Such development necessitates demand for travel, accommodation, bait, local touristic goods and guiding, some of which can be taken over by subsistence fisheries. Obviously, fish stocks must be reasonable healthy to offer tourist some attractive fishing opportunity. Under these situations development of angling tourism may also be highly beneficial for conservation of fish if angling tourism development demands constraints on destructive fishing methods and massive overexploitation. At the same time, however, development of angling tourism in developing nations must ensure that the economic benefits are accrued by the local and regional communities as a priority; foreign companies that may provide investment and development capital will need to see benefits as well, otherwise there will be few incentive to invest. To facilitate this development, education programs are needed to familiarize the local people with the desires and demands of foreign tourists, and this might entail a careful communication strategy to prepare local fishers to engage in alternative income generation activities that are more "service-oriented" than traditional catch, harvest and sell oriented. Not everybody will be prepared to take on this challenge and also develop the infrastructure needed to transform into a popular tourist destination. Moreover, as many tourist recreational fisheries may engage in catch-and-release fishing

(e.g., trophy fishing), one should clearly address cultural conflicts as this practice may conflict with traditional perspective of the legitimate use of fish that are captured. This again demands education and information campaign to develop sustainable angling tourism that result in net benefits for local communities and avoid cultural conflicts.

Guidelines – Developing Nations

I. *Recreational fisheries development in developing nations can only be sustainable if the appropriate institutional (including organizational) frameworks are in place to guide development and management of the sector.*

II. *Developing nations could involve expertise from the developed world in case they lack the experience specific for recreational fisheries development and management.*

III. *Where recreational fisheries exploit the same waters as commercial or subsistence fisheries in developing nations, priority should be given to combating hunger and poverty, and any resulting conflicts between the sectors should be minimized. All fisheries should be so managed that the combined exploitation is sustainable, economic benefits maximized and social impacts on the poorest fishing communities minimized.*

IV. *Where recreational fisheries in developing countries involve not only resident fishers but also tourists, the tourism sector should make sure that economic benefits are accrued specifically to the local communities, and the local communities be proactively involved prior to taking decisions on tourism development.*

V. *Development of the recreational fisheries sector should take due account of the potential for conflict on moral grounds emerging form different perspectives as to the acceptable use of fish, particularly in light of the dichotomy between fishing for food versus fishing as a leisure pursuit.*

VI. *In order to make appropriate allocation decisions, economic cost-benefit analysis and social impact studies are recommended that account for economic impact (jobs) and value (changes to consumer and producer surpluses) and social impacts (e.g., altered access, employment, number of people involved, changes to cultural identity) induced by altered scenarios in relation to livelihood.*

VII. *Much of the "decisions" as to whether develop recreational fisheries or not will occur naturally in relation to changes in economic prosperity and wealth of a given country. Only if resident people have economic alternatives, will fishing develop from subsistence to a more leisure-oriented pursuit.*

CONCLUSION

Recreational fisheries constitute the dominant or sole use of most freshwater fish stocks in the developed world, and its important in the developing world is rising rapidly. There is thus an increasing realization that recreational fisheries can no longer be ignored as a major player of the world's fisheries. However, to develop sustainably the sector may require guidance on specific aspects of governance, fish and people management and development. Adherence to the guidelines presented here help achieving sustainable recreational fisheries. Sustainability is particularly likely when states achieve or develop the needed infrastructure and data capacities for solid governance and management. Unfortunately, even in the most prosperous countries recreational fisheries management and development is constrained by low research support and lack of management infrastructure. In addition, many recreational fisheries are small sale operating in thousands of different small inland waters. Therefore, many recreational fisheries when

look in isolation lack the societal value to justify investments in research and management. Therefore, some basic rule of thumb management rather than sophisticated stock assessment-based management as is typically applied in industrial fisheries must be expected to remain a common approach in many of the world's small scale recreational fisheries. However, even under this situation adherence to the standards of sustainable management as detailed in the present document may provide useful. Clearly, these technical guidelines are subject to change in light of new information, and due to the diversity of recreational fisheries it was not possible to be too specific in sections of these Guidelines. Readers are thus asked to apply the guidelines as a frame and tailor more specific conclusions to local and regional conditions. In addition to the present document, also other Technical Guidelines for Responsible Fisheries by FAO offer relevant material for recreational fisheries development and management and may be consulted to complement the present text.

ANNEXES:

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GLOSSARY AND DEFINITIONS

The following definitions were taking from EIFAC (2008), modified by Cochrane and Garcia (2009) and Chapin et al. (2009, 2010). Some specific ones for recreational fisheries were developed by the authors.

Adaptive capacity: capacity of social-ecological systems (such as recreational fisheries), including both their human and ecological components, to respond to, create and shape variability and change in the state of the system.

Adaptive management: the management process of modifying policies and actions in light of evaluation of the success of past actions related to previously defined, operational objectives. Adaptive management may be pursued passively or actively. Active adaptive management refers to the deliberate approach of choosing interventions as to maximize learning and insights into a complex system's reaction to that interventions (e.g., treating management as experiments).

Aquatic biodiversity: the diversity of aquatic organisms at all levels (genetic, species, communities and populations).

Bag limit: Number of fish that may be retained by an individual over a specified time interval.

Best practice: planning, organization, managerial and/or operational practices that have proven successful in particular circumstances in one or more regions in the field and which can have both specific and universal applicability.

Catch-and-release: the process of capturing a fish, usually by angling, and releasing it alive. Catch-and-release ranges from legally required mandatory release of protected sizes and species to voluntary catch-and-release of fish that could have been retained.

Co-management (Cooperative management): A process of management in which government shares power with resource users, with each given specific rights and responsibilities relating to information and decision making (OECD, 1996). A partnership arrangement in which government, the community of local resources users (fishers), external agents (non-governmental organizations, research institutions) and sometimes other fisheries and coastal stakeholders (boat owners, fish traders, credit agencies or money lenders, tourism industry, etc.) share the responsibility and authority for decision making over the management of a fishery (Berkes et al. 2001)

Community-based management: A form of co-management where a central role for management is delegated to a community and where Government would usually have a minor role.

Creel survey: a survey approach in which anglers are intercepted on-site and data on catches, harvest, effort and social and economic information collected. Creel refers to a woven basket in which anglers may store fish.

Commercial fisheries: fisheries whose primary aim is to generate resources to meet nutritional (i.e. essential) human needs; in both full-time and part-time commercial fisheries, fish and other aquatic organisms are sold on domestic and export markets. Commercial fisheries include fisheries that supply feed to the aquaculture and agriculture sectors and raw material to other industrial sectors (e.g. the biomedical sector).

Ecosystem approach to fisheries: an ecosystem approach to fisheries strives to balance diverse societal objectives by taking into account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions, then applying an integrated approach to fisheries within ecologically meaningful boundaries.

Ecological services: ecological services are all services humans derive from aquatic ecosystems and fish stocks. They comprise four categories: supporting (e.g. nutrient cycling), regulating (e.g. water quality), provisioning (e.g. fish yield; recreational fishing experience) and cultural (e.g. existence value, spiritual and education dimension) services.

Environmental stewardship: environmental stewardship involves the wise and sustainable use of natural resources. It can be defined as the moral obligation to care for aquatic environments and the ac-

tions undertaken to provide that care and is a strategy to respond to and shape social-ecological systems under conditions of uncertainty and change to sustain the supply and opportunities for use of ecosystem services to support human well-being. This means that recreational fisheries stakeholders strive to maintain, enhance and protect fish populations and aquatic ecosystems. Any kind of damage to aquatic biodiversity and aquatic ecosystems is to be avoided and where it, for whatever reasons, occurs it should be managed with the best resources available.

Exploitaiton rate: the rate of removals of fish out of a stock in a specified time period. The exploitation rate may or may not involve by-catch or fish that die after release.

Fish welfare: good welfare means that an individual fish is in good health, with its biological systems functioning properly and with no impairment of fitness.

Ground bait: bait scattered on the fishing site to attract fish.

Harvest regulation: a fishing regulation that specifies what fish may be harvested (caught and kept) from a fishery; e.g, minimum-size or daily bag limits.

Hook bait: bait that is attached to a hook, as opposed to groundbait.

Input control: fishing regulations that limit the manner and amount of fishing allowed.

Institutions: the humanly devised constraints that structure human interactions (rules, laws, constitutions), informal constraints (norms of behaviour, conventions, self-imposed codes of conduct) and their enforcement characteristics.

Introduction: species or races of fish and other aquatic organisms that are intentionally or accidentally transported and released by humans into an aquatic environment outside their natural range set by biogeographic barriers.

Live bait: use of live invertebrates (e.g., crayfish), vertebrates (typically teleost fish) and worms and maggots as bait in recreational fishing.

Management organization: those persons or groups with the authority to make management decisions about the fishery

Maternal effects: effects of the phenotype of a female on the phenotype of her offspring.

Maximum size limit: a regulation in recreational fisheries where fish exceeding the size limit are to be released alive.

Minimum size limit: a regulation in recreational fisheries where fish below the size limit are to be released alive.

Output control: fishing regulations that limit the disposition of fish caught.

Precautionary approach: a term used in fisheries management to denote prudent foresight to avoid unacceptable or undesirable situations in the face of uncertainty, taking into account that some changes in fisheries systems are only slowly reversible, difficult to control, not well understood and subject to change in the environment and human values.

Recreational fisheries sector: the entire network of stakeholders involved in or fully or partly dependent on recreational fisheries including amongst others fisheries ministries and agencies, managers, non-governmental organizations (e.g., umbrella angling associations and clubs), anglers, non-angling recreational fishers, tackle shops and tackle manufacturers, bait suppliers, charter-boating industry, recreational boat builders and chandlery suppliers, marina operators and specialised angling and fishing media, recreational fishing tourism and other related business and organisations as well as all other enterprises supporting recreational fisheries including aquaculture operations that produce stocking material or commercial fishing enterprises that sell angling tickets on their waters. A range of other stakeholders and managerial regimes are not included in this definition though they may run or advocate activities and developments that have a direct impact on the recreational fishing quality and the recrea-

tional fisheries sector, the sector's viability and growth potential (e.g., hydropower generation, water management, irrigation).

Recreational fishing: fishing of aquatic animals that do not constitute the individual's primary resource to meet nutritional needs and are not generally sold or otherwise traded on export, domestic or black markets. The unambiguous demarcation between pure recreational fisheries and pure subsistence fisheries is often difficult. However, using fishing activity to generate resources for livelihood marks a clear tipping point between recreational fisheries and subsistence fisheries. Globally, angling is by far the most common recreational fishing technique, which is why recreational fishing is often used synonymously with (recreational) angling.

Recreational fishing effort: the amount of recreational fishing with gear of a specific type used on the fishing grounds over a given time span, typically normalized per area fished.

Recreational fishing mortality: the part of the total mortality rate acting on a fish stock that is due to recreational fishing.

Recreational fishing quality: a subjective evaluation by a recreational fisher of the perceived fulfilment of the needs that the fishing experience was supposed to provide.

Resilience: capacity of a social-ecological system to absorb a spectrum of disturbances and to sustain and develop its fundamental function, structure, identify and feebacks as a result of recovery or reorganization in a new context.

Recruitment: fish of a given age that are produced by a spawning stock.

Stakeholder: any person or legal entity (e.g., non-governmental organization) with an explicit or implicit interest (or stake) in an issue.

Size limit: A fishing regulation in which the fate of fish caught is determined by their size (usually length).

Slot limit: Size based fishing regulation in which only intermediate sized fish may be kept (open or protected slot) or must be released (closed or inverse slot).

Stock: a term used for the entire or a component of a fish population that is under consideration by management actions.

Stock assessment: the process of assessing the status of a fish stock to derive some management response in case certain criteria (reference points) are achieved.

Stocking: the release of cultured or wild caught aquatic organisms into the wild.

Structured decision making: the structured process of arriving at a management response in light of objectives and trade-offs.

Subsistence fisheries: fishing for aquatic animals that contribute substantially to meeting an individual's nutritional needs. In pure subsistence fisheries, fishing products are not traded on formal domestic or export markets but are consumed personally or within a close network of family and friends. Pure subsistence fisheries sustain a basic level of livelihood and constitute a culturally significant food-producing and distributing activity.

Sustainability: the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development concerns land, water, plant and animal genetic resources and is environmentally non-degrading, technically appropriate, economically viable, and socially acceptable. The four pillars of sustainability are social, economic, ecological and institutional sustainability.

Transfers: species or races of fish and other aquatic organisms that are intentionally or accidentally transported and released by humans into an aquatic environment within their natural range but from which they were previously absent.

Transformability: the capacity to reconceptualise and create a fundamentally new system with different characteristics (e.g., a tourism-dominated fisheries system originally dominated by resident anglers).

Utility: an economic term describing the capacity of individuals or societies to meet their own needs. The needs, and hence the utilities, desired by recreational fishers of often multi-dimensional involving multiple aspects, some of which are catch-dependent and others are non-catch dependent (e.g., aesthetic quality of a fishery).

Vulnerability: degree to which a system I likely to experience harm owing to exposure and sensitivity to a specified hazard or stress and its adaptive capacity to responds to that stress.

Zeitgeist: encompasses the cultural, intellectual, moral, ethical, spiritual and political climate within a nation or specific groups, along with the general socio-cultural mood within an era.

CODE OF PRACTICE FOR RECREATIONAL FISHERIES

The present document represents a modification of the EIFAC Code of Practice for Recreational Fisheries (EIFAC 2008) in light of the present Technical Guidelines for Responsible Fisheries: Recreational Fisheries (TG). The document shall be used to serve as a implementation means for the TG by emphasizing the most salient principles and guidelines.

ARTICLE 1 – Nature and Scope

1.1 The Code of Practice for Recreational Fisheries (hereafter abbreviated as CoP) constitutes an abbreviated set of guideline and principles as derived from the Technical Guidelines for Responsible Fisheries: Recreational Fisheries – a supplement to the FAO Code of Conduct for Responsible Fisheries. The CoP is voluntary and directed towards the entire recreational fisheries sector[1] and all entities, parties, organizations and individuals that directly or indirectly impact or depend on aquatic ecosystems, recreational fisheries resources and recreational fishing activity.

1.2 The CoP provides generic principles and best practice standards applicable to the conservation, management and development of recreational fisheries. It also includes human activities that support recreational fisheries, such as aquaculture production of fish for stocking, the manufacture of gear, the tourism industry, the media, as well as fisheries management and research.

1.3 The CoP is to be interpreted and applied in conformity with the relevant rules of various international and national agreements and legislation relating to the aquatic environment and fisheries.

1.4 It is hoped that interested parties may consider this CoP as a useful reference and even as a possible model for the regulation of the activities of their own recreational fishing sector.

ARTICLE 2 – Objectives

2.1 to establish best practice and management principles for responsible recreational fisheries, among nations, regions, organizations or individual recreational fishing communities in the EIFAC region, in accordance with the relevant rules of international, national and regional legislation, while taking into account their relevant biological, technological, economic, social, cultural and environmental aspects.

2.2 to serve as a guiding instrument of reference in establishing or improving the institutional and policy framework required to exercise responsible management of recreational fisheries.

2.3 to promote international exchange of knowledge and experiences on recreational fisheries, on their management and sustainable development.

2.4 to facilitate and promote cooperation among public bodies, non-governmental organisations and individual stakeholders in the conservation, management and development of recreational fisheries resources, including the aquatic ecosystems of which they are an intrinsic part.

2.5 to promote recreational fisheries in the long-term by outlining and facilitating best practices within the sector for long-term sustainability, and for the responsible use of all ecological services generated by aquatic ecosystems and aquatic organisms.

2.6 to promote understanding of the importance of recreational fishing as a socio-economic factor among public bodies, non-governmental organisations and individual stakeholders involved in conservation, management and development of aquatic ecosystems.

1 Further referred to as “Sector”.

2.7 to improve communication and mutual understanding among recreational fisheries stakeholders and with other parties.

2.8 to promote research into recreational fisheries as well as on associated aquatic ecosystems and the relevant environmental factors which influence recreational fisheries.

ARTICLE 3 – Implementation and Updating

3.1 The recreational fishing sector should collaborate in the promotion and implementation of the objectives and principles contained in the CoP and the TG on which it is built among international and national policy makers.

3.2 FAO members, relevant international bodies and national organizations should promote understanding of the CoP and the TG on which it is built among those involved in recreational fisheries, particularly local anglers and other recreational fishers.

3.3 FAO will monitor the application and implementation of the CoP and the TG on which it is built and its effects on recreational fisheries among its member countries.

3.4 FAO, as appropriate, will revise the CoP and the TG on which it is bultperiodically, taking into account new developments in recreational fisheries, with full consultation of relevant stakeholders.

ARTICLE 4 – General principles

4.1 Relevant international, national and regional administrations, fishing rights holders and other parties and persons that own or are responsible for fisheries resources shall protect, promote and encourage access to recreational fisheries while ensuring exploitation is sustainable and that potentially conflicting societal demands are taken into account.

4.2 The fisheries sector and other non-fishery sectors in charge of management of water and aquatic ecosystems and their supporting terrestrial habitats (e.g. riparian zones) should ensure that recreational fisheries interests, including the need to conserve the resources and supporting habitats, are taken into account along with the other multiple uses of aquatic ecosystems. Recreational fisheries stakeholders should be integrated into all decision-making processes that affect aquatic ecosystems.

4.3 The opportunity for recreational fishing carries with it the obligation to do so in a socially and ecologically responsible and overall sustainable manner to ensure wise use, conservation, management and development of wild living aquatic resources and the aquatic ecosystems and fisheries habitats for present and future generations.

4.4 The recreational fisheries sector supports and implements measures which aim at addressing undesirable impacts of recreational fishing practices and management actions on individual fish, fish populations and the aquatic ecosystems as a whole. Particularly, the sector aims at avoiding irreversible, costly or slowly reversible changes to aquatic biodiversity, fish populations and aquatic ecosystems.

4.5 Where recreational fisheries exploit the same waters as commercial fisheries, conflicts between the two sectors should be minimized and fisheries should be so managed that the combined exploitation is sustainable.

ARTICLE 5 – Environmental Stewardship and Ethics

Each stakeholder within the recreational fishing sector should:

5.1. know that aquatic animals, including fish, occur in aquatic ecosystems within natural limits and that recreational fishing mortality and other actions associated with recreational fishing have the potential to negatively affect fish populations and individual fish.

5.2. accept that aquatic animals are part of an interrelated web of life and aquatic ecosystems that provide various ecological services to society in addition to the opportunity to fish.

5.3. be aware that familiar practices within recreational fishing and recreational fisheries management might be subject to change based on new scientific knowledge, as well as in response to ecological and sociopolitical changes.

5.4. engage in actions that extend the pursuit of going fishing to, for example, educate other people, raise public awareness and the profile of recreational fishing, participate in recreational fisheries management, conservation and enforcement.

5.5. be aware that the behaviour of each individual engaged in recreational fishing related activities is representative of the action of all others, and act accordingly.

5.6. accept that environmental stewardship is the overriding ethical principle to which recreational fishing practice and its management will be judged by others.

ARTICLE 6 – Policy and Institutional Frameworks

With regard to recreational fisheries, governments, national, regional and international administrations and individual decision-makers, within their competencies and capabilities, should:

6.1 establish, and regularly review and update, the policy and regulatory frameworks for the management and development of recreational fisheries nationally, regionally and locally, and where necessary, internationally, to protect and promote the opportunities for recreational fishing and the sustainable use of recreational fisheries resources.

6.2 provide the necessary resources, information and infrastructure for sustainable management, conservation and development of the sector.

6.3 ensure that representatives of the recreational fisheries sector are consulted in the decision-making processes and involved in other activities related to aquatic ecosystem management, conservation and planning.

6.4 promote the establishment of procedures and mechanisms at the appropriate administrative level to settle conflicts that might arise within the recreational fisheries sector, between fisheries resource users and between other direct and indirect users of aquatic ecosystems.

ARTICLE 7 – Compliance and Enforcement

The competent authorities, the recreational fishing sector and each individual fisher should:

7.1 provide the resources, mechanisms and management tools (e.g. sanctions) to ensure compliance with and the enforcement of environmental and fisheries legislation and other relevant regulations.

7.2 communicate the applicable legislation and regulations, as well as other relevant information, to recreational fishers in an easily understandable and timely way. However, it is the responsibility of the individual fisher/angler to be informed about local, national and regional rules and customs and to act accordingly.

7.3 comply with local, regional, national and international regulations, requirements, customs and codes, and report violations of fishing regulations and damage to the ecosystem (e.g. fish kills, habitat degradation) to the relevant authorities and organisations in a timely way.

ARTICLE 8 – Recreational Fishing Practices

Each recreational fisher should:

Safety

8.1 be aware of, and comply with, local and national safety rules and regulations.

Fish

8.2 not sell or otherwise trade fish or other aquatic products harvested during the pursuit of recreational fishing.

8.3 not take more fish or aquatic organisms than needed.

8.4 only keep fish or other aquatic organisms that will be eaten within the family or within the network of relatives and friends; other fish should be released alive in agreement with national and regional legislation, needs and local customs and in accordance with Article 9 of this CoP.

8.5 not leave fishing gear unattended with the exception of recreational fishing techniques that cannot be continuously observed (e.g. gill netting, traps).

8.6 always use fishing tackle and methods that comply with national regulations.

8.7 preserve the quality of fish that are removed for consumption such as by putting them on ice, immediate removing and disposing of the entrails, quick storage in freezers or early consumption; dead fish should not be left in the environment.

Litter

8.8 not litter the environment; it is best not to bring material to the water that could litter the environment and to pack all equipment, bait and food in recycling boxes.

8.9 if feasible, remove litter left by other people and leave the fishing location litter-free; always bring a container to collect litter at the fishing site.

Environment

8.10 immediately report pollution incidences, distressed or dead fish, the presence of unusual species, non-native species and other environmental impacts/observations to the relevant authorities.

8.11 not stock, introduce or transfer live fish or other aquatic organisms within or between catchments without permission from the authorities. This applies particularly to non-native organisms.

8.12 avoid damage to riparian vegetation caused by accessing the fishing location, construction of fishing sites, piers, removal of woody debris, trampling or felling of firewood.

8.13 avoid disturbance or possible disturbance to wildlife and waterfowl, in particular avoid fishing near nesting birds and avoid using hook bait that might be ingested by waterfowl.

8.14 minimize the use of lead weights on the fishing line and use alternatives to lead where possible and when appropriate.

8.15 minimize boat travel, speed, noise and boat wash when these may disturb and potentially damage fish, riparian vegetation, waterfowl and other water users.

8.16 anchor boats only in areas that are not environmentally sensitive.

8.17 avoid wading in streams and lakes during fish and other aquatic wildlife's reproductive periods.

8.18 moderate the amount of groundbait introduced to water bodies and do not use potentially toxic chemicals (e.g. preservatives, colouring agents) in ground bait and hook bait.

8.19 use bait, particularly live bait, only in agreement with local or national regulation, and use aquatic organisms only in the water body from which these were collected. Never transfer aquatic live bait from one water body to another.

8.20 when collecting bait adopt environmentally friendly practices to minimise disturbance to habitats and the environment (e.g. backfill holes on the foreshore that are dug in the process of bait collection).

ARTICLE 9 – Fish Welfare

Each participant in recreational fishing and the recreational fishing sector as a whole should:

9.1 accept that, by nature of the activity recreational fishing may result in killing, will induce physical damage and may induce a stress response in individual fish during the process of capture, handling and possibly release, which may affect the fitness of the individual fish.

9.2 be aware that captured live or dead fish may be vectors for spreading of notifiable fish and other diseases.

9.3 use tackle and gear that is appropriate for the size and type of fish or other aquatic organism that is targeted. In recreational angling, chose tackle and gear in a way that:

a. minimizes landing duration

b. minimizes air exposure

c. minimizes injury

d. avoids hooking outside the mouth region if technically possible

e. allows safe landing, while avoiding deep-hooking whenever possible

9.4 after landing a fish, restrain it gently but firmly to control it during unhooking.

9.5 immediately anaesthetize and, if possible before unhooking, kill the fish that is to be taken, by an appropriate method such as a sharp blow to the cranium and then exsanguination (bleeding-out).

9.6 if fish are to be held alive after capture, use devices that provide sufficient space and water quality and keep the fish for the shortest time possible. Suitable devices include keepnets, live-wells and similar fish-retention equipment; stringers or very small metal cages should not be used. Avoid holding different fish species and sizes together if this might result in damage to the skin through abrasion or crushing or lead to predation.

9.7 use live baitfish only in jurisdictions where this is legally allowed. To ensure fish welfare recreational fishers should encourage use of alternative bait.

9.8 develop and promote practices that cause the least physical, physiological and behavioural impact on fish if they are to be assessed (e.g. weighed) and released after capture, as in some recreational fishing competitions and tournaments. If the fish are to be brought to a central weighing station, reducing weigh-in stress by minimizing air exposure and crowding/compromised water quality at the weigh-in facility. Afterwards, release the fish as close as possible to the original capture site. Encourage use of alternative fishing success criteria that do not depend on bringing live fish to a central weighing station.

9.9 release fish and other aquatic organisms after capture in the best condition possible and only if legal according to national and regional legislation. Specifically, in recreational angling this entails :

a. obtaining, reading and observing regionally-available best practice catch-and-release guidelines.

b. using appropriate landing devices to avoid mucus loss and damage to the skin and other fish organs.

c. carrying and using appropriate unhooking devices such as pliers, forceps, side cutters.

d. assessing the size of fish while keeping it under water, if possible.

e. avoiding extended periods of air exposure, preferably unhooking the fish in the water and touching fish only with wet hands.

f. avoiding touching the fish's gills and eyes while unhooking.

g. never squeezing a fish or using unnecessary force while unhooking.

h. releasing deeply-hooked fish by cutting the leader and only if survival is likely.

i. not releasing fish that show signs of impaired function or severe injury.

j. using validated and legal techniques to increase chances of survival when fish show signs of barotraumas.

k. avoiding fishing when the intention is to catch-and-release fish in situations that are known to substantially reduce the chances of post-release survival (e.g., for some species, a particularly high/low water temperature).

l. avoiding catching-and-releasing fish during their reproductive period.

m. reviving fish before release by moving water over the fish's gills if necessary.

n. releasing fish as quickly as possible by placing them gently into the water.

ARTICLE 10 – Stakeholder Interactions

The recreational fishing sector and all other parties responsible for aquatic ecosystem management should:

10.1 ensure that the decision-making processes are transparent, and that all stakeholders have an opportunity to provide input prior to making decisions on legislation, policies and regulations related to recreational fisheries management and the aquatic ecosystem.

10.2 understand that some human activities are of higher social priority than recreational fishing, even if they negatively impact fish and fisheries.

10.3 respect the value systems and perspectives of all stakeholders, even if they contradict values held by the recreational fisheries community.

10.4 respect the rights of those who own or use the fisheries/aquatic resource, land or harbours adjacent to the water that is fished.

10.5 respect other people's privacy, space, values, customs and objectives (commercial/subsistence) while fishing, accessing the fishery or moving through a fishery.

10.6 avoid conflicts, both within the sector and between other user groups. Should conflicts arise, work cooperatively with other stakeholders to develop a common solution based on factual evidence or compromise.

ARTICLE 11 – Management

11.1 The over-arching goal of recreational fisheries management is to ensure the long-term sustainability of fisheries resources thereby safeguarding the availability of these resources for future generations. Sustainability of fisheries resources includes conserving biodiversity at all levels, including genetic diversity, as well as supporting terrestrial and aquatic ecosystems.

11.2 Sustainable recreational fisheries management is based on an ecosystem approach to fisheries and a precautionary approach. Such management is holistic and integrated in orientation and differs from the more traditional narrow focus on one component of interest, such as a targeted fish stock.

11.3 Management of recreational fisheries is multi-dimensional, multi-disciplinary and sometimes multi-jurisdictional, and it requires recognition of the complexities of the resource system, the interactions between social and ecological subsystems of recreational fisheries, and effective communication and cooperation among stakeholders.

11.4 In some situations, recreational fisheries are essentially unregulated, e.g. no management is in place. It is recommended that the need for dedicated management is investigated in such situations.

11.5 Management decisions should be based on the best available science while recognizing traditional ecological, socio-economic and cultural knowledge and the need to balance competing demands. Lack of scientific information should not preclude management from decision making.

11.6 Recreational fisheries management decisions must consider the need for high quality fishing opportunities while balancing the needs of other parties, respecting the ecological limitations of the supporting ecosystem, and acknowledging the socio-economic needs of society.

11.7 Management decisions should include all parties that may directly or indirectly influence the fisheries resources.

11.8 Successful recreational fisheries management requires clear identification of goals and objectives. Such goals and objectives are highly dependent on societal values and should be developed in consultation with all stakeholders.

11.9 Management decisions should be implemented within an adaptive framework to allow structured, life-long learning from each management decision. Formal decisions on fisheries management should be based on the best understanding of the system being managed using both scientific and traditional knowledge.

11.10 Development of management plans is important for successful implementation of management actions. A management plan should consist of well-defined, measurable objectives; analysis of the current state and the problems requiring attention; suggested actions to overcome the identified problems; required human and financial resources for implementation of the proposed management actions; and proposed time scale and monitoring approach.

11.11 Monitoring of the fisheries ecosystem is necessary to inform management decisions in the future. Evaluation of the effectiveness and appropriateness of management actions, as well the collection and verification of information and the dissemination of information to all interested stakeholders, is critical for the sustainable use of fisheries resource and to allow capacity-building and should be conducted whenever possible.

11.12 Cost–benefit and risk analyses of possible management decisions should be conducted to help minimize potential detrimental impacts on the fisheries resource and supporting ecosystems, as well as to reduce potential conflicts with other resource user groups.

11.13 Information generated by, or amassed for, the management of recreational fisheries shall be verified and disseminated to interested parties through accessible and relevant media and in a timely manner.

11.14 Appropriate assistance should be provided as needed to countries in the EIFAC region that lack experience with recreational fisheries resource management, at the local, regional or national level, in the development of protocols and programs to establish a more coherent approach to recreational fisheries management.

11.15 As responsible users of the fisheries, recreational fishers should encourage management actions, and actions by fellow recreational fishers, that avoid intentional or unintentional detrimental change to aquatic biodiversity. This may be achieved by such actions as: discouraging excessive fishing mortality; carrying out appropriate habitat improvement activities; stocking fish based on ecologically-sound principles; and preventing the introduction of non-native species.

11.16 Recreational fisheries managers should seek alternative qualified advice when uncertain about likely outcomes of a planned management intervention.

11.17 Recreational fishers and other parties interested in the fisheries resources and its supporting ecosystem should recognize that fisheries management operates at three levels: (1) the fish habitat; (2) the people and fishing practices; and (3) the fish stocks at population or community levels.

Management of Fish Habitat

11.18 All parties interested in the fisheries resources should support measures to enhance fish habitats, including spawning, nursery, feeding and shelter areas and the connectivity between them.

11.19 Protection of fish habitat is important to maintain naturally-reproducing wild fish populations. Emphasis should be given to habitat protection measures in areas that have functioning fish habitat, before stocking actions are considered.

11.20 Modification or manipulation of fish habitat for the sustainability of a fishery and its ecosystem is a long-term solution that may be preferred to other forms of management intervention.

Management of the People and Fishing Practices

11.21 Recreational fisheries management measures that target the fishing public should aim at providing a diversity of fisheries to meet the needs of distinct fisher groups and other stakeholders, where this is biologically and ecologically feasible.

11.22 Implementation of scientifically-based, people-oriented management measures should aim at maximizing the social and economic benefits generated by recreational fishing while preventing overexploitation of the fisheries resources. It is acknowledged that the definition of overexploitation and determination of the level of sustainable fishing effort/mortality depends on data availability and management objectives. Ultimately, this is system-specific.

11.23 People-oriented management measures should be designed on a system-specific basis to account for the local and regional diversity in ecological and social conditions. They include the use of input control measures such as assigning areas closed to fishing and seasonal fishing closures (effort controls), output controls such as size-based harvest limits or bag limits (catch/harvest controls) and other incentive-based management tools. No actions, particularly effort control measures that limit access to a fishery, should be taken in an ad-hoc manner without a scientific or pertinent social justification.

11.24 When making management decisions for a given fishery, the potential behavioural responses of the fishers to particular management measures should be taken into consideration as such responses might curtail the success of management on a particular system.

Management of the Fish Stocks

11.25 Stakeholders should recognise that management of fish stocks can include addition to and removal of components of the stock, as well as culling of undesirable species and biomanipulation of the system using indigenous species. These actions might require environmental impact assessments and should occur only within a framework to protect ecosystem functions, services and aquatic biodiversity.

11.26 Many recreational fisheries are based on stocking programmes to maintain or enhance stocks of popular fish species. However, stocking should be the last option of many to maintain or enhance fisheries quality. Introductions of fish should follow national and international guidelines to avoid unintentional adverse consequences, particularly genetic contamination and spreading of diseases. Alternative management measures to fish stocking, such as habitat improvement, diseases and predator control, harvest regulations or regulation of fishing effort, should be preferred in most situations.

11.27 Introduction of non-native species to create fisheries should be avoided. Where proposed, they must comply with the EIFAC Code of Practice on Species Introductions and be reviewed by qualified, independent experts.

ARTICLE 12 – Research

12.1 Research activities on recreational fisheries are encouraged. These should support policy decision making as regards the aquatic environment, to reduce the risk of negative effects on recreational fisheries and to support and improve recreational fisheries management.

12.2 Recreational fisheries will need to adopt a multidisciplinary, interdisciplinary and transdisciplinary approach to problem solving. Research programmes should promote study designs that will succeed across research disciplines. Modern recreational fisheries research extends the traditional fisheries biology research domain and explicitly integrates the social and economic sciences.

12.3 Research programmes should work across multi-level governance systems at local, regional, national, and international levels, as well as involving various bodies with management and research responsibilities, such as universities, consulting and private sector organizations, local agencies, national institutes, and international fisheries organisations.

12.4 Adequate resources, including research facilities and trained staff should be provided for recreational fishery research programs. These programmes should be provided financial support from public sources and from a variety of self-sustaining funding mechanisms, such as user-pay initiatives and cost-recovery mechanisms.

12.5 Capacity building is essential to ensure that fishery research programmes are effective. States and relevant international organisations that have the ability to provide capacity-building support should work towards provision of resources to developing countries' fishery research programmes, such as technical training.

12.6 Development of frameworks to identify meaningful recreational fishery research questions is important for successful fishery management. These frameworks should incorporate traditional ecological knowledge of recreational fishers and other concerned stakeholders to ensure that their research needs are met. Researchers should take final responsibility for development of appropriate research proposals and approaches to answer these questions.

12.7 Research must use robust and accurate data collection and analysis strategies that incorporate appropriate standardized methods. Completed analyses should be published in a timely fashion and data made available subject to intellectual property and confidentiality being respected. If possible, results should be published to allow dissemination of the information internationally, but local and regional research reports are equally important for information of local end-users. Fishery research results should be shared with stakeholders using clear language and concise communication approaches that match the needs of the stakeholders.

12.7.1 Recreational fisheries organisations and agencies should monitor and assess the stocks under their responsibilities, including the impact of ecosystem changes resulting from land use, urbanization, climate change, habitat alteration, and other anthropogenic sources. Successful implementation of fisheries management programmes rely on development of broad-based monitoring schemes. These should collect pertinent data on the habitat, fishery, and fish stocks to assure that progress towards management goals and objectives can be documented. Researchers should encourage the fishers to contribute actively to the monitoring of fish populations by reporting relevant data and other observations to fisheries managers and researchers.

12.8 Recreational fisheries research should include an understanding of the social, economic, marketing, and institutional factors affecting recreational fishers and fisheries.

12.10 Recreational fisheries research results should be used to establish management objectives, reference points, performance criteria and to formulate and update management plans. Fisheries research results should be used as the baseline for development of adaptive management approaches, and outputs of research are essential for evaluation of management effectiveness.

12.11 Given the limited financial and human resources available, recreational fisheries research efforts may need to focus on a subset of fisheries. Where recreational and commercial fisheries co-exploit the same fish stocks collaborative research should be established.

ARTICLE 13 – Awareness, Education and Training

The recreational fishing sector should:

13.1 promote awareness of the present CoP to encourage responsible recreational fisheries through targeted information, education, and training of recreational fishers, managers, policy makers and other stakeholders.

13.2 publicize conservation and management measures and ensure that laws, regulations and policies governing their implementation are effectively disseminated and explained in layman's language.

13.3 ensure that local fishing communities and individual fishers are involved and aware of policy formulation and the associated implementation, enforcement and evaluation process, while facilitating awareness and implementation of the CoP.

13.4 make effort towards and invest in recruiting new recreational fishers and anglers, especially young people and children, instilling a sense of environmental stewardship with new recruits.

13.5 invest funds and manpower into development of education and training programs for fishers and managers to be informed about recent developments in recreational fisheries science, management and policy.

13.6 collaborate with relevant experts in developing awareness and education programmes aimed at improving attitudes towards recreational anglers and further promoting resource stewardship within the sector.

13.7 objectively and routinely communicate recent advances in recreational fisheries science, management and conservation. In the long term, objective communication of both the economic and ecological benefits, as well as the negative impacts of recreational fisheries practices, strengthens the sector and encourages critical debate which will further benefit the fish and the environment, those that enjoy recreational fishing and dependant commercial activites.

APPENDIX D

Opening statement by Devin Bartley, FAO Fisheries and Aquaculture Department

Ladies and Gentlemen,

It is my pleasure to welcome you all to Berlin and to thank you on behalf of the Director General of the Food and Agriculture Organization of the United Nations (FAO) for having kindly accepted to share your expertise at this *" Expert Consultation to Develop the FAO Technical Guidelines for Responsible Recreational Fisheries: Recreational Fisheries"* .

This expert consultation has been organized in recognition of the growing global importance of recreational fisheries in the overall fisheries sector development and management. Recreational fisheries has become an important sub-sector of the fisheries sector in terms of employment and income generation. At the same time, recreational fisheries is impacting some inland fish and marine fish stocks and aquatic biodiversity; sometimes positively and in other cases negatively. The FAO State of World Fisheries and Aquaculture (SOFIA 2010) noted that although recreational fisheries is primarily a developed country activity, it is becoming more important in developing countries as economies improve. Nevertheless, little attention has been paid in international policy documents to the responsible development and management of recreational fisheries.

The recreational fisheries sector has in recent years made considerable efforts towards improving the sustainability of recreational fishing practices by anglers, through local level rules and regulations, licensing or permit schemes, Codes of Practice, and awareness raising and capacity building schemes. These efforts have been effective in terms of improving the image of the sector in a number of cases, but sometimes failed in receiving support from fisheries policy and decision makers.

Examples of effective regional initiatives include, the EIFAC Code of Practice for Recreational Fisheries (2008) and the European Charter on Recreational Fishing and Biodiversity , which was prepared under the Bern Convention of the Council for Europe.

At the global level, the FAO Committee on Fisheries (COFI) has called upon the Organization to take necessary steps towards filling in a gap in interest in recreational fisheries, within the global fisheries policy framework. COFI is the only global inter-governmental forum where major international fisheries and aquaculture problems and issues are examined and recommendations are made and addressed to governments, regional fishery bodies, NGOs, fishworkers, FAO and international community COFI, emphasized the importance of the recreational fisheries sub-sector. To this end, COFI's "Sub-Committee on Aquaculture" requested the preparation of FAO Technical Guidelines for Responsible Recreational Fisheries: Recreational Fisheries".

While there are currently 20 Technical guidelines for Responsible Fisheries, addressing a wide range of important issues from aquaculture development to responsible fish utilization and from the conservation of sharks to genetic resource management, none of the technical guidelines deals specifically with recreational fisheries issues. This Expert Consultation is therefore a direct response to the request of COFI's Sub-Committee on Aquaculture and the limited attention, including at the global level, to the state of recreational fisheries and its sustainable development and management. It also aims to address the gap in specific coverage for the subject of recreational fisheries in the FAO Code of Conduct for Responsible Fisheries .

During the coming days we will jointly take the necessary steps towards the development of FAO Technical Guidelines for Responsible Recreational Fisheries. These Technical Guidelines should be directed at decision-makers, planners, the sport fishers and all those involved in developing and implementing policy and technical interventions relevant to recreational fisheries.

Your specific tasks will be to:

1) Review available draft chapters of the Technical Guidelines on Recreational Fisheries in relation to their completeness, scope, aims and relevance of the guidance provided;

2)Review regional and global institutional arrangements and mechanisms for advising on recreational fisheries policy and management, and make recommendations on how these can be strengthened; and

3)Prepare a near final draft of the Technical Guidelines on Recreational Fisheries

Your work at this consultation will ultimately contribute to improvements in the management of recreational fisheries world-wide, which is being awaited by the international community with anticipation.

At this point I would like to acknowledge the great preparatory work undertaken by our resource persons for this Expert Consultation, Robert Arlinghaus, Brett Johnson and Steven Cooke. Without their commitment and dedication, we would not have been able to provide you with the high quality draft Technical Guidelines which you find in front of you today.

I would like to thank you for taking the time to assist FAO with this task and for providing your knowledge, wisdom and insights. I wish you a productive consultation in the coming days and look forward with interest to the results of your work.

For those of you who are not familiar with FAO rules and procedures, I should perhaps clarify your role in this expert consultation. Each of you is attending this meeting in your individual capacity, and not as a representative of your government or organization. all of you are encouraged to freely share your frank views and comments, as well as provide your intellectual input to the various chapters of the draft technical guidelines prepared for this consultation.

I finally wish to express, on behalf of FAO, our sincere gratitude to the Government of the Federal Republic of Germany for its kind agreement to host this Expert Consultation in Berlin, and to the Department of Biology and Ecology of Fishes of the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) for its generous support in the organization of this expert consultation. Special thanks are due to Mr Arlinghaus and Ms Oswald of IGB and Ms Salur of FAO Ankara for their kind assistance in the preparations for this meeting.

Once again, thank you very much, Ladies and Gentlemen, for your attention, and I wish you a successful consultation and a pleasant stay here in Berlin.

The Expert Consultation to Develop the FAO Technical Guidelines for Responsible Fisheries: Recreational Fisheries was held at the Department of Biology and Ecology of Fishes of the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) in Berlin, Germany, on 5 and 6 August 2011. The Expert Consultation was organized in recognition of the growing global importance of recreational fisheries in the overall fisheries sector development and management. Recreational fisheries has become an important sub-sector of the fisheries sector in terms of employment and income generation.

The Expert Consultation had before it a comprehensive working document on the subject matter. The Expert Consultation reviewed the working document and provided specific guidance for the finalization, publication, dissemination and global level promotion of the Technical Guidelines. The Expert Consultation also provided general recommendations on recreational fisheries management and development aspects to FAO and other relevant stakeholders.

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