FISHERIES

1. BOAD is an institution that supports rural and agricultural development including fishing. Thus, in its policy of granting funding to fisheries projects, the bank must ensure that a number of measures are taken to limit or avoid the environmental damage of these projects. This document provides guidance on the implementation of projects or actions related to the fisheries sector in countries members. Fishing can be classified into two broad categories: capture fisheries and farmed fish (aquaculture and mariculture).

2. Capture fisheries refers to any type of capture of living resources naturally occurring in both marine and freshwater environments. The major methods are: (a) actively seizing fish or shellfish in a net (seine, trawl) or trap; (b) tangling fish in a net (gill, drift or trammel); and (c) catching them with hook and line . Capture fisheries operate in marine, fresh and brackish waters and range from large commercial concerns to small-scale artisanal fisheries. Marine fisheries include offshore and near-shore operations. Inland fisheries include those on rivers, lakes, reservoirs and estuarine areas.

3. Culture fisheries is the capture of fishery products from aquaculture (marine, brackish and fresh water, ranching, etc.). It involves management of resources to increase fishery production beyond that which is normally available from wild stock. Fish farming achieves higher concentrations of fish or shellfish by raising them in ponds; containing them in naturally productive areas by using cages, pens or nets; providing substrates for the attachment of nonmotile animals (e.g., oysters); or adding fish or shellfish to natural habitats (e.g., reef seeding, clam grow-out areas).

Potential Environmental Impacts

4. Since the Second World War, strong and sustained demand for fish for human consumption and livestock feed has put increasing pressure on fishery resources. Fish farming has the greatest potential to increase fishery production, but it is associated with many environmental problems.

5. As demand is approaching production limits, many fishery resources are deteriorating. Overexploitation is depleting certain stocks, and other human activities are affecting fishery productivity and aquaculture potential in fresh, brackish and saltwater systems. These impacts affect traditional and commercial fishery operations as well as recreational and related water-based tourism. Pollution from industrial, urban and agricultural areas, land use in watersheds and water management affecting river flows and sediment loads, and coastal development all are having negative impacts on fisheries (see Table 1 at the end of this section for further discussion). The direct impacts on the environment by capture and aquaculture operations, as well as external environmental impacts on the fishery resources are examined in this section.

Capture Fisheries

6. The major direct negative environmental impact of capture fisheries is overexploitation. Overfishing not only degrades the target fish population by changing its population size and structure, but affects other species linked to it in the food chain. Non-target species are also inadvertently

harmed or killed by the use of certain fishing equipment and practices that do not catch the desired species exclusively or that are harmful to habitats. Trawling is of special concern because dragging nets across the bottom can damage benthic communities. Accidental damage to coral reef by anchors and divers can be significant. Lost or discarded fishing nets, traps and other fishing gear entangle and subsequently kill fish needlessly (i.e., "ghostfishing"). Although almost universally prohibited, explosives and poison are still used by some fishermen. Not only are many of the fish that are indiscriminately killed, wasted, but these practices may destroy habitats (e.g., coral reefs). Finally, the risk of oil and fuel pollution from accidental spills increases with intensified fishing activity.

7. Fisheries are subject to a wide variety of environmental impacts caused by human activities. Man's impact on the condition of the oceans, which still are in reasonably good condition, is limited. Substantial man- induced resource degradation is evident, however, in freshwater and coastal systems.

8. The effects of inland water resource management and land use are apparent both locally and downstream, often all the way to coastal ecosystems. Land use changes in the watershed, such as clearing of forests and increased agricultural activity, often will affect the quantity and quality of water entering surface waters which in turn have an impact on aquatic populations and in wetlands. The construction of dams and reservoirs, irrigation schemes, and flood control measures interrupt the pattern of seasonal flooding necessary to many fish for breeding and growth, change seasonal flow patterns, alter water quality, and disrupt or destroy fish habitats. (See the following documents for more information: "Dams and Reservoirs"; "Flood Protection" and "Irrigation and Drainage.") Losses to

riverine and floodplain fisheries caused by dam construction, however, can be compensated, at least in part, by the reservoir fishery which is created.

9. Pollution of river, lake and marine waters by sewage, industrial effluent, acid rain and agricultural chemicals can reduce the survival rate of aquatic organisms, contaminate fish and shellfish, and create human health problems. Eutrophication from nutrient-rich inputs, such as fertilizer runoff, domestic detergents and untreated sewage effluent, can lead to mass fish mortality or gradual decline in fish populations, changes in species composition, and algal and phytoplankton blooms which foul nets and may be toxic to humans. Another source of pollution is non-biodegradable debris (e.g., plastic materials), which is increasing in quantity and becoming a serious hazard to fish which ingest the material or are entrapped by it.

10. Coastal ecosystems, including estuaries, mangrove swamps, seagrass beds, salt marshes and coral reefs are highly productive fishery habitats and play important protective roles against waves and high tides from the sea and flooding and sedimentation from the land. Many areas are being damaged or destroyed by the effects of accelerated settlement and economic development on the coastal fringe. Coastal development activities often affect runoff and cause silting and sedimentation of breeding grounds, coastal fishing areas and coral reefs. Dredging, land reclamation, drainage of wetlands and destruction of mangroves can directly or indirectly destroy important breeding and nursery grounds for fish and other species. Oil pollution from offshore oil exploitation and naval traffic can foul nets, taint or kill fish, spoil aquatic habitats and impact the entire food chain.

Culture Fisheries

11. Aquaculture and mariculture projects, by manipulating natural systems, inherently have more significant possible environmental impacts than capture fisheries. Pond culture should receive attention.

12. The most obvious effect is the clearing of land and establishment of the ponds. This can be most destructive in coastal areas, such as in mangrove swamps and other wetlands which are particularly sensitive to disruption. The worth of these areas' production and protection functions is frequently undervalued and the importance of these areas to local economies underestimated. Extensive systems which involve large areas of ponds managed with minimal inputs are particularly destructive by virtue of the extent of land converted to ponds. Fish ponds established in inland areas are often established on flat, marginal agricultural lands of lower economic or ecological value. Nonetheless, ponds constructed on these lands may conflict with traditional uses of the land (e.g., seasonal grazing, livestock watering) which are of critical importance to local residents.

13. Fish ponds may have both positive and negative effects on local hydrologic conditions by altering water flow and affecting groundwater recharge. Ponds located in a natural stream channel, for example, can help reduce flooding in the immediate area, serve as a trap for sediments carried in runoff, and through seepage, raise local soil moisture. If located in an area subject to flooding, water diverted from the ponds by dikes could cause flooding elsewhere.

14. Water management in the areas affected by fish ponds is crucial, as fish ponds can reduce the water supplies available for competing demands,

such as for irrigation, domestic or industrial use. Traditional drinking water supplies and washing areas can be disturbed when streams are diverted to aquaculture ponds. Local groundwater can be depleted by withdrawals for ponds. In general, the establishment of aquaculture ponds which draw on scarce ground or surface water supplies, particularly in arid areas, should be avoided except where fish production can be integrated with other water use (e.g., reusing pond water for irrigation, cage culture, in irrigation canals).

15. Pond drainage water can pollute nearby aquatic environments. The extent of pollution will depend on the quality of the pond water as well as characteristics of the receiving waters. The type and intensity of pond management frequency of water exchange, inputs of fertilizer and chemical swill determine the quality of water in the ponds. Pond water is almost always more nutrient-rich than surrounding waters, but will be more so if fertilizers and feeds have been added to the pond to increase fish productivity. Chemicals used in the ponds (i.e., for pond sterilization, weed, insect and disease control, water quality regulation, and control of undesirable fish) can also contaminate local waters. The quality of the receiving waters at the time of release from the ponds, and their dilution and dispersion capabilities will determine the effect of pond effluent on the nearby aquatic environment.

16. Ponds often are stocked with larvae and juveniles captured locally. This can deplete wild populations of fish, and erode capture fishery operations in the area.

17. Other potential negative impacts of fish pond aquaculture arise from the use of exotics: negative impacts on the wild native species from the spread of disease and parasites by the exotic species or from escape of pond fish

to the wild. Selective breeding also has a potential long-term impact by reducing genetic diversity within fish populations.

18. Lastly, ponds can increase the incidence of human disease in an area by providing habitats for water- borne or water-related disease vectors such as snails (schistosomiasis) and mosquitos (malaria, dengue and other arboviruses).

19. Although fish farming operations that involve raising fish in nets or cages have few potential negative impacts, they can cause problems if practiced too intensively. The concentration of pens may increase to such an extent that navigation is hampered, water circulation restricted, and water quality decreased. Similarly, rafts or pilings installed for the cultivation of nonmotile animals can cause navigational hazards.

20. The external impacts on aquaculture are similar to those affecting capture fisheries. These include agricultural, industrial, municipal or transportation activities that decrease water quantity, degrade water quality, and increase sediment loads in supply waters. Drainage from irrigated fields or runoff from other agricultural areas containing fertilizers and pesticides will also affect fish pond water quality.

Processing and Transport

21. The indirect impacts of fishery projects result from the processing and transport of fish and shellfish. The effluent from fish processing plants is high in organic matter (offal and blood), oil and grease, bacteria, nitrogen and suspended solids. Discharge of the effluent into waters that cannot adequately dilute and disperse the waste can result in anaerobic

conditions and fish kills; increased turbidity which affects corals, seagrasses and other organisms settling out of solids which smother bottom dwelling organisms; oil and grease that cause ecological and aesthetic problems; and contamination of fish and shellfish.

22. Fish processing, which often requires large volumes of water, can compete with other demands on the water supply.

23. The processing and transport of fish in a large fisheries project may require substantial infrastructure development, including roads, port and harbor facilities, and power and water supplies (for icing and refrigeration. etc.). Such developments have their own attendant impacts and are discussed in more detail in the following documents: "Rural Roads"; "Electric Power Transmission Systems"; "Roads and Highways" and "Port and Harbor Facilities."

Special Issues

Socioeconomic Issues

24. The development of all fisheries must be concerned as much with proper management of the fish resource as with improving the welfare of, or avoiding negative socioeconomic impacts on, fishermen, fish farmers, people involved in marketing and seafood consumers. While fisheries development can have beneficial effects on human nutrition in an area, the growth of commercial fisheries which export fish to external markets may reduce the quality or quantity of fish available for local consumption by competing with local fishermen and destroying or degrading aquatic habitats. Traditional lifestyles, patterns of resource use and subsistence

economies may be disrupted or subverted by the introduction of cash economies in rural development fisheries schemes. Finally, human health risks are posed by contaminated or spoiled seafood, or as can be the case with fish ponds, by creating a habitat for vectors of water-borne or water-related diseases.

25. Integrating both technical aspects and socioeconomic needs of fishing communities requires that the community actively participates in planning and execution of development activities. This improves the possibility that the fishery resource will be properly managed. It will also help assure that fishery resources are shared equitably between large and small-scale producers. Attention should be paid to ensuring that benefits accrue fairly to different social groups and that middlemen do not erode fishermen's earnings. Also, to the extent possible, local labor should be given preference over imported labor.

Pond Fish Farming

26. Although in theory a promising enterprise, pond fish farming has had a high rate of failure. The most common causes of failure are poor siting and improper pond management. Poor siting can lead to problems with soil, water supply, drainage, and conflicting land use practices. The most important issue in management is flushing or exchange of pond water which must be done frequently enough to prevent the deterioration of water quality in the pond.

27. These factors are especially important for ponds located on coastal wetlands, whose previously waterlogged soils (if rich in pyrite and organic matter) can form acidic conditions when exposed to air or highly oxygenated water. Production decreases when the pond water becomes

acidic or its quality deteriorates in other ways. In extensive areas of coastal wetlands (e.g., mangroves, tidal marshes) where the impression is that land is "unused" and therefore available, more land may be cleared for ponds when the existing ones become unproductive. The cycle begins again in a syndrome called "shifting aquaculture". Such pond operations not only are uneconomical, but economically unjustifiable, for the productivity of the ponds often proves to be lower than that of the natural ecosystem which has been lost.

28. Institutional factors also affect the success rate of pond fish farming projects. The private sector has been proven to be more successful than governments in this area. Where fish farming is judged to be economically feasible, efforts should be made to encourage private enterprises to invest.

Introduction of Exotics

29. The introduction of exotic species for fish farming or capture fisheries is a controversial practice. Not only have introductions or transplantations been less successful than anticipated, but they may have a net negative effect. Introducing exotics into new environments almost always poses the risk of competition with and predation on the indigenous species. Although exotics are introduced to increase fisheries productivity, they may be responsible for a net loss in fishery production by reducing populations of native species. In addition, exotics have the potential for introducing diseases and parasites into the local aquatic environment. In general, the introduction of exotics should not be advocated for capture fisheries, and should be done only with extreme care and only after precautions are in place in fish farming operations.

Project Alternatives

30. The main alternative to launching a new fisheries project is to improve the efficiency of existing fishery operations. In some places post-harvest losses due to spoilage are very high, particularly in traditional/artisanal and small-scale fisheries located in remote rural areas without infrastructure facilities for handling, processing, storage and marketing of the catch. In addition to reducing post-harvest losses, measures can be taken to salvage fish now discarded and intensify use of all fish by developing new products and expanding markets.

An alternative to pond aquaculture in coastal wetlands is to develop ways of utilizing the natural productivity of the intact ecosystems (e.g., mangroves, salt grass marshes) instead of converting them to pond production.32. Within a given project there are a number of options for its design and implementation which can reduce ecological, social and economic problems. They are as follows:

(a) Culture Fisheries

. Procedures and techniques: native vs. exotic species; stocking from wild or hatchery organisms; extent of use of fertilizers, feeds and chemicals; harvest methods such as seining and pond draining; marketing methods; selling fresh vs. preserving; preservation methods such as icing, freezing, drying, salting, and smoking.

(b) Capture Fisheries

. Procedures and techniques: number and size of boats; fishing methods and equipment used; catch goals; fishing areas; marketing methods; preservation practices.

Management and Training

33. Costal countries have fisheries policies and development plans, but achievement of successful fisheries development is difficult. This is due to the following factors:

. it is difficult to predict the size of various fish stocks targeted by capture fisheries due to natural fluxes in population size;

. sound management of the resource requires reliable statistics on fishery stocks and catches over time, involves expensive scientific programs, and requires effective enforcement of plans and regulations;

. there are many conflicting demands on freshwater and coastal aquatic environments which must be balanced by governments;

. land and resource practices outside of the jurisdiction of government fisheries agencies have profound effects on the fishery resources;

. coordination between governments and local communities is often weak, and where national government policies conflict with local views, needs and customs, the policies are difficult, if not impossible, to enforce;

. collaboration between governments in the management of stocks which cross national boundaries is difficult; and

. national governments are unprepared to take over the authority and complex responsibilities outlined by the Law of the Sea legislation, and other laws protecting individual species.

34. Multidisciplinary approaches essential for planning the optimal use of inland water, coastal or near-shore habitats, choice of technology, prevention of pollution, and reduction of conflicts with other sectors such as agriculture and industry, will require integrated planning. Coordination with other line agencies, local water pollution control agencies, appropriate agencies responsible for conservation of critical coastal ecosystems and riverside communities is essential. Intersectoral approaches should be explored at the earliest possible stage in project preparation to identify potential issues and conflicts so that mitigation strategies can be proposed. It may be impossible to satisfy the interests of all parties involved under a national fisheries law or government venture agreements. Negotiations must be conducted on a continuing basis. It is essential that an institutional environment be fostered in which competing interest groups may reach mutually acceptable and enforceable compromises.

35. Knowledge of existing law and socioeconomic norms which regulate individual and community property and use rights to fishing grounds within a project area are fundamental to project design. National fisheries laws and joint venture agreements for fisheries should contain provisions that would help achieve resource management objectives and protect the environment. Any or all of the following detailed provisions would best be determined at the time of project design: number and size of boats, authorized fishing areas, catch quotas, fishing methods, and catch limits. In some instances, new regulations may be needed to protect habitats or community rights of access to certain fishing grounds.

36. Appropriate project design for fisheries that factors sound management and development of the resource require a range of skills in biology, ecology, economics, law, and engineering. Many of these skills are lacking in developing countries, requiring sufficient institutional support, both at the local fishermen level and within the government agency responsible for the

sector. Provision of skills through technical advisory services, technical and managerial training to develop capacities at all levels, and pilot or research components to determine appropriate management of the stocks or pond culture in question may be required.

Monitoring

37. Factors to be monitored include:

(c) For Capture Fisheries

. water quality (including pollution and oil spills)

. fish stocks (population size and structure)

. fish landings (quatity, species)

. conformance by fishermen to regulations on equipment use, fishing areas, catch, fishing seasons

. presence of any discarded materials causing "ghostfishing"

. effects of land use or water management on water quality and fishery resources

. condition of non-fish species, especially indicator species (those most susceptible to changes in water quality)

. contamination of fish or shellfish or presence of conditions which could lead to contamination (e.g., red tide, oil spills)

. condition of wetlands (mangroves, sea grass beds, coral reefs)

(d) Culture Fisheries

. water quality in fish ponds or fishing waters containing traps, nets

. water quality of fish pond effluent

. water quality and quantity of fish pond receiving waters

. hydrologic effects of fish ponds

. effect of aquaculture on local capture fisheries (population size and structure, health condition)

. presence of fish diseases or parasites

. contamination of fish or shellfish

. increase in water-borne or water-related disease vectors or human disease attributable to fish pond establishment

(e) Processing

. water quality of influent to and effluent from fish processing plants

. changes in commercial and non- commercial (especially indicator) species down-stream of processing plants

Potential negative impacts	Mitigation Measures
Direct impacts: capture fisheries	
Over exploitation of fish stocks and long-term degradation of fishing.	Fisheries management for optimal sustainable yield: develop management plans for fishery resources before exploitation and periodically revise • restrict catches (minimum size limit, catch quotas, seasonal closures); • apply restrictions (prohibiting trawling, specify the mesh size of nets); • closing areas to fishing (permanent reserves, periodic closures); • restrict access (permits, exclusive access);

	• prohibit certain practices (such as the use of explosives and nets); • take into account traditional fishing practices, improve and incorporate as much as possible in the modern methods of fisheries management. • Create protected areas in the aquatic environment
Damage to non-target species and damage to biotopes caused by equipments and practices unsuitable for fisheries.	• Use proper fishing methods, restrict or prohibit the use of equipment and destructive practices of wildlife and biotope. • Test and experiment small-scale new technologies prior to introduction. • Expand the range of products based on fish and develop the markets. • Protecting vulnerable or endangered species
Pollution caused by oil leaks and oil spills and bilge water.	• Develop public education programs that explain how to handle oils and hydrocarbons and remove the bilge water. • Construct storage and handling facilities and implement bilge and waste disposal services
Damage caused by divers and anchors	• Develop educational programs to inform fishermen of the extent of the damage and measures and solutions to avoid them. • Install mooring buoys. • Identify places anchor.
"Fishing invisible" and navigational hazards resulting from the abandonment and loss of fishing nets and traps.	Provide for fishermen public education programs warning them of the dangers posed by the abandonment of equipment.
Use of explosives and poisons.	Ban such practices and enforce regulations .
Introduction of alien species threatening native stocks.	Prohibit the introduction of exotic species

Direct impacts: culture fisheries	
Clearing or development of coastal wetlands for the construction of fish ponds.	• Prohibit the installation of fish ponds in areas where the ecological environment is of particular importance. • Limit the areas of development. • Strengthen the management of new ponds and existing ones to discourage the low investment "traveling aquaculture» and extensive aquaculture occupying large areas.
Erosion and siltation problems during the construction phase	• Restrict clearing around the locations of fish ponds. • Build the ponds during the dry season. • Consolidate exposed soils with herbaceous plants or other vegetation
Competing demand for water resources and land allocated to breeding ponds	• Assess the traditional use and demand of water resources and soil in agricultural, industrial and municipal sectors. • Plan , manage and conduct negotiations in order to reach an acceptable distribution of resources. • Locate the breeding ponds so as not to interfere with traditional uses of water for washing or for human consumption . • Coordinate aquaculture ponds with other activities to share water consumption (recycle water basin irrigation water, for example).
Productivity losses or formation of toxic elements in the basins due to a rise in temperature, low oxygen content and residue buildup. Acidification of pond waters due to the formation of hydrogen sulfide.	Adequately transfer basin water, and regularly drain ponds Locate ponds in areas that are not sensitive to acidification (avoid saturated water whose content of pyrite and organic matter in soil is high).

Declin in local stocks of larvae and fry	Appropriately renew and dump pond waters. Produce larvae and fry in tanks.
Water pollution from effluents (rich in nutrients and containing a variable number of chemicals, depending on the intensity of production ponds).	• Release the effluent into the aquatic environment may provide sufficient dilution and dispersion. • Dilute the effluent prior to discharge. • Select the time of high tide to discharge effluents. • Reduce the retention time of water in the pond: more frequent transfer and winnowing. • Treating wastewater before discharge.
Introduction of exotic species likely to harm native species, as competition, predation and spread of diseases and parasites. Spread of diseases among stocks living in ponds and wild stocks when their populations become too numerous. Concentration of compound, pilings and frame in natural waters (out of the watershed) whose magnitude interferes with navigation, restricts the flow of water, reduces its quality and harms capture fisheries. Dams that affect the water quality and flow of streams and damage to fishing rivers and floodplains.	• To prevent the introduction of exotic species, unless the knowledge of biology and evolution of species suggest low risk and that the necessary precautions are taken to prevent fish from escaping. • Perform regular monitoring of risk of disease and parasites , and if diseases or parasites are present or spread , destroy infected populations. • Consider the use of sterile hybrids . • Monitor the incidence of disease . • Limit the population when it is shown that the onset of disease is directly related to their density. • Eliminate the individuals responsible for the spread of disease. Regulate aquaculture in order to limit the activities to an acceptable intensity. • Establish fisheries on the impoundment. • Manage water discharges in order to reduce the impacts on fisheries (see " Dams and reservoirs ").

External impacts: capture and culture fisheries	
Irrigation projects which affect the quality and quantity of water. Land use and agricultural practices in the watershed affecting the composition of the sediment and water quality . Measures against floods that affect the quality and quantity of water and threaten aquatic habitats. Pollution from industrial effluents, sewage and agricultural chemicals that endanger the survival of fish and their contamination. Air pollution and acid rains which endanger the survival of fish. Exploitation of coastal areas as dredging, filling, destruction of mangroves and infrastructure development. Oil pollution caused by coastal and inland navigation by oil spills from drilling, transportation activities and the unloading of tankers.	Establish fishing activities in irrigation networks (use , for example, water basin for irrigation, nets and traps in the irrigation canals) . • Provide irrigation processes to reduce impacts on fisheries (see " Irrigation and Drainage "). • Establish an integrated development and watershed management plan. • Ensure close collaboration between fishermen and government agencies responsible for resource management in watersheds to draw their attention to the effects on fisheries. Refer to the «Flood prevention " section. See section " collection , treatment, recycling and evacuation of sewage " in Chapter 9, and those dealing with the " Location of factories and development of industrial complex " and " Industrial Risk Management " in Chapter 10. See " Air Pollution " in Chapter 2 . See sections " Coastal areas Management " and " Ports and harbors " in Chapter 9. See sections in Chapter 9 dealing with " Inland navigation " and " Ports and harbors ," and sections of Chapter 10 entitled "Exploitation of Offshore Oil and Gas", "Exploitation of onshore oil and gas."
Development of beach tourism incompatible with fishing activities.	See "Tourism Development" in Chapter 9. Comply with regulations relating to tourism activities in the country
Indirect impacts capture and culture	

fisheries	
Creation or expansion of port areas, coastal facilities and infrastructure (roads, water, energy) for machining and transportation of fish products.	Réaliser une évaluation environnementale avant tout projet au niveau de zone côtière ".
Pollution by effluents from fish processing plants	Discharge the effluent in outfalls able to satisfactorily dilute and disperse them. • Monitor water quality by measuring the presence of solids, fats and oils, dissolved oxygen, nitrogen and fecal coliforms. • Reduce the amount of waste by recycling as usable products and reduce the amount of water used. • Treat waste before discharge into the natural environment.