PART 2

SELECTED ISSUES FACING FISHERS AND AQUACULTURISTS

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Capture-based aquaculture[28]

THE ISSUE

Capture-based aquaculture (CBA) has been defined as the practice of collecting "seed" material – from early life stages to adults – from the wild, and its subsequent on-growing to marketable size in captivity, using aquaculture techniques. This category of farming includes the rearing of some species of finfish, most molluscs, and certain forms of the extensive culture of marine shrimp. The scale of CBA activity is difficult to quantify because statistical records do not differentiate between production from capture-based and other forms of aquaculture in which hatchery-reared juveniles are stocked. However, it has been estimated that it accounts for about 20 percent of the total quantity of food fish production through aquaculture. Using FAO data from 2001, this is equivalent to over 7.5 million tonnes per year, principally molluscs. The production of finfish, especially carnivorous species (including milkfish, groupers, tunas, yellowtails and eels), through CBA, is currently receiving the most attention.[29]

Production data deriving from statistical returns provided to FAO for some of these species groups are believed to be underestimates; higher estimates for eels, groupers, bluefin tunas and yellowtails are provided in Table 11. The value of the CBA output of these groups in 2000, using FAO data, exceeded US$1.7 billion. The output of bluefin tuna alone is expected to surpass 25 000 tonnes in 2004. Although Japan is the primary market for bluefin tuna, it is estimated that demand in the United States is around 45 000 tonnes, mainly for *sushi* and *sashimi*, but also for grilling.

CBA is an interface between capture fisheries and true aquaculture and provides an alternative livelihood for local coastal communities in developing countries and several industrialized countries. However, a number of important issues have yet to be resolved relating to the impacts on third parties of management practices that are environmentally questionable – especially the use of wild seed and the use of raw fish as feed. In addition, a practical method for monitoring the aquaculture production contributed by CBA has yet to be found. The sector has also created popular new market segments; it has successfully filled the gap between the two extreme categories (high-quality/expensive and low-quality/inexpensive) of bluefin tuna in the Japanese market and has provided a source of groupers that is cheaper than the wild-caught equivalent. CBA also provides opportunities for developing low-hazard, good-quality products that satisfy codes of conduct and practice.

Use of wild seed

By definition, CBA relies on the use of wild-caught "seed" (a term that covers fry, juveniles and, in some cases, larger fish) for stocking on-growing facilities such as tanks

[28] The information in this section has been derived from FAO. 2004. *Capture-based aquaculture*, by F. Ottolenghi, C. Silvestri, P. Giordano, A. Lovatelli, and M.B. New. Rome; and several other sources (Anonymous, 2004. Burris tuna diet "extends shelf life". *Fish Farming International*, 31(4): 42; FAO. 2003. *FAO Yearbook of Fishery Statistics 2001: Aquaculture Production*. Volume 92/2. Rome; C.W. Laidle and R.J. Shields. 2004. Amberjack culture progresses at Oceanic Institute. *Global Aquaculture Advocate*, 7(1): 42–43; M. Rimmer, S.-Y. Sim, K. Seguma and M. Phillips. 2004. Alternatives for reef fishing: can aquaculture replace unsustainable fisheries? *Global Aquaculture Advocate*, 7(1): 44–45; V. Scholey, D. Margulies, J. Wexler and S. Hunt. 2004. Larval tuna research mimics ocean conditions in lab. *Global Aquaculture Advocate*, 7(1): 38; I.Q. Tan. 2003. Success with formulated feeds for groupers. *Asian Aquaculture Magazine*, September/October: 16–18; T. Wray. 2004. The rise and rise of tuna. *Fish Farming International*, 31(4): 11.

[29] See, for example, R.L. Naylor, R.J. Goldburg, J. Primavera, N. Kautsky, M.C.M. Beveridge, J. Clay, C. Folke, J. Lubchenco, H. Mooney and M. Troell. 2000. Effect of aquaculture on world fish supplies. *Nature*, 405: 1017–1024.

Table 11
Estimates for capture-based aquaculture production of eels, groupers, bluefin tunas and yellowtails in 2000

Species group	Estimated production *(thousand tonnes)*
Eels	288
Groupers	15
Bluefin tunas	10
Yellowtails	136

or cages. This source of seed will be unsustainable in the short term and inadequate in the long term because the catch per unit of effort of seed – whether juveniles or adults – appears to be in decline. Nursery and adult habitats (e.g. mangrove, seagrass and coral) are increasingly being damaged by pollution, destructive fishing practices and other environmental impacts. Moreover, accurate information is not always available on the status of these resources. Overfishing of the target resources frequently occurs during normal fishing activities, but is exacerbated by the demand created by CBA. The collection of seed for CBA can also lead to mortalities in non-target species and the destruction and disturbance of habitats; it also generates discards, contributing further to the depletion of other resources. In addition, the transfer of seed to CBA farms is characterized by high mortality rates (and thus wastage of resources) and conflicts with other resource users (e.g. the obstruction of waterways caused by the towing of cages containing bluefin tuna).

Use of raw fish as feed

Many forms of CBA use raw fish as feed (sometime referred to as "trash fish"). To date, assessment of the related environmental impacts, such as the depletion of the stocks used and the potential transfer of disease vectors to farmed fish and possibly to fish sharing the same water body, has been inadequate. The transfer of human pathogens is also possible. Even when the use of raw fish is replaced with formulated compound aquafeeds, the reliance on marine resources as feed ingredients tends to remain, as high levels of fish oil and fishmeal are used in these feeds.

Effects of CBA management

The siting and operation of CBA farms can be problematic. Significant among the environmental and safety issues still to be addressed by the CBA sector is the lack of adequate, cost-effective environmental assessment systems that would ensure good site selection. The latter is essential in order to minimize sediment build-up, thereby preventing eutrophication and avoiding the risk of contaminating farmed products (e.g. with dioxins and PCBs).

Farm operations sometimes involve inadequate technologies such as unsuitable feeding regimes, poor mooring systems and deficient cage structures. Limited knowledge of the optimum conditions for on-growing facilities and a lack of trained personnel (with many operations being undertaken at an artisanal level, resulting in poor performance and loss of fish) also affect the sustainability of CBA. Also, any untreated farm-generated waste harms the coastal environment and imposes a cost on local populations.

Monitoring CBA production

Substantial difficulties are experienced in quantifying the output from CBA. Fish caught from the wild for stocking purposes are considered as having been produced by capture fisheries and thus only the weight added through fattening is considered as aquaculture production. For CBA activities that depend on juveniles caught in the

wild this is not an issue, as their weight is negligible. In the case of tuna, however, the fish caught for fattening are already adults and their weight must be assessed using a reliable method.

POSSIBLE SOLUTIONS

Seed supply and transshipment

Hatchery-rearing technology is being researched and developed for species that are currently stocked in CBA as fry. Provided that these technologies prove economically viable, hatchery-reared fry will ultimately replace wild-caught fry (at which time the rearing of these species will become true aquaculture, not CBA). However, it is unlikely that it will become commercially viable to rear seed under controlled conditions when, instead of being small fry, the seed consists of large juvenile or adult fish (such as those often used for bluefin tuna). It is expected that the need for supplies of wild-caught seed will continue, not only for species cultured at present, but for others that may be cultured in the future in response to market forces.

Improvements in the management of fisheries for species used in CBA are key to solving these seed-related problems. To this end, further studies on the biology of the species concerned and specific research on more selective fishing gears should be undertaken. New technologies for the transshipment of wild fish to farms are also needed in order to reduce mortalities. Moreover, there is a need to develop specific policies and legal frameworks for CBA that incorporate and create interactions between the fishing and farming sectors.

Replacement of raw ("trash") fish as CBA feed

An important breakthrough will occur when specific cost-effective formulated diets are developed for each species and accepted by farmers. The substitution of raw fish by compound feeds will reduce the existing dependence on capture fisheries, thus indirectly protecting marine resources. It will also reduce the pollution caused by waste feed, promote a favourable ecological equilibrium, enable diet quality to be controlled and guarantee more efficient feed conversion ratios, thus reducing handling and feeding costs (although the ultimate economic gain through such improvements depends on the relative unit costs of the alternative feeds as well as feed conversion ratios). The use of formulated diets will also eliminate the health risks (to the cultured fish) associated with the uncontrolled quality of raw fish. Other factors also need to be taken into account in order to achieve a successful transition to specific formulated diets. These include the final consumer acceptability, and therefore the value, of the products produced using alternative feeds. Such factors are important, because they heavily influence the willingness of farmers to change from current feeding practices.

Improved site availability

Further developments in equipment and technology for offshore farming in cages will result in improved water quality and fish health. The use of offshore locations will necessitate improvements in feeding systems, require larger boats for servicing and call for new techniques for the repair and cleaning of nets and the maintenance of mooring systems. Increased automation, electronic monitoring and the use of tension leg mooring systems are examples of possible solutions.

Waste management

Controlling and reducing wastes would be beneficial to the CBA sector. Sustainable practices would not only preserve the environment and reduce the potential for conflicts with other coastal users; they would also provide products that are perceived as safe by the consumer (thus improving marketability). An integrated and multidisciplinary approach is needed to achieve sustainability. The development of rapid and innovative low-cost environmental impact assessment programmes, together with regular monitoring based on key environmental performance indicators, would be highly beneficial for CBA.

Legal and institutional control of CBA activities

The application of responsible production methods must become the norm in CBA. In many cases, CBA represents the first (but sometimes, as in eel production, very lengthy) step towards true aquaculture. However, this evolution will not affect the characteristics of certain forms of CBA as currently practised, such as the stocking of large bluefin tuna. Furthermore, the CBA of new species will emerge. It is therefore essential that governments explore and develop legal and institutional instruments that recognize CBA as a distinct sector. CBA also needs to be integrated into resource use and development planning. International agreements for specific actions in the CBA sector need to be drafted and signed by all the countries that share common resources. The management of CBA, particularly where the practice is currently unsustainable, needs to be improved. Governments should also actively promote CBA, as it is likely that it will lead to the rearing of new aquaculture species and thus reduce the pressure on existing wild stocks.

Monitoring CBA production

For more than a decade FAO has been refining the questionnaires on aquaculture production that it sends to member countries. These initiatives have been designed to assist in defining which production activities result in aquaculture output (from a statistical point of view) and which should be regarded as capture fisheries production. In 2001, the Coordinating Working Party on Fishery Statistics addressed the specific issue of tuna CBA and decided that the weight of the captured fish should be recorded as capture fishery production and that subsequent incremental growth in captivity should be recorded as aquaculture production. This would avoid double counting.[30]

Although this solution is ideal in theory, there are practical difficulties in weighing the fish both at the start and at the end of the culture activity. The matter is therefore still under discussion and awaits a satisfactory resolution.[31] Until this has been reached, some difficulties will remain in interpreting the statistical data relating to species of tuna that are raised by CBA. Cooperation between FAO and the tuna CBA industry is essential for developing appropriate rates for measuring increments over time so that the correct proportions of the total production can be assigned to the statistical returns for capture fisheries and aquaculture production.

The CBA of eels, groupers and yellowtails does not currently present similar statistical problems because the negligible weight of the fish caught from the wild for stocking into rearing units means that the total production is recorded as aquaculture. However, they may arise in reporting the output from the on-growing of other species that may be caught as large fish and reared by CBA in the future.

RECENT ACTIONS

Hatchery-reared seed

Great strides are being made towards the hatchery production of several species currently reared through CBA. As a result, some portions of the sector will move closer to true aquaculture, thereby limiting the ecological impacts of wild seed capture. Progress in this area may also ultimately facilitate fisheries enhancement programmes.

In Japan, technologies have been developed for sustaining bluefin broodstock in offshore cages and in barrier net/closed cove systems for fisheries enhancement, leading to the first closed-cycle breeding of bluefin tuna in 2002; similar efforts are proceeding in Australia and the Mediterranean. Captive bluefin tuna broodstock are also being maintained in a number of other locations, including California, United

[30] FAO. 2001. *Report of the Nineteenth Session of the Coodinating Working Party on Fishery Statistics*. FAO Fisheries Report No. 656. Rome.

[31] For example, this topic forms part of the deliberations the General Fisheries Commission for the Mediterranean/ICCAT Ad Hoc Working Group on Sustainable Tuna Farming Practices in the Mediterranean.

States. The IATTC has maintained a spawning broodstock of yellowfin tuna (*Thunnus albacares*) on an experimental scale in Panama since 1996, and experimental work on optimizing the conditions for larval tuna rearing is ongoing.

Natural spawning of wild-caught greater amberjacks (*Seriola dumerili*) and the longfin or Almaco jack (*S. rivoliana*) was achieved in Hawaii, United States, in 1999; since then, domesticated F1 and F2 stocks have been used as broodstock.

The survival of hatchery-produced fingerlings of various marine finfish species cultured in Asia, including groupers, has until recently been low and variable. However, there has been a significant expansion of grouper fingerling production in Indonesia, for example, mainly from "backyard hatcheries" in Bali; the principal output of these hatcheries had formerly been another species that was once stocked with wild seed, namely milkfish (*Chanos chanos*). It is estimated that 15–30 percent of the farmed groupers in Indonesia now come from hatchery-reared seed.

There appears to be little immediate hope that seed for eel CBA can be provided through a commercially feasible closure of its life cycle. However, it has been reported that research success, at least for *Anguilla anguilla*, is within sight.[32]

Feed developments

CBA producers are usually reluctant to change feeding practices; the possible failure of alternatives when so much is at stake economically (especially in bluefin tuna production) means that many fear to take the risk. Despite this, there are moves towards the partial substitution of raw fish by manufactured diets.

Research on tuna diets has been ongoing in Australia since 1997 but has been hampered by the difficulties of conducting controlled experiments with such valuable fish. High feed production costs and the suboptimal acceptance of pelleted feeds by tuna have also proved problematic. In addition, a degree of consumer resistance to tuna (and other species produced by CBA) that have been fed using "artificial" feeds has been encountered.

In 2004, at the World Aquaculture Society exposition in Hawaii, United States, an American feed company exhibited a tuna feed being used in Mexico as a supplement at 25–50 percent of the diet; moreover, some farmers were said to be "looking at feeding a 100 percent dry diet to their tuna".

Intensive eel farms, while continuing to use small aquatic worms and fish flesh for the first few days of elver rearing, move through a transitional phase of feeding an artificial moist paste feed subsequently followed by steam-pressed or extruded pellets for on-growing purposes.

Raw ("trash") fish remains the most commonly used type of feed for groupers, despite decades of research aimed at producing pelleted substitutes. Nevertheless, attempts at marketing commercial grouper feeds continue; for example, following a successful commercial-scale experiment with the orange-spotted grouper (*Epinephelus coioides*), one aquafeed manufacturer began selling a grouper feed in the Philippines in 2002.

Raw fish is still used in the CBA of yellowtails in Japan but, since farmers became aware of the environmental damage caused by this practice in the early 1990s, its substitution by moist, semi-moist and "soft-dry" pellets and extruded pellets has been increasing. By 1998, over 120 000 tonnes of artificial feeds were being used. A suitable artificial feed for yellowtails that exceed 3 kg in weight has yet to be identified; these fish exhibit a strong preference for raw fish over extruded pellets.

The need for the partial or complete replacement of marine resources as aquafeed ingredients is not restricted to CBA but is relevant to the rearing of all carnivorous fish and crustacean species.[33]

[32] Anonymous. 2003. Dana Feed Research Project: reproduction of European eel is almost within reach. *Eurofish*, 2/2003: 36.

[33] FAO. 2002 *Use of fishmeal and fish oil in aquafeeds: further thoughts on the fishmeal trap*, by M.B. New and U.N. Wijkström. FAO Fisheries Circular No. 975. Rome.

FUTURE PERSPECTIVE

CBA is an economic activity that is likely to continue to expand in the short term, both with finfish species currently under exploitation and probably with others that will be selected for rearing in the future. In the case of non-finfish species, such as a variety of bivalves (e.g. mussels), CBA is certain to continue indefinitely in view of the very large number of gametes released. However, the CBA of selected species of finfish is more uncertain; where it becomes a direct competitor of capture fisheries there will be many who will argue, at least, for strict limits to this activity. It is therefore critically important that economically viable means be found to rear the species concerned throughout their full life cycle. When that goal is achieved, not only will the future aquaculture production of those species be assured, but the feasibility of restocking programmes may be explored to enhance their capture fisheries.

While opportunities exist for market expansion for species currently reared through CBA, there is a tendency (as has occurred in the aquaculture of salmon, sea bass, and sea bream, for example) for farm-gate prices to decline as the supply increases. Thus, expansion will only be feasible if farmers are able to reduce costs. The main technical constraint to expansion is seed supply. In the case of tuna CBA, future expansion will be constrained by limited fishery quotas. Eel farming is already constrained by the shortage of seed and future expansion is likely to be limited by controls over elver capture. Damage to the environment (e.g. by the collection of grouper seed) may also result in controls that will limit expansion. There is enhanced interest in yellowtail farming but, again, seed supply is a limiting factor.

The potentially positive long-term benefits of CBA should not be ignored. As grouper culture metamorphoses from CBA to true aquaculture in Indonesia, the supply of hatchery-reared juveniles is causing fishers to replace the cyanide harvesting of aquarium fish with aquaculture of reef fish. This development has positive implications for the future of reef fish culture as an alternative to destructive capture fisheries practices – not only in Indonesia but globally.

More research, development and capacity building in the private and public sectors are essential for success in this area. Researchers worldwide have been working for many years on the reproductive cycles of many species, achieving results that range from a hint of success in the case of eels to partially successful ones in the case of bluefin tunas and selected species of groupers. These studies will become even more important if capture fisheries for the species used as wild seed for CBA become threatened, as has happened in the case of eel fisheries. A ban on the capture and export of elvers may result; if this occurs, the farming of eels will cease unless a feasible means of rearing them artificially to the required stocking size becomes available.

In conclusion, critical issues for the future are the development of fry production in hatcheries on an economically viable commercial scale and the refinement of environmentally acceptable grow-out technologies. Failure to address these could have severe consequences for the future of both aquaculture and some capture fisheries.

Labour standards in the fishing sector

THE ISSUE

One of the most significant changes in marine fishing over the last 40 years has been the changing status of fisheries resources. Burgeoning demand for fish, in conjunction with technological innovations in fishing and navigation, especially in the absence of effective fisheries management, has led to a situation where there is little scope for increasing fish production from capture fisheries. This has serious implications for employment in the fishing sector. The emphasis, according to the ILO, is now changing from maximum employment to sustainable employment. At the same time, the global fleet is aging – with consequent effects on the occupational safety and health of crews.

The oldest labour instrument in fishing is the Hours of Work (Fishing) Recommendation, adopted in 1920, just one year after the founding of the ILO.[34] The existing ILO fishing labour standards that apply to persons working on board fishing vessels are the Conventions on minimum age, medical examination, articles of agreement, accommodation and competency certificates, and the Recommendations on vocational training and hours of work. Two of the existing labour standards – competency certificates and accommodation of crews – also explicitly exclude small-scale fishing vessels from their scope. In practical terms, the scope of the existing labour standards in fishing, in general, does not include people who work on artisanal and small-scale fishing vessels. New issues that are not covered by existing instruments include identity documents, repatriation, recruitment, medical care at sea, occupational safety and health, social security protection, and compliance and enforcement.

Although it is almost 40 years since the last ILO fishing labour standard was adopted, the ratification levels of these Conventions have been very low. Moreover, these instruments are no longer fully relevant and need to be updated to reflect the changing nature of fishing operations in today's world. The ILO is therefore in the process of revising them in order to update and strengthen the Organization's standard-setting system to reflect the changes in the sector.

POSSIBLE SOLUTIONS

In March 2002, the 283rd Session of the Governing Body of the ILO decided to place on the agenda of the session of the forthcoming International Labour Conference an item concerning a comprehensive standard – a Convention supplemented by a Recommendation – on work in the fishing sector. The new standard was to revise the seven existing ILO instruments. Issues hitherto not addressed in relation to people working on board fishing vessels would be taken up, namely, occupational safety and health, and social security.

The ILO also intends to provide protection for people working on both large and small fishing vessels in all its fishing labour standards. The Organization believes that the objectives of the new instruments should be to extend coverage to reach as many people working on board fishing vessels as possible; minimize obstacles to ratification; achieve a more widespread ratification; enable the provisions to be implemented in practice and minimize the risk of the Convention becoming outdated in a short period of time.

The new comprehensive standard on work in the fishing sector would take into account the provisions of the 1995 FAO Code of Conduct for Responsible Fisheries and would try to integrate the work of the ILO with that of other international organizations concerned with fisheries and the operation of fishing vessels. This, the ILO believes, would result in the standard being clearly understood and found more acceptable by the ministries responsible for labour issues as well as those responsible for fisheries management and vessel safety, and by fishing vessel owners and individuals who work on fishing vessels.

RECENT ACTIONS

A Committee on the Fishing Sector was set up by the 92nd Session of the International Labour Conference, held in Geneva in June 2004, to adopt provisions on a number of substantive issues related to fishing labour standards. The Conclusions adopted by the Committee, after 20 sittings, aim to reach the majority of the world's fishers, including those on board small fishing vessels. This coverage will provide protection also to the self-employed, especially those who are paid in a share of the catch.

The Conclusions also provide sufficient flexibility to ensure wide ratification and implementation. Such flexibility is particularly important in view of the complex nature

[34] The texts of all ILO Recommendations and Conventions are available on the ILO Web site at http://www.ilo.org.

of the fishing sector, which stretches from small vessels in territorial waters to bigger vessels in the high seas. The Committee sought to achieve flexibility without any dilution of the protection provided to fishers working on vessels of different sizes and in various fishing operations.

The ILO broadens the definition of "commercial fishing" in the new standard to include all but subsistence fishing and recreational fishing (including fishing operations on inland lakes and rivers). The definition of "fisher" includes every person employed or engaged in any capacity on board any fishing vessel, including persons working on board who are paid on the basis of a share of the catch.

Certain categories of fishers and fishing vessels are exempted from the requirements of the Convention where the application is considered to be impracticable. However, such exclusions could occur only after consultation with the representative organizations of fishing vessel owners and fishers.

The instrument will include, for the first time, provisions that will address safety and health in the fishing sector, and thus help reduce the rate of injuries and fatalities in the sector. This is significant, considering that fishing is considered one of the most hazardous occupations. Finally, the instrument will include new provisions on compliance and enforcement, especially those promoting intervention by port states in relation to conditions on board fishing vessels visiting their ports.

OUTLOOK

The International Labour Conference has approved the report of the Committee on the Fishing Sector and adopted the proposed Conclusions concerning the fishing sector. Much work, however, remains to be concluded at the forthcoming Second Discussion during the 93rd Session of the International Labour Conference in June 2005. A new section concerning additional requirements for vessels above a certain, as yet unspecified, length is to be developed by the International Labour Office for examination at the Conference. Provisions concerning longer fishing vessels and accommodation on board fishing vessels are yet to be finalized, and are considered to be "complex and controversial" by the Chairperson of the Committee. There has to date been only limited discussion on social security, which needs to be addressed in the Convention, given that fishers are excluded from the ILO Social Security (Minimum Standards) Convention, 1952. The area of fishers' work agreements also remains outstanding.

While the Employers' Group looks forward to sufficiently broad and flexible standards, the Workers' Group is seeking the adoption of a balanced approach that would be global in scope and provide the flexibility necessary for the progressive extension of standards to the small-scale subsector, and that would ensure that the protection afforded to the larger vessels by current ILO instruments is retained and not eroded. As the proposed Consolidated Maritime Convention would exclude fishers from its scope, the Workers' Group is concerned that the fishing standards should also make provisions to retain protections under existing maritime conventions that are currently extended to fishers.

While addressing the Fishing Committee, the Director-General of the ILO observed: "It is clearly important that no fisher slips inadvertently through the protective net of the Convention … For this to be achieved, the mesh of this net must be just right: not too large that everything is exempt, but not so small that it would stifle ratification and implementation."

The International Labour Conference in 2005 is expected to adopt the revised labour standards for the fishing sector.

Source: S. Mathew, International Collective in Support of Fishworkers (ICSF)

Fisheries management and CITES

THE ISSUE

CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) entered into force on 1 July 1975.[35] It is an international agreement and, at the time of writing, included 166 signatory countries, referred to as Parties. CITES aims to assist in the conservation of species threatened with extinction or species that, although not necessarily threatened with extinction now, may become so unless trade in them is subject to strict regulation so as to avoid utilization that would otherwise threaten their survival. It does this by controlling international trade in specimens of species of concern. The species are listed in one of three appendixes, according to the degree of protection they are considered to require.

- *Appendix I* includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances.
- *Appendix II* includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization that is incompatible with their survival.
- *Appendix III* includes species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade.

The criteria for deciding whether or not a species qualifies for listing are contained in CITES Resolution Conf. 9.24. This provides detailed criteria, with accompanying definitions, guidelines and notes, for listing species in Appendix I as well as more general criteria for listing species in Appendix II. Appendix II has a dual function as it can include species, as described above, for which there is concern over their conservation status (covered by the Annex 2a criteria), but it can also include species that must be subject to control so that trade in specimens of other species listed because of concern for their conservation status can be effectively controlled. This is the so-called "look-alike provision" covered by the Annex 2b criteria. As discussed in the next section, both of these Appendix II criteria are cause for some concern and the source of differences of opinion among FAO Members.

Any Party can submit a proposal to CITES for listing, down-listing or de-listing a species. Typically, such a proposal would be submitted to a Conference of the Parties (CoP) meeting, where it would be voted upon. All CITES Members are eligible to vote on all listing proposals and a majority of two-thirds is required for acceptance. While this mechanism is designed to achieve international cooperation in protecting species of conservation concern, it can also create problems; in practice, achieving a two-thirds majority has frequently proven difficult, leading to frustrations for Parties trying to get a species listed, down-listed or de-listed. Naturally, voting is often preceded by intense lobbying. Critics of the present system maintain that, at times, votes will therefore be decided not by considerations that are inherent to the CITES agreement but by arguments that are extraneous to the issues under discussion.

At the time of writing, there were 827 species listed in Appendix I, over 32 500 species in Appendix II and 291 species in Appendix III. Each appendix also contains a number of subspecies and populations. Appendix II largely comprises plant species (28 074) but also includes mammals (369 species), fish (68 species) invertebrates (2 030 species) and species from other major taxonomic groups. Until fairly recently, CITES had paid little attention to species that are important to fisheries, but at the 10th Session of the Conference of the Parties (CoP 10), held in Harare in 1997, a proposal was tabled for the creation of a working group for marine fisheries. The proposal was motivated by concerns that some fish species exploited on a large scale and subject to international trade might qualify for listing in CITES appendixes. At the same meeting,

[35] See footnote 27, p. 66.

however, caution was also expressed that the CITES criteria might not be appropriate to deal with exploited and managed fishery resources.

Following CoP 10, the matter was brought to FAO on the occasion of the Sixth Session of the Committee on Fisheries (COFI) Sub-Committee on Fish Trade at Bremen, Germany, in June 1998. There it was proposed that FAO should consider the suitability of the CITES listing criteria for commercially exploited aquatic species and explore the need for amendments to, or appropriate interpretation of, the criteria in relation to such species. This marked the start of an intense, frank and fruitful engagement by FAO with CITES, which has led to greater cooperation and mutual understanding between the two organizations and to the formulation of recommendations by FAO for significant changes to the listing criteria. These recommendations were accepted by CITES at CoP 13 in Bangkok in October 2004 as part of a broader revision of the previous criteria.

POSSIBLE SOLUTIONS

The FAO process

The issue of CITES in relation to commercially exploited aquatic species has been discussed at three sessions of COFI (1999, 2001 and 2003) and three sessions of the COFI Sub-Committee on Fish Trade (1998, 2000 and 2002) and has also been the subject of two technical consultations (2000 and 2001) and two expert consultations (both in 2004). In addition, an ad hoc Expert Advisory Panel for Assessment of Listing Proposals to CITES was convened in July 2004 to consider the technical merits of the proposals to CoP 13 for listing commercially exploited aquatic species. Although the work by FAO has focused on the listing criteria and the process for evaluating listing proposals, the administrative and monitoring implications for countries of the listing of a commercially exploited aquatic species and the legal implications and implementation of CITES have also been examined.

In relation to the criteria, the first FAO Technical Consultation on the Suitability of the CITES Criteria for Listing Commercially-exploited Aquatic Species (Rome, 28–30 June 2000) quickly came to the conclusion that the existing (Res. Conf. 9.24) criteria, were not entirely suitable. Discussion of the Appendix I criteria has always been largely technical and at the Consultation included issues such as the need to provide sound technical guidelines on the processes and methodologies for quantifying threshold levels; the need for, and problems associated with, verification and validation of population numbers (Criterion A); and problems associated with the estimation and significance of changes in geographic area of distribution and fragmentation of populations (Criterion B).

In contrast, consideration of the more general criteria for listing under Appendix II, especially the Annex 2a criteria, generated wider disagreement on the intent of the criteria. The Annex 2a criteria stated:

A species should be included in Appendix II when either of the following criteria is met.

A. It is known, inferred or projected that unless trade in the species is subject to strict regulation, it will meet at least one of the criteria listed in Annex 1 in the near future.

B. It is known, inferred or projected that the harvesting of specimens from the wild for international trade has, or may have, a detrimental impact on the species by either:

i) exceeding, over an extended period, the level that can be continued in perpetuity; or

ii) reducing it to a population level at which its survival would be threatened by other influences.

Concern was expressed about the wording in this paragraph, including the interpretation of terms such as "extended period" and "in perpetuity". In particular, FAO Members could not agree on the intention of the criteria and a key conclusion of the Consultation was that "there were differences of opinion as to whether it relates to reducing the risk of extinction and/or promoting sustainable use." These differences of opinion are also found within CITES – they have yet to be resolved and constitute a major cause of controversy over the role of Appendix II.

The Consultation also discussed potential problems concerning the implementation of listing a commercially exploited aquatic species in relation to the Annex 2b criteria – the "look-alike" clause. Annex 2b, Paragraph A states that species should be included in Appendix II if they "resemble specimens of a species included in Appendix II under the provisions of Article II, paragraph 2 (a), or in Appendix I, such that a non-expert, with reasonable effort, is unlikely to be able to distinguish between them". As many fish products are traded in processed form, for example as white fillets, implementation of this paragraph has potentially widespread ramifications for fisheries and fish trade. Furthermore, there were concerns among FAO Members that the references to the precautionary approach, as applied in Annex 4 of Res. Conf. 9.24, could be subject to extreme interpretations.

The 24th Session of COFI in 2001 agreed that a further technical consultation should be held to develop the formal FAO input to CITES on the criteria. Subsequently, a small group of high-level experts was convened in June 2001 to prepare a working document for the Consultation. The group referred to the most recent work on extinction risk in aquatic species, in particular the work undertaken by the United States National Marine Fisheries Service.[36]

A report and recommendations were prepared and submitted to the Second Technical Consultation on the Suitability of the CITES Criteria for Listing Commercially-exploited Aquatic Species.[37] Using these as a basis, the Consultation agreed on some substantial revisions and additions to the CITES listing criteria for application to commercially exploited aquatic species. The FAO recommendations were based on the following fundamental principles:

- In general, it is considered that taxonomic characteristics are less important to risk of extinction than life history characteristics and that population resilience (the ability to rebound after perturbation) is the demographic variable generally considered to be of greatest relevance to the risk of extinction.
- There is no reliable way of measuring resilience, but it is thought to be closely related to population productivity, with more productive species likely to have greater ability to rebound from low numbers.
- Productivity is a complex function of fecundity, growth rates, natural mortality, age of maturity and longevity; more productive species tend to have high fecundity, rapid individual growth rates and high turnover of generations.
- Populations that are low relative to the environmental carrying capacity can give rise to concern about their risk of extinction because they may be susceptible to "depensation", where depensation is defined as a negative effect on population growth that becomes proportionately greater as population size declines.
- Populations experiencing depensation are prone to further reductions in size, even in the absence of exploitation, and therefore have a greater risk of extinction.

Based on these fundamental principles, the Consultation put forward a series of recommendations on biological criteria for consideration for listing commercially exploited aquatic species in Appendixes I and II. Central to the recommendations was the importance of declines in determining extinction risk, where declines can be considered either as a historical extent of decline (the current population size in relation to some historical baseline size) and the recent rate of decline (the observed rate of decline of a population or species over recent time). Criteria were developed for both Appendix I and Appendix II based on these types of decline. This quantitative approach to the interpretation of the Appendix II criteria is considered by FAO to be

[36] NMFS. 2001. Report of the NMFS CITES Criteria Working Group. Preliminary Draft 16 May 2001. Woods Hole, USA, National Marine Fisheries Service; J.A. Musick. 1999. Criteria to define extinction risk in marine fishes. *Fisheries*, 24(12): 6–13; C.S. Holling. 1973. Resilience and stability of ecological systems. *Annual Rev. Ecol. Systematics*, 4: 1–23.

[37] Details of the recommendations are available in FAO. 2001. *Report of the Second Consultation on the Suitability of the CITES Criteria for Listing Commercially-exploited Aquatic Species. Windhoek, Namibia, 22–25 October 2001*. FAO Fisheries Report No. 667. Rome.

an important contribution to the implementation of Appendix II for commercially exploited aquatic species.

In addition to its recommendations on the criteria, FAO emphasized the importance of using the best scientific information available when preparing listing proposals. This information should be subjected to comprehensive analyses, quantitative where possible, in order to integrate the available relevant data. This is the most reliable means of obtaining the best estimates of important indicators such as population size and production rates. FAO also expressed concerns about the process normally used by CITES for scientifically evaluating the proposals because it did not ensure a rigorous evaluation and provided little opportunity for reconciling conflicting views. It was recommended that FAO assist in the evaluation of proposals for relevant species.

After formal approval, the FAO recommendations were sent to CITES for consideration.

The CITES process

When the Res. Conf. 9.24 criteria were adopted by the 9th Conference of the Parties to CITES in 1994, it was recommended by the Parties that the text and annexes of that Resolution be reviewed, in terms of their scientific validity, before CoP 12. CITES therefore began to review the criteria in 2000, after CoP 11. The CITES process included holding two meetings of a specially constituted Criteria Working Group, constant consultation with Parties and interested organizations, extensive review and discussion at CoP 12, testing the draft revised criteria against a number of species from different taxonomic groups and finalization at CoP 13. The FAO Fisheries Department was invited by CITES to serve on the Criteria Working Group and participate in most of the other discussions and consultations. A number of other fish and fishery specialists were also closely involved. Throughout the process, CITES recognized the concerns of FAO, national fisheries authorities and regional fisheries management organizations (RFMOs) about the Res. Conf. 9.24 criteria and was receptive to recommendations and inputs from fishery experts and from FAO. CITES considered it desirable to retain a single set of criteria that is applicable to all species and therefore the definitions and criteria that have been included specifically to address commercially exploited aquatic species have largely been included in Annex 5 of the revised criteria (containing definitions, guidelines and notes). This decision has not, however, weakened these considerations and the revised criteria are now considered suitable, if not ideal, for application to commercially exploited aquatic species.

RECENT ACTIONS

In addition to ensuring that the CITES criteria would be suitable for application to commercially exploited aquatic species, FAO also recommended improvements to the process for scientific evaluation of proposals for listing, down-listing or de-listing species. This has now also been addressed. In terms of the CITES Convention text on proposals for marine species (Article XV, paragraph 2b), the CITES Secretariat is required to consult intergovernmental bodies having a function in relation to those species for the purposes of "obtaining scientific data these bodies may be able to provide" and "ensuring coordination with any conservation measures enforced by such bodies".

Prior to CoP 13, FAO had declined to respond to requests from CITES for information under Article XV on the grounds that the FAO Secretariat did not have a mandate to do so. This situation changed after the 25th Session of COFI in 2003 and the 9th Session of the COFI Sub-Committee on Fish Trade in 2004, where terms of reference for an FAO ad hoc Expert Advisory Panel for the Assessment of Listing Proposals to CITES were approved and it was agreed that such a panel should be convened to evaluate listing proposals to CoP 13 for commercially exploited aquatic species.

The panel, consisting of a group of high-level experts from around the world, met in July 2004 and considered the following proposals to CoP 13:

- *Carcharodon carcharias* (white shark) to be included in Appendix II with a zero annual export quota;
- *Cheilinus undulatus* (humphead wrasse) to be included in Appendix II;
- *Lithophaga lithophaga* (Mediterranean date mussel) to be included in Appendix II;
- Helioporidae spp., Tubiporidae spp., Scleractinia spp., Milleporidae spp. and Stylasteridae spp.; an amendment of the annotation to these taxa to exclude fossils from the provisions of the Convention.

The panel's recommendations were forwarded to the CITES Secretariat and made available to the Parties to CITES in accordance with Article XV. The recommendations were noted by CoP 13 although they were not consistently adhered to in the final decisions, in which it was agreed to list white sharks (without the constraint of a zero quota), humphead wrasse and Mediterranean date mussel in Appendix II.

FAO Members have also been concerned about the implications for exporting, re-exporting and importing states of the listing of commercially exploited aquatic species. An expert consultation was therefore held in May 2004 to consider the following issues:

- the fundamental principles of CITES Article II, especially paragraph 2(b), the "look-alike" clause;
- Annex 3 of CITES Res. Conf. 9.24, which deals with split-listing and aquaculture issues;
- the administrative and monitoring implications of listing and down-listing, including the implications of Annex 4 of Res. Conf. 9.24 in this context. Consideration of this issue included an analysis of the socio-economic impact of listing on selected commercially exploited aquatic species.

In addition, a second expert consultation was held to address a number of legal issues related to CITES and fisheries. These included:

- the application of the phrase "introduction from the sea" used in the definition of trade in Article I of the CITES Convention, including consideration of the administrative costs associated with the various interpretations of this term.
- an analysis of the legal implications of the existing CITES listing criteria and the CITES Convention itself in relation to the UN Convention on the Law of the Sea and related international law covering fisheries.

GLOBAL PERSPECTIVE

Many, if not most, of the world's fisheries are currently caught in a dilemma. A number of the resources on which they depend are overexploited and it is widely accepted that there is considerable excess capacity in the fishing fleets of the world – but fisheries are still important sources of food security, employment and other economic benefits. The fishing nations of the world are attempting to address these problems in a responsible manner. In terms of its mandate, CITES clearly has a role in solving some of the problems confronting fisheries, although countries differ in their views on the extent of that role.

When FAO first became involved in working with CITES, the fisheries agency or agencies and the CITES agency in individual countries were frequently located in different departments and did not communicate with each other to a meaningful extent. Arguably, the most significant progress that has been made over the last five to six years has been the breaking down of such barriers in many countries, thus encouraging the greater involvement of the fisheries agencies in CITES regarding matters of relevance to them. In addition, revision of the criteria so as to bring them further into line with the best practices in fisheries science and stock assessment, coupled with a rigorous and transparent review process, should result in better-informed decisions on commercially exploited aquatic species being made by CITES Parties, thereby contributing to the improved effectiveness of CITES in fulfilling its role and mandate.

Trade implications of fish species and fish product identification

THE ISSUE

Developments in food preservation and processing technologies and liberalization of trade have contributed significantly to the globalization of fish trade and the diversification of seafood, in terms of both species and products. It is currently estimated that more than 800 fish species are traded internationally in many different forms, shapes, brands and preparations.

As prices differ depending on the product/species and consumer preferences and perceptions, it is important that market forces and the market environment provide for the protection of consumers from fraudulent and deceptive practices whereby low-value species or products are substituted for high-value similar ones. At the national level, food legislation generally indicates that the label must not mislead consumers, but international trade and the use of similar terms for different products make this complicated when a product from one country is introduced to another in which the market niche already exists.

Seafood companies and exporting countries are increasingly seeking to sell their products using commercial names with established international repute so as to derive maximum value and recognition. The matter is exacerbated by the fact that different species may have the same common name in different countries (or even regions of the same country). On the other hand, sometimes the same species has different names in the same language in different locations within the same country. For example, in Nordic countries, canned *Sprattus sprattus* is labelled "sardiner" or "ansjos" and is called brisling if not canned, while in other countries sardine refers to *Sardina pilchardus* and anchovy to Engraulidae species. A market name such as "seabass" is frequently used in international trade, but it refers to very different species from various families; the same observation can be made for the name "catfish". This factor may be a source of misleading information.

On the other side, food companies, trade associations and even entire countries can be protective of market niches for given fish species and products. They consider that establishing such market niches often requires significant investment in research and development, publicity, promotion and consumer sensitization towards the claimed attributes of the specific product they are trying to protect. Therefore, the successful companies or countries are unwilling to accept that other similar products may use the same commercial denominations and compete in the same marked niches. Such occurrences may be a source of trade disputes between countries.

Recent examples of international trade disputes (scallop muscles, canned sardines – arbitrated by the WTO) show that the implications of fish species identification represent a recurrent and worldwide issue. Although such disputes generally involve a limited number of countries, they have a direct impact on international fish trade.

In the sardine case, the dispute arose from the fact that the name "sardine" was exclusively reserved for *Sardina pilchardus* in certain countries whereas other countries were intending to develop trade in different clupeid species labelled as "sardine" products. The dispute was taken to the WTO Appellate Body, which looked into the Codex Standard for Canned Sardine and Sardine-type Products.[38] The labelling provisions of the standard state that the name of the product shall be:

(i) *"Sardines" (to be reserved exclusively for* Sardina pilchardus *[Walbaum]); or*

(ii) *"X sardines" of a country, a geographic area, the species, or the common name of the species in accordance with the law and custom of the country in which the product is sold, and in a manner not to mislead the consumer.*

"X" refers to sardine-type species listed in the "Product definition" section of the standard, which include small pelagic fish such as anchovies or herring.

[38] CODEX STAN 94 –1981 Rev. 1-1995 (available at http://www.codexalimentarius.net/web/standard_list.do?lang=en; accessed September 2004).

As an outcome of the dispute on the trade description of preserved sardines, the WTO Appellate Body concluded that the labelling provisions of Codex standards are relevant, effective and efficient in pursuing the legitimate objectives of promoting market transparency, consumer protection and fair competition. Consequently, countries will have to modify their labelling regulations in such a way that they are consistent with Codex provisions.

Other implications of fish species identification may be pointed out in CITES provision implementation. Annex 2b of the Convention establishes two conditions under which a species may be included in Appendix II in accordance with Article II, paragraph 2(b).

A. *The specimens resemble specimens of a species included in Appendix II under the provisions of Article II, paragraph 2(a), or in Appendix I, such that a non-expert, with reasonable effort, is unlikely to be able to distinguish between them.*
B. *The species is a member of a taxon of which most of the species are included in Appendix I under the provisions of Article II, paragraph 2(a) or in Appendix I, and the remaining species must be included to bring trade in specimens of the others under effective control.*

Criterion A addresses the 'look-alike' problem by providing a mechanism for including in Appendix II all species that closely resemble in appearance any species included in either Appendix I or Appendix II in accordance with the provisions of Article II, paragraph 2a.

Some countries are concerned that these criteria have the potential for interpretation in a manner that could result in the inclusion in Appendix II of an economically important marine fish species. Another concern is the difficulties experienced by customs officers in identifying – readily and accurately – imported commodities derived from species included in Appendix II, whether or not they are accompanied by appropriate export documents.

The development of procedures for fish species identification based on sound scientific methods should allow for a more accurate management of protected species and look-alike species and mitigate the economic impact of precautionary principle implementation.

POSSIBLE SOLUTIONS

FAO's Code of Conduct for Responsible Fisheries calls for the liberalization of trade in fish and fishery products and for the elimination of unjustified barriers, in accordance with the principles laid down in the agreements of the WTO.[39] But such liberalization can only take place in a framework of transparency and enhanced information to consumers, particularly with regard to product labelling.

Reconciling the interests of those seeking to protect commercial denominations and those seeking to use these denominations for "similar" species requires an international undertaking using a reliable approach and methodology. The principles depicting the environment to achieve this are embodied in the WTO's binding Agreement on Technical Barriers to Trade. The objective of the Agreement is to prevent the use of national or regional technical requirements, or standards in general, as unjustified technical barriers to trade. It includes numerous measures designed to protect the consumer against deception and economic fraud. In essence, the Agreement provides that all technical standards and regulations must have a legitimate purpose and that the impact or cost of implementing the standard must be proportional to the purpose of the standard. It also states that, if there are two or more ways of achieving the same objective, the least trade-restrictive alternative should be followed. The Agreement also places emphasis on international standards, with WTO Members being obliged to use international standards or parts of them except where the relevant standards would be ineffective or inappropriate in the national situation. The aspects of food standards that are covered specifically are

[39] In section 11.2, "Responsible international trade"; see footnote 14, p. 35.

quality provisions, nutritional requirements, labelling, packaging and product content regulations, and methods of analysis.

Labelling the product so as to indicate exact nature and characterization is considered the most appropriate and transparent method in international trade. Doing so should enable consumers to make choices in full knowledge of the facts and thus should protect them from deceptive practices. Likewise, verifying that a fish product conforms to the claims made on its label requires reliable authentication techniques.

It is therefore important that scientific criteria be developed for listing species under a given denomination and a reliable methodology for verifying the authenticity of labelling claims. In this respect, the Codex standards have become an integral part of the international regulatory framework within which international trade is being facilitated through harmonization. Already, they have been used as the benchmark in international trade disputes, and it is expected that their role will increase in the future.

Fish-exporting countries are increasingly seeking recognition of their fishery products in the Codex standards and it is perfectly understandable that a country would want to derive maximum benefit from its resources and expertise. The potential reward from including additional species or families of species in a Codex standard is, of course, linked to international recognition of the derived products of this species. This recognition is associated primarily with the commercial name of the product; authorization to use a name with established international repute is therefore an important asset and a declared objective. However, value-enhancing appellations are being sought for many species, but such appellations are relatively few. Labelling provisions therefore need to be sufficiently clear to avoid consumers being misled and the creation of conditions of unfair competition in international trade.

Because Codex standards are used as reference documents in trade disputes, discussions within the Codex Committee on Fish and Fishery Products (CCFFP) tend to be tough and lengthy, in particular when considering the definition and labelling sections of new draft standards. The inclusion of additional species in existing standards is also a sensitive issue, to the extent that the Committee has embarked on work to develop an improved methodology for this purpose.

The species proposed for inclusion in a Codex standard need to be identifiable. The present procedure requests that biological information be supplied in order to place the species within a classification, although additional information should also be provided to improve the effectiveness of this procedure. With the prospect of growing international trade and an increasing number of potentially marketable species, reliable methods for verifying product authenticity are essential. The country requesting the inclusion of an additional species in a standard should therefore be in a position to provide biochemical references that will permit the identification of the species in the products covered by the standard, for example, protein electrophoretic profiles or DNA sequences.

The same reasoning may be applied for inclusion of additional species in CITES lists. The development of procedures based on sound scientific methods for fish species identification should allow for a more accurate management of protected species and look-alike species and mitigate the economic impact of precautionary principle implementation.

RECENT ACTIONS

Since the mid-1960s, FAO has developed a programme to clarify and improve, on a national, regional and global scale, the identification of species of actual or potential interest to fisheries;[40] more recently, conservation criteria are also being considered. This programme has produced world catalogues, regional identification sheets and national field guides, used for four decades by many fish trading companies as the

[40] FAO Species Identification and Data Programme (SIDP) (available at http://www.fao.org/fi/sidp; accessed September 2004).

authoritative source of scientific and vernacular names and characteristics. During the last decade, information regarding bony fish and cartilaginous fish has progressively been included in FishBase.[41] FAO has recently established a list of species of interest to the international fish trade and compiled current information on the authentication of fish species using techniques such as electrophoresis and DNA sequencing. This work supports the deliberations of the CCFFP on the identification of fish species for the standardization of fish and fishery products and on facilitating fish trade, especially exports from developing countries.

Based upon available information, in particular in FishBase, the corresponding common names have been indicated, where available, in the different languages used in the different countries classified according to the regions: Africa, Asia, Europe, Latin America and Caribbean, Near East, North America and the Southwest Pacific. It is to be noted that, according to most Codex standards for fishery products, "the name of the product declared on the label shall be the common or usual name applied to the species in accordance with the law and custom of the country in which the product is sold, and in a manner not to mislead the consumer". FAO names and taxonomic codes are also indicated, based upon the Aquatic Science and Fisheries Information System (ASFIS). Nevertheless, this list is to be considered as a starting list which needs to be improved and taken forward to completion. FAO has called upon the collaboration of the member countries of Codex Alimentarius in undertaking this work. The list of species needs to be corrected and updated, in particular to verify whether all species are genuinely of commercial interest, to remove species that have no or little such interest and insert additional species as necessary.

FUTURE PERSPECTIVE

Molecular biology has made considerable progress in the identification of processed fishery products, including products that have undergone extensive technological treatment. It would be interesting to draw up an inventory of the analytical protocols used to identify species used in fishery products and to collate available reference data in the Codex member countries. A compilation or database of internationally recognized references of this nature could be useful for applying the inclusion procedures and for verifying product conformity with the labelling requirements of standards.

Correct identification of the species and their origin requires the collaboration of the scientific community at an international level. During the first Trans-Atlantic Fisheries Technology (TAFT) meeting held in Reykjavik, Iceland, in 2003, the creation of an international network of institutions to provide authentic reference samples was proposed; indeed, the main problem in authenticating a sample is often the lack of reference material at the location where the analysis is required. A useful way forward might be to construct a database or Web page containing a list of each species being used as food and providing the common names for each species, the location where each common name is indeed common, the scientific name, a description of the analyses performed on the species and a link to the results. The results page might present a graphic of how the results look (e.g. a photograph of the gel, or the scan) and, if possible, a table providing the values corresponding to the graphic. For each species, it would also be helpful to include a link to an institution from which samples of authentic material might be obtained

The support of an internationally recognized institution such as FAO would be beneficial in establishing the infrastructure and the contacts among the relevant institutions in each country. FAO is currently examining the possibilities of assuming this responsibility in relation to the Aquatic Food Programme being developed under the direction of FAO Fishery Industries Division, keeping in mind the need to ensure improved access to scientific information on the part of developing countries.

[41] Available at http://www.fishbase.org; accessed September 2004.

By fostering collaboration among international institutions and individual scientists, FAO expects that this programme will generate a peer-reviewed and multidisciplinary aquatic food safety and quality knowledge base. Its long-term goals are to support member countries in the areas of safety and quality (including authenticity) of food produced from aquatic species. Under this programme, the use of information technologies will be maximized to facilitate information dissemination and to enhance capacity-building initiatives in developing countries.

A list of common names linked to the Aquatic Food Programme knowledge base containing scientific data could be useful for preparing and implementing a new Codex inclusion procedure and, more generally, for further work on species identification and for enhancing international fish trade transparency.

Depleted stocks recovery: a challenging necessity

THE ISSUE

During the eighteenth and nineteenth century, thinkers such as Jean-Baptiste de Lamarck and Thomas Huxley assumed that the size of the oceans and the high fecundity of commercially exploited fish and shellfish meant that, under the conditions prevailing at that time, the risk of extinction of fishery resources was low. These scientists overestimated the ocean's resilience to fishing and underestimated both the future demand and the potential progress in fishing efficiency. However, the fact that local natural renewable resources could be depleted through wasteful competition and lack of ownership has been known literally for centuries,[42] and by the end of the 1960s the "tragedy of the commons" was already common knowledge.[43] The problem of overfishing was already recognized by the first FAO Fisheries Technical Committee in 1946 and was flagged recurrently in the successive FAO fisheries conferences, for example in Vancouver (1973), Rome (1984) and Reykjavik (2002), to cite just a few major events. The depletion issue was flagged again at the start of the twenty-first century in *The State of World Fisheries and Aquaculture 2002*, which indicated that "An estimated 25 percent of the major marine fish stocks … are underexploited or moderately exploited … About 47 percent of the main stocks or species groups are fully exploited … 18 percent of stocks or species groups are reported as overexploited … The remaining 10 percent have become significantly depleted, or are recovering from depletion." Among the stocks considered depleted, the Northeast Atlantic and the Mediterranean and Black Seas are the areas with stocks having the greatest need for recovery, followed by the Northwest Atlantic, the Southeast Atlantic, the Southeast Pacific and the Southern Ocean areas.

The depletion of stocks contravenes the basic conservation requirement of the 1982 UN Convention on the Law of the Sea and of sustainable development. It is also contrary to the principles and management provisions adopted in the 1995 FAO Code of Conduct for Responsible Fisheries. It affects the structure, functioning and resilience of the ecosystem, threatens food security and economic development, and reduces long-term social welfare. The demand for fish as human food may reach around 180 million tonnes by 2030 and then neither aquaculture nor any terrestrial food production system could replace the protein production of the wild marine ecosystems.

The Plan of Implementation of the World Summit on Sustainable Development specifically urges the need to "Maintain or restore stocks to levels that can produce the maximum sustainable yield with the aim of achieving these goals for depleted stocks on an urgent basis and where possible not later than 2015." Considering the trends since 1946, this time-frame certainly represents a high-order challenge.

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[42] S.M. Garcia and J. Boncoeur. 2004. *Allocation and conservation of ocean fishery resources: connecting rights and responsibilities.* Paper presented at the 4th World Fisheries Congress, Vancouver, Canada, May 2004, as an opening to the session on Allocation and Conservation.

[43] G. Hardin. 1968. The tragedy of the commons. *Science*, 162: 1243–1248.

ACTION REQUIRED

While stock recoveries from stocks driven to 10 percent of their unfished biomass level have been documented, it is advisable to develop an explicit recovery plan before they fall below 30 percent of that level and, preferably, as soon as resources appear to be clearly below their long-term maximum average yield.

The measures needed for stock rebuilding are no different, in essence, from those needed to avoid its depletion, namely:

- the reduction of mortality through more or less abrupt reduction of effort, including moratoria when they are unavoidable, and bycatch reduction;
- the reduction or elimination of environmental degradation;
- the enhancement of factors of growth, for example through stock enhancement and habitat rehabilitation.

Under the ecosystem approach to fisheries, stock rebuilding is a prerequisite for ecosystem rehabilitation. In the last issue of this report it was stated that "recovery usually implies drastic and long-lasting reductions in fishing pressure and/or the adoption of other management measures to remove conditions that contributed to the stock's overexploitation and depletion". The explicit adoption of a rebuilding strategy, however, implies that rebuilding be adopted as an explicit objective in a formal stock rebuilding plan, including target reference values, specific management measures and performance assessment. It emerges from available examples that a successful recovery plan needs most, if not all, of the following basic components, in some order of priority:

1. A "rule-based" precautionary management framework providing non-discretionary measures incorporated into overriding legislation.[44] Subsidies and other measures that allow participants to continue to fish a depleted stock will compromise recovery.
2. A proper institutional set up with: (i) teams of experts to take responsibility for recovery plans; (ii) a participatory process involving fishers in all operations to promote transparency; (iii) public information and education programmes; and (iv) integration of goals, strategies, measures and data among jurisdictions. In the case of shared resources a cooperative management regime would be needed in most situations.
3. Mandatory limitation of access to the resource and reduction of capacity and exploitation rates to levels compatible with recovery conditions. This may involve closing all or critical parts of the stock range and allocation of explicit fishing rights. In multi-species fisheries, tradeoffs may arise between attaining recovery of the depleted stock and continued harvesting of other, healthier, stocks.
4. Provisions for compensation for definitive or temporary loss of rights and livelihood in the form of alternative employment. These may not be required if alternative resources are available but may be essential in the case of poor, rural or disenfranchised communities.
5. *Ex-ante* assessment of the consequences of the planned measures, for example in terms of bioecological as well socio-economic impacts, the transfer of excess capacity to other areas or resources, and a likely time-frame for recovery. This assessment should offer an analysis of cost–benefits of various options with different grades of severity for the people involved.
6. A system for monitoring stock, people's/communities' status and fleet activities using indicators of fishing pressure, economic well-being, recruitment and environmental conditions and, if affordable, a fishery-independent monitoring of stock biomass by regular research vessel surveys.
7. A system of indicators with target reference points and limit reference points representing agreed "dangerous" stock conditions, unsustainable levels of exploitation of the stock, or deterioration of critical habitats for the resources in question.

[44] As provided for in the Magnuson-Stevens Fishery Conservation and Management Act of the United States Congress.

8. Tight enforcement of the recovery plan until there is a high probability that the stock spawning biomass is above the level corresponding, at least, to the one that provided the maximum sustainable yield or equivalent prior to collapse. In particular, the occurrence of a good year class should be seen as a rare opportunity to rebuild stock biomass and not an excuse to increase quotas or prematurely terminate a rebuilding plan.
9. The elaboration of post-recovery management plans avoiding significant new increases in effort and incorporating aspects of recovery planning into routine, post-recovery management.

Even the best planned recovery may be inhibited by one or more of the following factors:

- unfavourable climate conditions,[45] which, combined with overcapacity, may contribute to the failure of recovery plans, either through delaying the stock recovery response to management or providing incentive (pressure) to curtail management action as soon as a good recruitment is observed;
- a change in species composition, such as replacement by a competitor or depletion of its main prey;
- continued and surreptitious high mortality, for example inflicted through bycatch in another fishery;
- environmental degradation;
- interference in the life cycle, for example through the interruption of migration routes or destruction of spawning or nursery areas.

All of the above factors could be aggravated by loss of genetic diversity.

Because of the costs involved and the essentially uncertain nature of the recovery process, the number of fisheries to be included in recovery plans and the time-horizon for recovery will need to be carefully considered. Recovery times vary according to the resource, the scale of the intervention and the socio-economic and climatic environments. If a large proportion of stocks are depleted and overcapacity is high, the process may need to be drastic, and hence costly, if any impact is to be made in a reasonable time. The reproduction of depleted stocks consisting of young fish is unlikely to give optimal results,[46] and rebuilding the older age groups requires that the recovery time extends beyond a single generation to rebuild the stock capability to "bridge" across medium-term climatic oscillations.[47] Impacts may be felt in the target fishery as well as in other fisheries connected to it, for example through bycatch or predator–prey relationships.

Because of their potential social costs, the development of recovery plans needs the close involvement of the communities concerned.[48] The plans may not be very popular but, as shown by past examples, the cost of *laissez-faire* policies is likely to be much higher in the medium to long term.[49] Rebuilding may require a permanent reduction

[45] Experience shows that environmental fluctuations may delay or accelerate recovery and climate regime shifts produce effects comparable to those of fishing and predator–prey interactions. See, for example, J. Jurado-Molina, and P. Livingston. 2002. Climate-forcing effects on trophically linked groundfish populations: implications for fisheries management. *Can. J. Fish. Aquat. Sci.*, 59: 1941–1951.

[46] See, for example, E. Kenchington. 2001. *The effects of fishing on species and genetic diversity*. Paper presented at the Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Reykjavik, 1–4 October 2001; R. Law. 2000. Fishing, selection, and phenotypic evolution. *ICES J. Mar. Sci.*, 57: 659–890. A. Longhurst. 2002. Murphy's Law revisited: longevity as a factor in recruitment to fish populations. *Fish. Res.*, 56: 125–131.

[47] Recovery times for short-lived tropical and small pelagic fish will, in principle, be shorter than for long-lived demersal resources of high latitudes, for which recovery times upwards of 15 years may be expected, subject to the climatic vagaries mentioned above. As much as a half century may be needed to restore very long-lived resources such as sturgeons, ocean perch or orange roughy.

[48] In the yet unsuccessful cod fishery moratoria in Canada, rights-based comanagement has been used as a means to assist in rebuilding and the industry plays an active role in monitoring closed areas and formerly productive grounds, reducing conflicts between managers and stakeholders.

[49] The collapse of the Canadian Atlantic cod fishery caused a yearly expense of Can$50 million in assistance to individuals and communities in addition to the earlier government expenditures associated with the moratorium. See Fisheries and Oceans Canada. 2003. *Closure of the cod fisheries and action plan to assist affected individuals and communities.* In Focus – Archive, 24 April (available at http://www.dfo-mpo.gc.ca/media/infocus/2003/20030424_e.htm; accessed September 2004).

in fishing capacity and may also lead to the displacement of fishing crew. In most countries, some form of compensatory measures will be needed for both the vessel owners (e.g. vessel buy-back) and the fishing crew (e.g. unemployment insurance, soft loans, retraining, alternative employment). Buy-back programmes have led to mixed results and care must be taken that the financial support provided is not reinvested in more powerful vessels.

During the recovery plan, enforcement and monitoring are of key importance. When recovery begins to be obvious, pressure from the sector to resume or increase fishing rises drastically and strict management will be needed to avoid a repetition of the problem.

ACTION TAKEN

Curbing fishing effort has been the main measure for recovery when the stock has been depressed by overfishing – combined or not with unfavourable climatic conditions. The progressive reduction of fishing, for example through a reduction in total allowable catches, has generally been the first choice in order to limit the need to address social and economic consequences. However, because of the cost and difficulty of reducing fishing capacity to the level of harvest compatible with stock recovery, the action has often been "too little and too late". Allocating the residual effort among the artisanal, industrial and recreational segments of the fishery is a difficult task and rarely attempted. In addition, the fact that catchability tends to increase exponentially with some stocks as abundance decreases seriously complicates the control of fishing pressure. Effort may therefore have to be eliminated abruptly, for ecological or economic reasons; indeed, most of the abrupt fishing closures in the past have been forced by the economic collapse of the fishery.

Seasonal closures (e.g. "biological rest") have also often been proposed as "soft" rebuilding measures. These have been shown to be ineffective if the overall fishing capacity remains excessive.

Moratoria have generally been called for following failed attempts to curb fishing pressure progressively. They have often been imposed as a result of the economic demise of the fishery. No-take sport fisheries may have a similar effect if all individuals caught and released survive. Moratoria were relatively successful in restoring herring fisheries in the North Atlantic and Northeast Pacific. Such closures are more easily implemented and hence acceptable for selective pelagic fisheries than for demersal multispecies multigear fisheries; the latter require an integrated recovery plan that addresses all segments of the fisheries affecting the resource in the area and pose a more complex challenge to a wide range of interest groups. There is no guarantee that the success of total closures will be rapid or even certain, as evidenced by the very slow recovery of the Canadian cod fishery after a decade of efforts.

Areal closures, either permanent (sanctuary), temporary or seasonal, aimed at protecting nursery or spawning habitats and concentrations of spawners or juveniles, have also been used for some time. They may be introduced to protect critical habitats in rivers and streams, mangroves, seagrass meadows, algal beds and coral reefs. Their efficiency depends on the level of overcapacity and degree of enforcement or compliance. Marine protected areas, if adequately located, may be useful in this respect. The closure of a 17 000 km^2 reserve on the United States side of George's Bank to haddock and flounder trawl fisheries demonstrated, after five years, a significant recovery of the two target species as well as some recovery of cod and a large-scale build-up of scallop stocks. However, the results of a closed area or closed fishery are not always entirely predictable, as demonstrated by the rise of lobsters, snow crabs and shrimp landings in the Northwest Atlantic and Scotian Shelf following the cod fishery closure. The high value of these landings might generate pressures against the original recovery plan objective.[50]

[50] Fisheries and Oceans Canada. 2003. *Current state of the Atlantic fishery.* Backgrounder – Archive, 24 April (available at http://www.dfo-mpo.gc.ca/media/backgrou/2003/cod-1_e.htm; accessed September 2004).

Although not uniformly successful, experience shows the importance of a "harvest control rule" specifying the conditions under which rebuilding is obligatory and its strict enforcement for as long as rebuilding is not completed. A rule-based approach requires precautionary or limit reference points to be defined (e.g. for spawning biomass and fishing capacity) and non-discretionary action must be decided in advance and taken if and when these limits are reached. Action should continue until the spawning stock is restored to some predetermined level – possibly higher than that formerly supporting the maximum sustainable yields. A lack of capacity control will then result in the fishery oscillating dangerously around the boundary of the overfished condition.

Results obtained

Proactive recovery planning is recent. The majority of proper recovery plans relate to waters adjacent to developed countries and have less than 10–20 years of track record. Their success has been limited and many plans are still underway. If such a plan is considered successful when an upward trajectory of biomass is registered some time after a plan has been initiated, past experience shows that recovery has been successful in 12 (46 percent) of the cases for groundfish, 8 (67 percent) of them for pelagic fish and 10 (71 percent) for invertebrates, possibly related to reduced predation by collapsed groundfish stocks.[51] These statistics suggest that groundfish stocks recovery has been less successful than for other resources, except for some local area closures in the tropics. It has also been shown that many small pelagics recovered five years after the major decline, while 40 percent of the groundfish stocks continued to decline even 15 years after the period of largest decline in the stock history was over.[52]

OUTLOOK

Can we meet the Johannesburg directive?

The review provided above and the results experienced to date illustrate both the major scale of the task called for in the Plan of Implementation of the World Summit on Sustainable Development, the time frame of which results from political bargaining more than any scientific analysis of recovery times. Recovery will inevitably have a high cost, although the alternative (taking no action) can only be more costly. From the few successful recovery plans located, restoring demersal stocks is a much more difficult task than for pelagic fish and invertebrates, especially on high-latitude fishing grounds. Rapid recovery will also be compromised if environments are unfavourable, or stocks reduced to much below 30 percent of the unexploited stock size. Local recoveries of mainly tropical shallow shelf resources have been achieved relatively rapidly by closing areas to fishing, but it is expected that recovery of high-latitude demersal stocks will require rebuilding periods of 15 years or more, and will probably need to be supplemented by large closed areas and technical measures. Unfortunately, relatively few large-scale closures of demersal fisheries have been attempted in temperate zones, although this mechanism seems to offer chances of success over a decadal time frame.

A negative sign is given by the slow progress achieved in adjusting fishing capacity to biological productivity since the problem was first recognized at least 50 years ago. Awareness is now extremely high and pressure from both fisheries and environmental quarters is growing. However, capacity to fulfil this task is still very unequal and often insufficient, particularly in developing countries. In addition, the concept that without allocation there will be no conservation – a concept reaching back to Greek civilization – has still to be accepted in the modern political arena, jeopardizing the process in many areas.

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[51] J.F. Caddy and D. Agnew. 2003. *Recovery plans for depleted fish stocks: an overview of global experience.* International Council for Exploration of the Sea Doc CM 2003/Invited lecture 2 (available at http://www.ices.dk/products/CMdocs/2003/INVITED/INV2PAP.PDF;accessed September 2004).

[52] J.A Hutchings. 2000. Collapse and recovery of marine fishes. *Nature*, 406: 882–885.

Governance and management of deep-water fisheries

THE ISSUE

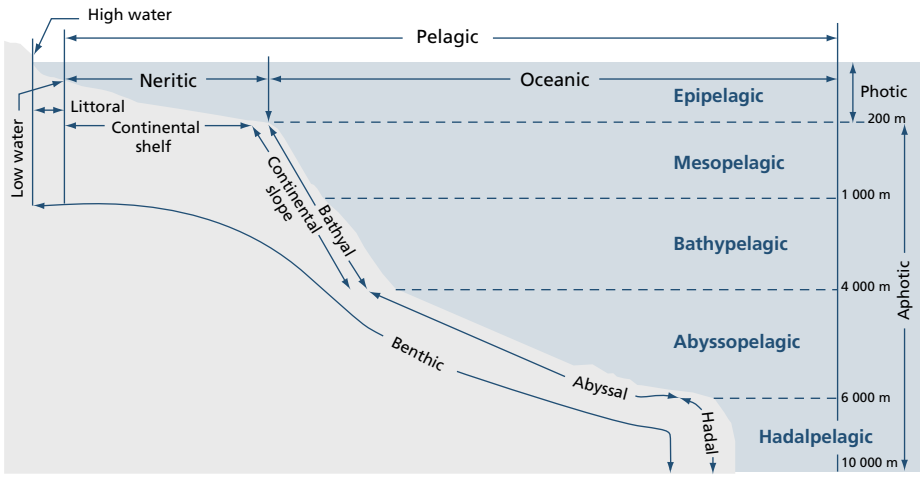
An unequivocal definition of a deep-sea fish is difficult. The recent Deep Sea 2003 Conference, held in New Zealand,[53] took the view that such fish, characteristically, would not be found above the continental shelf or in epipelagic waters (see Figure 37). The Deepsea Fisheries Working Group of the International Council for the Exploration of the Sea takes a limit of 400–500 m as defining their upper-depth range. The behaviour of many deep-sea fishes complicates such definitions – several species undergo extensive daily vertical migrations, moving from the mesopelagic zone into the epipelagic zone to feed; other species move between the continental shelf and slope waters.

In the past, the great depths where these fishes are found prevented, or inhibited, fishing operations in such regions, but technological development has brought possible solutions, albeit with associated management problems. Developments have been rapid during the last 50 years. From a low of 1.2 percent in 1952, reported deep-water landings (excluding China) had risen to a share of 4.7 percent of total marine landings by 2002. China's reported landings of deep-water fishes are almost entirely represented by largehead hairtail (*Trichiurus lepturus*), which accounted for 1.5 percent of total world marine fish landings in 2002.

Today, commercially exploited deep-water species include orange roughy (*Hoplostethus atlanticus*), oreos (*Allocyttus* spp., *Neocyttus* spp., *Pseudocyttus* spp.), alfonsinos (*Beryx* spp.), cusk eels and brotulas (Ophidiidae), Patagonian toothfish (*Dissostichus eleginoides*), pelagic armourhead (*Pseudopentaceros wheeleri*), sablefish (*Anoplopoma fimbria*), Greenland halibut (*Reinhardtius hippoglossoides*), morid cods (Notocanthidae and Moridae) and various species of Scorpaenidae. Away from seamounts, Gadiformes such as Macrourids predominate – these are also slow-growing species but less "extreme" in their population characteristics than, for example, the roughies (Trachichthyidae) caught in the vicinity of seamounts. Several species of deep-water snappers (*Etelis* spp.) and jobfish (*Pristipomoides* spp.) are found above

Figure 37

Ocean biogeographic depth zones



[53] Papers presented at the Deep Sea 2003 Conference are available at http://www.deepsea.govt.nz/; accessed September 2004.

Box 7

Deep-water fisheries: some history

The development of deep-water fisheries has been most extensive in the North Atlantic, and this area dominates global landings of deep-water species (see Figure below). Landings from the Pacific Ocean have been important, although development in this region has lagged behind that of the Atlantic Ocean. During the 1970s and 1980s much of high seas fisheries operations were poorly recorded as many of the nations fishing at that time lacked the legal power, or the interest, to document carefully the catches and fishing efforts of their high seas deep-sea trawling fleets. One such fishery was that for the Pacific pelagic armourhead. In this case, trawling on the Emperor Seamount chain and in the Northern Hawaiian Ridge areas by Russian and Japanese vessels began in 1969. The total catch is unknown but has been estimated at between 36 000 tonnes and 48 000 tonnes per year for the period 1967–1977; 90 percent of the catch comprised pelagic armourhead. Total catches fell to between 5 800 and 9 900 tonnes per year between 1977 and 1982 – and today the fishery no longer exists.

Reported deep-water species landings by oceans and major seas

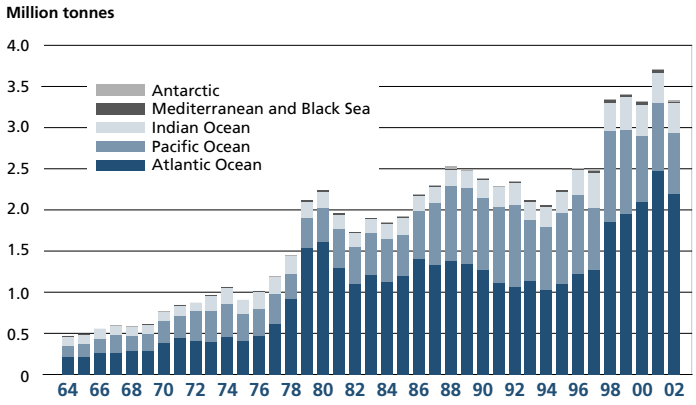


Table 12
Global data on reported landings of deep-water fishes

	1952	1962	1972	1982	1992	2002
Deep-water catch, world excluding China *(tonnes)*	232 574	360 125	870 693	1 726 181	2 348 990	3 325 006
Decadal increase *(percent)*	–	54.8	141.8	98.3	36.1	41.6
Fraction of total marine catch excluding China *(percent)*	1.2	1.0	1.7	2.8	3.3	4.7
Deep-water catch, world including China *(tonnes)*	468 174	759 125	1 366 193	2 219 554	2 971 233	4 613 684

the continental slope in depths of 100–400 m in low latitudes of the Pacific and Indian Oceans. These valuable fish are harvested by small-scale line fishers and, because of their slow growth, are highly vulnerable to depletion.

The drop-line fishery for black scabbard fish (*Aphanopus carbo*) in Madeira is one of the few traditional deep-water fisheries; most commercially important deep-water fisheries today are harvested by trawl in regions of seamounts and seafloor ridges.

The rapid development of deep-sea fisheries has, in many cases, outpaced the acquisition of the knowledge needed for successful resource management. The population biology of many species is not yet fully understood and, despite the widespread nature of these fisheries, little information exists about the impact of fishing on bycatch species (e.g. deep-water elasmobranchs). In the case of benthic effects, the information from the few studies that have been done indicates cause for concern – as in the case of deep-water corals.

In addition to problems encountered in traditional fisheries, deep-water fisheries face other problems that are specific to their industry. These include the low sustainability of long-lived fish resources, discarded bycatch, and the impact of fishing operations on benthos habitats – especially those providing nursery habitats for commercially exploited species. Moreover, because most deep-water fishing occurs on the high seas, an additional concern has been the ability (or inability) of international legal regimes and instruments to provide a satisfactory framework for the effective management of these fisheries' resources.

POSSIBLE SOLUTIONS

Management of deep-water fisheries – the need for more and better data

The management of deep-water resources requires strategies to deal with a variety of species, many of which have an unusual population biology. Among the various types of fish behaviour encountered are: fishes with strong diurnal migrations; pelagic larval phases that may be extended (e.g. oreos and Pentacerotidae); groups that have one, or a few, global spawning populations; those with highly localized spawning populations (e.g. orange roughy, whose eggs quickly become negatively buoyant to facilitate retention near their spawning habitat); and those with behavioural phases of acute aggregation for, at times intermittent, annual spawning. Some deep-water populations are geographically restricted while others have extensive distributions. Many deep-water species have relatively high longevity (around 100 years) and relatively late maturity (15–20 years), while others have life histories that are not dissimilar to those of shelf-bound fish stocks.

Given these challenges, not unsurprisingly, the management success of deep-water resources has been little better than that for many shelf-based fisheries. Even when a precautionary approach has been pursued, total allowable catches set in the absence of definitive information, have initially tended to overestimate the productivity of deep-sea resources. In such cases, fisheries theory predicts that recovery from the effects of overfishing of long-lived species with low growth rates and episodic recruitment will take generations. This underlines the need for resource managers – where they exist and have a mandate and capacity for action – to pay specific attention to the implications of insufficient scientific information, poor or unavailable catch and effort data,[54] little if any information on bycatches and the unknown past development trajectories of the deep-water fisheries. What is known is that the productivity of many such fisheries (but not all) will be low, a consequence in part of the lack of food in mid- and deep-water habitats. Providing operational meaning for management paradigms such as the "ecosystem approach" for the management of deep-water fisheries will require explicit consideration of the conservation of benthic biodiversity and sustaining of minimum spawning biomasses of what may be small fish populations subject to reproductive isolation.

[54] A major obstacle is that historic catch data often do not distinguish between the related product forms, e.g. whole fish, headed and gutted or fillets.

Box 8

The deep sea and its environment

The environment inhabited by deep-sea fishes is large (comprising more than 50 percent of the earth's surface) and its ocean dynamics, fisheries biology and ecosystems are poorly understood. However, over the last two decades, studies of these regions have begun to describe their often astonishing physical and biological nature. While many of these areas are flat with silt and mud-covered bottoms, others are characterized by chains of seamounts and bottom ridges and knolls. Across the continental shelves, turbidity currents have excised submarine canyons, whose importance as links to the deep seas is only beginning to be understood. Other features, such as seafloor seeps and hydrothermal vents, have produced bizarre and complex chemosynthetic communities with highly evolved and unusual faunas.

Diverse and long-lived benthic fauna, most notably the deep-water corals, are associated with seamounts and similar seafloor features. Cold-water corals have longevities potentially in excess of 10 000 years. Their structure, proud of the bottom, and brittleness make them vulnerable to destruction by trawls when inexpert skippers allow their trawls to encounter the surface of seamounts. Also of concern is the apparent high level of endemism of the species in those seamounts that have been researched; thus recruitment of many species from other seamounts may be less than would be expected.

Seamounts have oceanographic features that are important for fisheries. First, commercially important species form spawning aggregations in association with seamounts resulting in profitable catch rates, while those distant from seamounts may produce far lower rates. Second, currents flowing over seamounts bring nutrient-rich waters into the photic zone, enhancing biological production. Then, when Taylor's Columns (named after the scientist who discovered these phenomena) form over the top of the seamount, zones are created that retain fish larvae in the region of the adult fish habitat. Further enhancement occurs when plankton migrate into the surface layers at night and are unable to descend when advected over seamounts, thus providing biomass that can be "captured" by the seamount-based ecosystems.

Successful resource assessment and harvesting strategies for these resources will need:

- *Accurate catch data* – complemented by log books and observer programmes, particularly for areas where no management protocols have been agreed, or satisfactory means have not yet been established that ensure that such information will be made available for resource management purposes.
- *Time series of abundance indices and physical parameters*. Some important deep-water fisheries developed and expired before any protocols for capturing fisheries-related data came into effect. Additionally, vessels that were under no obligation to record information needed for management may not have done so.
- *Stock identity and distribution information*. Deep-water fisheries, especially those of the high seas, tend to be mobile; vessels may remain at sea for several months

and move large distances before discharging their catches. Thus knowledge of the port of discharge may provide little useful information for resource management purposes.

- *Key life-history information* (maximum ages, fecundity, growth and maturity data). When the fish populations targeted are small, the financial and human resources are not usually available to undertake the necessary analyses, and even where they are, it is not always cost-effective to do so.
- *Population biology statistics and age-frequency data*. This information is often unavailable. In such cases, resource management may be possible based on meta-population analyses – the aggregating of information across all relevant species or population groups.

Such considerations will require inventiveness and an ability to make best use of the most recent developments in fisheries resource management. These will include:

- the use of several models to capture alternative hypotheses concerning the available fisheries data and the underlying population dynamics that encompass space and spatial structures;
- an ability to undertake assessments based on analyses of auxiliary information when few pre-specified model parameters are available;
- the use of Bayesian inference to quantify uncertainty in point estimates and the sensitivity of the results to changes to data weightings.
- judgement methods to determine many resource management parameters based on meta-analyses. Assessments for which little data are available will depend on *a priori* expectations about the state of the resources in preference to the commonly used, but often overly simple and optimistic, traditional models.

Additionally, efforts are needed to prevent inexperienced skippers or risk-prone operators from entering deep-water fisheries, where inexperience can result in considerable damage to bottom fauna and its biodiversity. Industry-organized certification of vessel officers who participate in these fisheries may help ensure that they can be carried out with minimum damage to bottom fauna.

Governance of deep-water fisheries

In spite of the adoption of several international instruments building upon the development of the international law of the sea and the international law of the environment, as well as advances in good practices in the ambit of regional fishery bodies or arrangements, numerous shortcomings remain. In fact, most of the world's deep-water fishery resources and the high seas areas where they are found could currently be considered as "unregulated". As the Deep Sea 2003 Conference demonstrated, there appears to be no single view on how best to proceed in regulating and ensuring good governance for these resources. Developing and implementing new binding instruments or modifying existing agreements would probably take too much time to allow for the adoption of the urgent measures that are often required. There are other difficulties to be addressed, such as uncertainty regarding the level of acceptance of these instruments and the need to avoid undermining through this process some of the key elements contained in the existing instruments. Many fear that the conservation, and perhaps even survival, of many threatened deep-water ecosystems would be forgone. Hence, as many believe, the best way to manage high seas deep-water fisheries resources may be to make full use of the existing legal framework and ensure its implementation by all stakeholders. In some instances, the broadening of the competences of existing RFBs or arrangements might be considered; in others, it might be necessary to create new competences.

A regional or fishery-by-fishery approach will probably not be sufficient. It is essential to ensure that problems are not merely exported from one marine area to another. A global approach is also necessary, as in the FAO Compliance Agreement, for example, which seeks to ensure that there is effective flag state control over all fishing vessels used, or intended, for fishing on the high seas. In addition to the action

taken by the flag state itself, the Compliance Agreement contains provisions related to port states, allowing a port state "to promptly notify the flag state" if it "has reasonable grounds for believing that a fishing vessel has been used for an activity that undermines the effectiveness of international conservation and management measures". Other high seas monitoring activities, such as vessel monitoring systems and future catch documentation systems will also stand a better chance of success if embraced in a global manner.

RECENT DEVELOPMENTS

Perhaps first among the developments that have enabled deep-water fisheries to develop have been the satellite-based geographical positioning systems. These allow fishing vessels to set their trawls within tens of metres of open-ocean seafloor features and replicate successful trawls "on a shackle pin" when fish distribution is highly localized. Thus, while this technology has rendered deep-water species available to capture, they have also enabled skippers to locate with greater accuracy where they will set their gear and avoid areas where fishing is impossible or undesirable.

Matching this above-sea technology have been developments in acoustic telemetry of trawls. These enable the net, often a kilometre aft of the ship, to be precisely located in vertical and plane coordinates, so avoiding bottom "hang ups" and allowing gear to be positioned accurately to catch deep-water fish shoals. Supplementing these developments have been the advances in fish detection – the traditional echo sounders and sonars used to locate the fish ahead of the trawl.

Seabed swath mapping systems represent another acoustic development that facilitates the targeting of deep-water resources found within narrowly defined, and often highly irregular, areas. These methods provide highly defined images of bottom profiles and assist aimed trawling so that skippers can avoid areas where the gear might be lost or where bottom contact might occur (Figure 38). Swath mapping provides the equivalent of terrestrial topographic mapping, to the benefit of the fishing skipper.

Successful deep-water demersal fisheries require a suite of particular abilities. First, aimed trawling in deep waters requires skills in vessel manoeuvring and gear control if damage to bottom fauna is to be avoided and the gear not lost. As for any marine resource, the productivity of deep-water fisheries is finite, though usually unknown, and careful management is required to ensure that harvests and resource biomasses are sustained. However, data show that reported landings from the deep seas continue to increase, presumably in some cases through fishing down of resource biomasses and also through gains in fishery productivity.

OUTLOOK

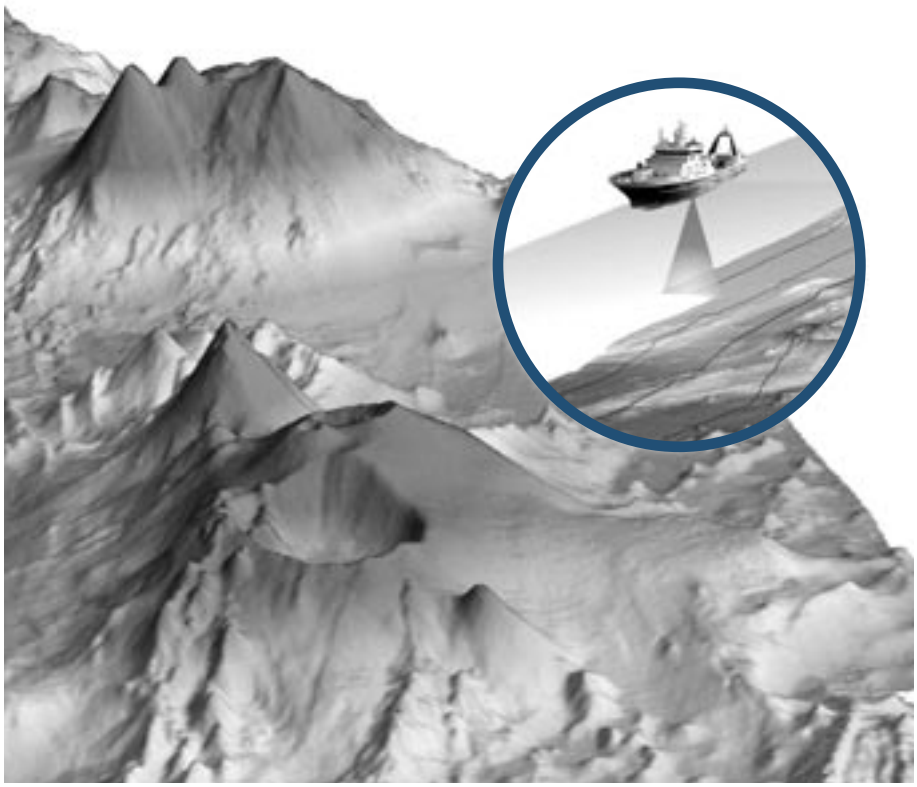
Technology will continue to evolve. Future developments may benefit those who try to control deep-water fisheries on the high seas; they may also benefit those who conduct those fisheries. In view of this uncertainty, there is likely to be a continued effort to strengthen the governance of high seas fisheries in general, and of deep-water fisheries in particular.

Some thought that the provisions of the United Nations Convention on the Law of the Sea, including the qualified freedom to fish on the high seas, would provide comprehensive answers for problems related to the management of the fishery resources of the high seas, where many deep-sea fisheries occur. However, in practice, the freedom to fish on the high seas and the open access to fishery resources this permits have resulted in many problems, most notably the lack of incentives for individuals to constrain fishing effort and comply with conservation measures.

High seas conservation and management regimes under the Convention are limited to transboundary stocks, marine mammals and the use of driftnets. A further continuing problem is how to achieve, through RFMOs, effective enforcement of their conservation and management measures, especially the enforcement of catch quotas. This is discussed further in Box 9.

Figure 38

Bottom imaging has transformed skippers' ability to target demersal tows



Source: National Institute of Water and Atmospheric Research, New Zealand

Despite the broadening of the high seas fisheries conservation and management regimes through such hard- and soft-law instruments, their effectiveness in promoting and facilitating management and conservation of high seas fisheries resources remains to be seen. Effective governance of high seas fisheries will build on the application of relevant conservation and management measures whether a state is a member of an RFMO or not. In this regard, the FAO Compliance Agreement and, more importantly, relevant provisions of the UN Fish Stocks Agreement build on, and give support to, the provisions of the Convention.

Box 9

Governance and fisheries in the high seas

The freedom to fish on the high seas, where most deep-sea fisheries occur, can be traced back to the work of Grotius in the seventeenth century, but its roots can be traced back even earlier – to the time of Roman law. Its continued acceptance in the ensuing centuries resulted in its incorporation into customary international law and subsequently into its codification during the second half of the twentieth century. Thus, the United Nations Convention on the Law of the Sea, which entered into force in 1994, 12 years after its adoption and opening to signature in 1982 and providing the cornerstone of the current high seas legal regime, strongly reaffirms in its Article 87 the principle of "freedom of the high seas". Among the freedoms listed in that article is the "freedom of fishing". It must be stressed that this freedom is not unlimited or unqualified; rather, it is "subject to the conditions laid down in the articles under Section 2 [of Part VII]", which establish a number of obligations that states fishing on the high seas must respect. Additionally, as noted in Article 87 (2), all "these freedoms shall be exercised by all States with due regard for the interests of other States in their exercise of the freedom of the high seas".[1]

It is important to stress that these provisions apply to all countries – to the Parties to the Convention, and also to non-Parties in respect of its requirements that reflect the existing customary international law. Thus, the rights of states fishing on the high seas are qualified by: (a) their treaty obligations (Art. 116 [a]); (b) their duty to adopt measures for the conservation of living resources (Art. 117); (c) their duty to cooperate with other states in the conservation and management of living resources in the areas of the high seas (Art. 118); and (d) their duty to take measures to maintain or restore populations of harvested species [to] produce the maximum sustainable yield (Art. 119 [a]).

It could be expected that these provisions of the Convention would provide a framework sufficiently comprehensive and strict to allow for an efficient management of the fishery resources of the high seas, where many deep-sea fisheries occur, and in particular to avoid the problems that might arise from an unqualified regime of freedom. However, in practice, the establishment of this set of obligations has not been followed by their development and implementation, and freedom to fish on the high seas combined in most cases with a *de facto* open access to fishery resources has resulted in a serious and problematic situation, characterized most notably by the lack of incentives for individuals to constrain fishing effort and comply with conservation measures.

One of the persisting problems is how to achieve, through RMFOs, the adoption and effective enforcement of conservation and management measures, especially catch quotas. Additionally, conservation and management issues are often overshadowed by those related to maximizing benefits from high seas fisheries resources and solving the allocation problems that are commonly experienced in fisheries management arrangements. Countries that already belong to an RFMO might argue that the resource is effectively managed

under a common-property arrangement, i.e. the resource is harvested in common among those who have accepted the rules of the RFMO or management arrangement. However, the expectation of new entrants when becoming members of an RFMO is that they will participate in harvesting the allowable catch. If no provision is adopted to regulate this situation and control access to the resource or the total fishing effort, particularly where there is flexibility in allowing for membership of the RFMO, then, operationally, there is no distinction between this and a truly open-access situation.

The 1990s brought the problems in managing high seas stocks into sharp relief. To address issues of high seas fisheries management raised in the Convention on the Law of the Sea, a series of international instruments have been negotiated and adopted, including Chapter 17 of the 1992 Agenda 21, the 1993 FAO Compliance Agreement, the 1995 UN Fish Stocks Agreement, the 1995 FAO Code of Conduct for Responsible Fisheries,[2] and several international plans of action including the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing.[3] While the FAO Compliance Agreement and the UN Fish Stocks Agreement are treaties that bind states that are Parties to them, the Code of Conduct and its Plans of Action are voluntary in nature. However, while differing in scope, nature and contents, these hard- and soft-law instruments were largely negotiated over a similar period and represent significant steps in the development of principles and standards applicable to the conservation and management of high seas fisheries.

Beyond the need to ensure the widest acceptance of these instruments and their effective implementation, the issue still remains of the applicability of the agreed international regimes to non-Parties. Effective governance of high seas fisheries resources requires the application of relevant conservation and management measures by all states whose nationals fish these resources, whether they are members of the competent RFMO or not. In recent years, a number of RFMOs have developed their practice in this respect in order to ensure compliance by non-members (for instance through establishing a category of "cooperating non-Parties"). In addition to the relevant provisions of the FAO Compliance Agreement, it is interesting to note that the UN Fish Stocks Agreement has attempted to go beyond the traditional exclusiveness of the flag state responsibility in several of its provisions on compliance and enforcement, although this effort met with the strong reservation of a number of countries.

[1] The full text of the Convention is available at http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm; accessed September 2004.
[2] Op. cit., see footnotes 11,13 and 14, pp. 27 and 35; for Agenda 21, see Box 5, footnote 4, p. 63.
[3] The text of the Plan of Action is available at http://www.fao.org/DOCREP/003/y1224e/y1224e00.HTM; accessed September 2004.