ADDRESSING PROJECT IMPACTS ON FISHING-BASED LIVELIHOODS

A GOOD PRACTICE HANDBOOK:
Baseline Assessment and Development of a Fisheries Livelihood Restoration Plan

IFC International Finance Corporation
WORLD BANK GROUP

CONTENTS

LIST OF ABBREVIATIONS

BMP	Best management practices
CITES	Convention on International Trade in Endangered Species
CMP	Construction management plan
CRP	Communal resource plan
CSR	Corporate Social Responsibility
dB	Decibels
DSTD	Deep-sea tailings disposal
EIA	Environmental impact assessment
ESHIA	Environmental, social and health impact assessment
ESIA	Environmental and social risk and impact assessment
ETP	Endangered, threatened, and protected
FAD	Fish attracting device
GIS	Geographic information system
GPS	Global Positioning System
HDD	Horizontal directional drilling
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
km	kilometer
LARAP	Land Acquisition and Resettlement Action Plan
LNG	Liquefied natural gas
MARPOL	International Convention for the Prevention of Pollution from Ships
M&E	Monitoring and evaluation
NGO	Nongovernmental organization
PEL	Probable effect level
PNG	Papua New Guinea
PRA	Participatory Rural Appraisal
PS	Performance Standard
RAP	Resettlement Action Plan
RTD	Riverine tailings disposal
SIA	Social impact assessment
SLA	Sustainable Livelihoods Approach
STD	Submarine tailings disposal
SWOT	Strength/weakness/opportunity/threat
TEL	Threshold effect level
TSS	Total suspended solids
UV	Ultraviolet
WWF	World Wildlife Fund

ABOUT THIS HANDBOOK

This handbook addresses the assessment and management of project impacts on fish resources, fisheries and fishing-based livelihoods, and specifically the assessment and management of physical and/or economic displacement of small-scale subsistence and artisanal fishermen.

These issues are primarily covered by the 2012 IFC Performnace Standard 5, Land Acquisition and Involuntary Resettlement, which identifies project-related restrictions of access to and usage of natural resources as a trigger for application of the standard. Specifically:

> *"The Performance Standard applies to physical and/or economic displacement resulting from… (i) project situations where involuntary restrictions on land use and access to natural resources cause a community or groups within a community to lose access to resource usage where they have traditional or recognizable usage rights and (ii) restriction on access to land or use of other resources including communal resources such as marine and aquatic resources, timber and non-timber forest products, fresh water, medicinal, hunting and gathering grounds and grazing and cropping areas."*
>
> Further, PS5 stipulates that *"where projects involve economic displacement only, the Client will develop a Livelihood Restoration Plan. For persons whose livelihoods are natural-resource based and where project-related restrictions on access apply, implementation of measures will be made to either allow continued access to affected resources or provide access to alternative resources with equivalent livelihood earning potential and accessibility. Where appropriate, benefits and compensation associated with natural resource usage may be collective in nature rather than directly oriented towards individuals or households."*

PS5 recognizes the potential for projects to impact upon marine and aquatic resources and their use, and outlines the basis for mitigating such impacts. However the assessment and management of project impacts on such resources and their use is both complex and challenging. Accordingly, this handbook has been developed to help in the assessment and mitigation of project impacts on fishing-based livelihoods.

This handbook utilizes the Sustainable Livelihoods Approach[1] (SLA) to characterize livelihoods and thereby guide the assessment and restoration and development of livelihoods impacted by displacement. The SLA presents a more overtly holistic view of livelihoods and livelihood restoration than that commonly applied through application of IFC PS5, by considering the relationship between capital assets (human, natural, financial, physical, and social) and the broader policy and institutional environment in determining livelihood strategies and achieving livelihood outcomes (e.g., well-being, income, food security, vulnerability/risk management, sustainable use of natural resources, etc.). As such, in addition to PS5, the SLA entails consideration of some aspects of livelihoods that are addressed in other IFC Performance Standards, particularly PS1, Assessment and Management of Environmental and Social Risks and Impacts, and PS4, Community Health, Safety and Security. Finally, it should be noted that the Handbook does not provide a comprehensive treatment of all Performance Standard requirements as they might apply to fish resources and fisheries.

[1]Ashley. C and Carney, D., *Sustainable Livelihoods: Lessons from early experience*. Department for International Development, UK (1999).

1. INTRODUCTION

Fishing-based livelihoods and the fisheries that support such livelihoods may rely on lake-based (lacustrine), riverine, and/or marine fish resources. The development and operation of private sector projects across a range of industries has the potential to adversely impact upon fish resources and habitats and peoples' access to and use of these resources. In particular, project activities involving the development of infrastructure (riverbank/shoreline and offshore), increased shipping traffic and/or the enforcement of exclusion zones inevitably impact upon fish resources and habitats, small-scale subsistence and artisanal fisheries exploiting these resources, and the fishing-based livelihoods of communities within the project-affected area. Examples of such impacts include:

- filling or draining of wetlands;
- blockage and/or alteration of waterways with roads, dams, and other utilities;
- blockage and/or alteration of fish spawning and rearing areas and migratory corridors;
- modification of riverbanks and coastlines by dredging and construction of jetties, breakwaters, and other structures;
- development of offshore facilities;
- erosion of riverbanks and shorelines;
- increased water turbidity;
- increased ambient water temperatures from the discharge of heated water (e.g., thermal and nuclear power stations);
- increased levels of acoustic disturbance, especially from pile driving;
- intentional or unintentional discharge of waste products;
- disruption of fishing activities by shipping traffic, development of infrastructure, enforcement of coastal and marine exclusion zones, etc.;
- increased risk of damage to fishing equipment; and
- increased risks to life of fishermen.

These impacts may affect subsistence, artisanal, and commercial fishing operations.[2] They also have the potential to directly or indirectly affect livelihoods based on fishing through either economic and/or physical displacement (as well as other social impacts) and, thereby, require a project to implement measures to avoid, minimize, or otherwise mitigate these impacts. Ultimately these impacts may affect the project's social license to operate.

Although small-scale and artisanal fisheries are often affected by project development, for various reasons described below, the assessment and management of project impacts is generally inadequate.

In many countries, small-scale subsistence and artisanal fishing communities are often politically marginalized, with limited representation in local organizational and decision-making structures and limited allocation of government resources to the sector. Consequently, the sector experiences a general lack of investment and development, which leads to a failure to (i) encourage

FISH RESOURCES, FISHERIES, AND FISHING-BASED LIVELIHOODS

The following definitions are used in this handbook:

- Fish resources: Fish and all other products, the aquatic environment, and the ecosystems in which these resources exist.
- Fisheries: All livelihood activities of small-scale subsistence and artisanal fishermen related to access to and utilization of fish resources, including harvesting (fishing and capture of other marine products, e.g., harvesting of seaweed, bivalves, crabs, etc.), processing (salting, drying, smoking, food preparation), and distribution and marketing (i.e., the entire value chain).
- Fishing-based livelihoods: Livelihoods that include and are substantially dependent on fishing for subsistence and/or income.

[2]There also may be adverse impacts include access to and use of ports, passenger transport, commercial/industrial fishing, and general shipping. However, this handbook is only concerned with a project's impacts on livelihoods reliant on access to and use of small-scale subsistence and artisanal fisheries.

PLATE 1 | Offshore construction phase activities of the BP Tangguh LNG Project (Papua, Indonesia). A construction phase exclusion zone excluded both fishing activities within the area and passage of fishermen through the area, thereby restricting their access to other fishing grounds. Ships involved in supply of goods and services laid anchor outside the exclusion zone representing additional hazard and disruption to fishing activities and transit through the area. A larger exclusion zone came into force during the operations-phase of the project. **Credit: Robert Gerrits**

systematic and thorough assessment and management of the interrelated habitats and resources, and (ii) promote sustainable development of small-scale subsistence and artisanal fisheries.

Major projects, including those that use and develop lake, riverine, and/or marine resources, rely on environmental and social assessments to identify, assess, and mitigate their potential impacts on fish resources and habitats, fisheries, and fishing-based livelihoods. However, experience demonstrates that a project's environmental and social risk and impact assessment (ESIA) often does not provide a sufficiently thorough and systematic identification and assessment of the potential impacts on fish habitats, resources, and fisheries. As a result, mitigation is inadequate and, often, operators of lacustrine, riverine, coastal, or oceanic facilities are hampered by litigation, protests, blockages, and ongoing poor relations with local fishermen.

While this gap is partly a result of the country-level marginalization of small-scale subsistence and artisanal fisheries, it must also be recognized that the identification and assessment of project impacts on small-scale subsistence and artisanal fisheries and successful mitigation of these impacts is often difficult. This difficulty stems from the nature of the resource, people's varied use of the resource, and the possible consequences of the most common project-sponsored mitigation and development measures.

The nature of fish resources

Fisheries are reliant upon aquatic habitats and the ecosystems in which fish (and other harvestable produce) live. Their boundaries are not clearly defined, and their productivity may change by season, annually, and in the medium-to-long term. Many factors may contribute to changes in productivity, including changes in the breeding habitats of the fish species, the intensity of fishing, cumulative impacts from near-shore and offshore developments, climate change, etc. Often, local fisheries may already be overexploited and in decline prior to project entry and development. When a project is started in such an environment, it can become a focus

of local concern and may be blamed for causing the deterioration in fishing, whether or not this is really the case. In such situations, robust baseline information on the fishery and catches gathered over time is critical for rebutting such claims or defending against any resultant grievances. Accordingly, specialist expertise is required to undertake fisheries baseline studies and assess a project's potential impacts on fish resources and habitats and fisheries.

Fisheries

Assessing a project's potential impacts on fisheries—specifically, people's access to and use of fish resources and habitats and the productivity of their fishing activities—can be very difficult, because of the varied way in which people use fisheries. Challenges include:

- the ease of entry/exit from subsistence and artisanal fishing activities;
- the use of multiple fishing grounds by fishermen;
- the changing use of fish resources and habitats by season and in the medium-to-long term;
- the variety of fishing activities practiced by any one fisherman, household and/or community;
- the changeable and unpredictable nature of many people's fishing activities;
- the need to assess impacts on the value chain, including processing, distribution, and marketing;
- the fact that fishing may be just one of several different livelihood activities and may assume different importance to different households depending on the household context; and
- the effect of indirect, project-induced impacts on fish resources and habitats and fishermen's behavior.

Consequences of mitigation and development measures

A review of project-sponsored mitigation and development measures demonstrates that:

1. the proposed mitigation for economic displacement often takes the form of a general community-level or area-wide fisheries development plan. While such plans may have merit as part of the project's community investment programs, where the project has direct impacts upon the livelihoods of specific group of fishermen, the requirements of a Livelihood Restoration Plan should be followed, specifically 'economically displaced persons whose livelihoods or income levels are adverselyaffected will also be provided opportunities to improve, or at least restore, their means of income-earning capacity, production levels,and standards of living.'
2. the majority of interventions focus on increasing the capacity of affected people to exploit fish resources and/or improving the business environment for their fisheries activities. Experience shows that, without adequate resource assessment and management systems, such interventions may lead, either directly or indirectly, to higher intensity of resource use (through greater catches per unit of effort and/or higher participation rates). Hence, in the absence of an assessment of the sustainability of resource use, these activities may inadvertently lead to unsustainable resource use in the medium-to-long term.

All of these issues create specific challenges for impact assessment and management, including:

- defining the system being impacted and characterizing its fish resources;
- accounting for the ease of entry/exit into fisheries activities;
- assessing the productivity of fish resources and fisheries and their contribution to livelihoods;
- determining the appropriate mitigation strategy – individual, group, or community-level approaches; and
- determining the adequacy of compensation and livelihood restoration measures.

Accordingly, assessment and mitigation is complex and often time-consuming and costly.

1.1 PURPOSE AND STRUCTURE

This handbook is intended to be a guide for projects whose development and operations impact upon fish resources and habitats, fisheries, and the fishing-based livelihoods of small-scale subsistence and artisanal

fishermen who depend, to a greater or lesser extent, upon these resources. The handbook may also be used by projects that aim to contribute to the sustainable development of fishing-based livelihoods in fishing communities within the project-affected area, through their strategic community investment programs and/or targeted development assistance.

The handbook aims to provide such projects with:

- a description of potential project impacts on fish resources and small-scale subsistence and artisanal fishing activities, including impacts on people's access to and use of these resources and the productivity of their fishing activities;
- guidance for the assessment of project impacts on fish resources, fisheries, and fishing-based livelihoods;
- tools to identify and conduct a baseline assessment of the fish resources, fisheries, and fishing-based livelihoods in the project-affected area;
- a description of the range and content of measures available to mitigate impacts on project-affected households and communities and/or promote development of fishing-based livelihoods through community investment programs; and
- guidance for development of a fisheries livelihood restoration or more broadly applicable fisheries development plan that includes stakeholder involvement and participatory assessment, design and implementation of mitigation and development plans, and monitoring and evaluation.

Chapters 2 and 3 of this handbook provide a high-level description of fish resources and fisheries, including lake, riverine, and marine (estuarine, coastal, and oceanic) fisheries. Chapter 4 describes a project's potential impacts on fish resources, fisheries, and fishing-based livelihoods. Chapter 5 discusses impact assessment, and Chapter 6 considers mitigation options. Finally, Chapter 7 describes the development of a fisheries livelihood restoration plan and/or development plan.

Figure 1.1 (pg xx) provides a road-map to the second part of the document (Chapters 5-7).

FIGURE 1.1 | Assessment and Management of Project Impacts on Small-Scale Subsistence and Artisanal Fisheries

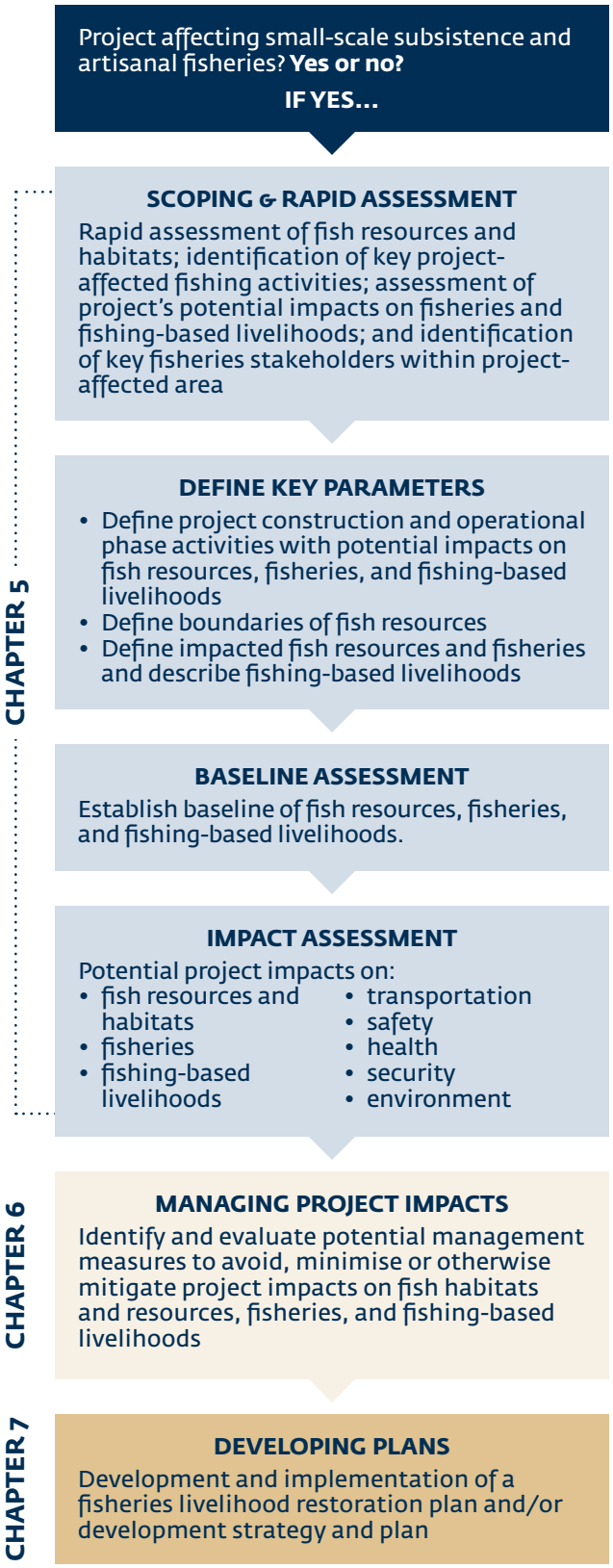


FIGURE 1.2 | Location of the Tangguh LNG Project, Bird's Head Peninsula, West Papua, Indonesia

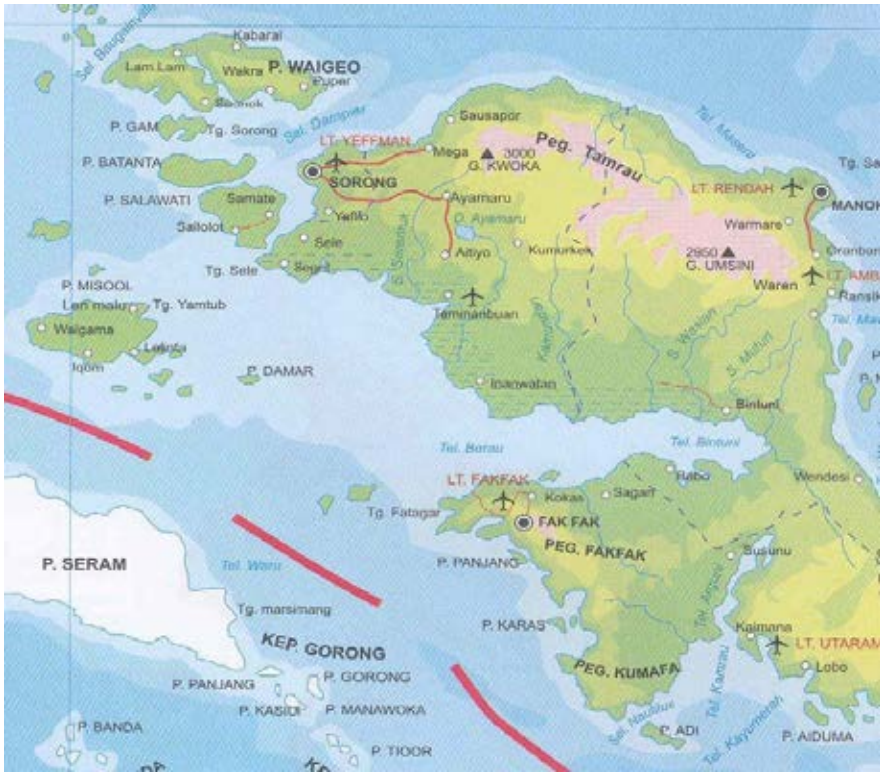
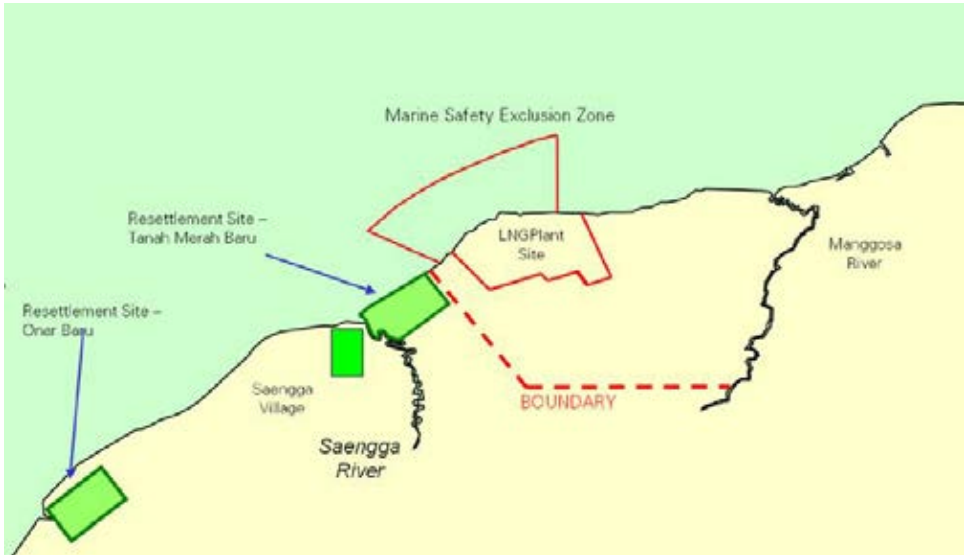


FIGURE 1.3 | Resettlement villages and project marine safety exclusion zone



1.2 THE TANGGUH LNG PROJECT

The BP Tangguh Liquefied Natural Gas (LNG) Project is located in the Bintuni Bay on the Bird's Head Peninsula of West Papua, Indonesia (see Figure 1.2). Construction of the project started in 2001 and was completed in 2006; operations commenced in 2007.

The project area has a relatively small, albeit diverse, population distributed over a large area, and thus low population densities. While several towns serve as population centers, most of the population lives in small villages distributed on the northern and southern shores of Bintuni Bay. As part of their livelihood activities, villagers (both men and women) practice near-shore drift net fishing for prawns and fish and line fishing; women also engage in the collection of shellfish on extensive tidal mudflats, where such opportunities exist.

The LNG plant was constructed on a 3,266-ha plot on the southern shore of the Bintuni Bay, on the site of a village called Tanah Merah. Prior to construction, all Tanah Merah households were resettled to two locations lying to the west of the project site (see Figure 1.3). Tanah Merah Baru, the site closest to the LNG site, is three km west of the LNG plant and lies adjacent to Saengga village. Onar Baru is located 12 km west of the LNG plant and lies adjacent to Onar (Lama) village. Beyond the physical and economic displacement associated with resettlement, the resettlement-affected households and host communities were also impacted by the establishment of a large marine safety exclusion zone extending three kilometers from the shoreline of the project's terrestrial footprint into Bintuni Bay.

The project ESIA was supplemented with (i) an Integrated Social Program (ISP) describing the project's social management plan and addressing the project's local and regional social impacts and (ii) a Land Acquisition and Resettlement Action Plan (LARAP) to guide resettlement of Tanah Merah village.

The project LARAP included assessment of livelihood impacts, the resettlement process, and livelihood restoration. In retrospect, the assessment of fisheries activities and their contribution to fishing-based livelihoods was inadequate: Women's harvesting of shellfish from the extensive mudflats located in front of Tanah Merah was overlooked. Off-shore fishing activities involving small canoes accessing fishing grounds through use of the (strong) tides, sails, and outboard motors focused only on Tanah Merah residents and did not consider use of the same fishing areas by the proximate (and later host) villages. An assessment of the fishing activities, including consideration of the location of the fishing grounds, which household members were involved in fishing, temporal and geographical variation in fishing intensity, harvest levels (and thus household income), and the effects of alternative economic (livelihood) activities on participation in fisheries, was inadequate. Furthermore, the productivity of fishing grounds at resettlement sites and potential competition between host and resettlement villages was not considered. Finally, the impact of the marine safety zone on households' access to their traditional fishing grounds, and more generally on transportation along the southern shore of the bay, was not assessed.

While resettlement-affected households have adapted their livelihood strategies to take advantage of new opportunities (particularly vegetable production and sale) provided by the project, the project context, together with its specific resettlement impacts (including impacts on fisheries) and the assessment and management of the latter, provide the basis for a substantial number of case studies and lessons learned. Accordingly, the Tangguh LNG Project is used as an example throughout this handbook, highlighting various issues affecting assessment and management of project impacts on fisheries and fishing-based livelihoods (see Boxes 3.1, 4.2, 5.2, 5.4, and 6.2).

2. FISH HABITATS AND FISH RESOURCES

To identify and assess a project's potential impacts on fish resources and habitats, fisheries, and fishing-based livelihoods and determine how to avoid, minimize or otherwise mitigate those impacts, it is necessary to understand the type of fish habitats and the physical and biological resources that may be present in a project-affected area. This chapter provides a basic introduction to the different types of fish resources and habitats.

2.1 HABITATS

Fish are found in lakes, rivers, and marine environments (including estuaries and coastal and ocean waters), each of which represents a fundamentally different fish habitat. A basic understanding of these habitats is vital to consideration of the environmental impacts on both fish resources and habitats and human use of these resources.

Lake (lacustrine) habitats

Lakes are usually relatively large bodies of water surrounded on all sides by land. A lake system typically comprises the sources of inflow (runoff, streams, etc.), the body of water (lake), and the outflow. However, some lakes (e.g., Lake Ngami in Botswana, Lake Chad in Chad, Lake Turkana in Kenya) and smaller bodies of water (e.g., pans in southern Africa, billabongs in Australia, ox-bow lakes) that can have important fish resources for local communities are located in closed river or drainage basins (endorphic basins) and have no outlet. Lakes vary significantly in terms of shape, size, and depth, which in turn define other physical and biological characteristics to which fish resources must adapt. Shallow lakes tend to have a greater diversity and quantity of fish resources and are more vulnerable to pollution impacts, because of their lower water volume. A lake's shoreline may include wetland marshes, sandy beaches, gravel/cobble beaches, rocky shores, or armored (bulkhead/riprap) shores. Shoreline type plays an important role in habitat for juvenile fish rearing and food organism production.

River (riverine) habitats

A river basin (or watershed) includes the land area drained by a river and its tributaries. Within the river basin, the river system comprises headwaters (the tributaries of the river, which together act as the source of the river) located in upland or mountainous areas that carry water to the main river channel and onward, through floodplains and wetlands, to a larger body of water (either a lake or the sea). River systems are dynamic, and the configuration of rivers will change over time.

The geography of a river basin can be varied and complex. This geography and the hydrological cycle greatly impact the flows and, ultimately, the availability of water throughout the basin. The size and location of the basin determine the regional and seasonal variations in its climate, which directly impact the flow in different parts of the basin. The physical and chemical aspects of a river system determine its ability to sustain life and the specific habitats for fish resources in different parts of the system. The characteristics of the river habitats, such as watershed conditions, flow hydrology, channel conditions, habitat access, habitat elements, and water quality, are determined by the environmental properties of the river basin, including climate, topography, vegetative cover, soil types, and erosion. While project activities may be site-specific and, as such, directly impact only a limited scale and number of habitats, the potential downstream impacts of these activities must be considered.

Marine habitats

Marine resources include the various marine habitats and the stocks of fish and shellfish that inhabit them. Marine fish environments include estuaries, coastal (near-shore) and oceanic (offshore) habitats, and associated vegetation and natural structures. Characteristics of marine habitats to consider include habitat access, shoreline conditions (e.g., mangroves), habitat elements (e.g., seagrass, sandflats, etc.), water column quality, and oceanographic processes (e.g., tides). Typically, projects have a defined footprint and may

impact multiple fish habitats within a limited area. However, for linear projects such as pipelines, it may be appropriate to define separate and distinct ecoregions (estuaries, near-shore, continental shelf, continental slope) that will have different salinities, depths, substrates, flora and fauna, etc.

Estuarine habitats

An estuary is a partially enclosed body of water along the coast where freshwater from rivers and streams meets and mixes with salt water from the ocean. Estuaries and the lands surrounding them are places of transition from land to sea and freshwater to salt water. Although influenced by the tides, they are protected from the full force of ocean waves, winds, and storms by land forms such as barrier islands or peninsulas.

Estuarine environments are among the most productive on earth, creating more organic matter each year than comparably sized areas of forest, grassland, or agricultural land. The tidal, sheltered waters of estuaries also support unique communities of plants and animals that are specially adapted for life at the margin of the sea.

Many different habitat types are found in and around estuaries, including mangrove forests, freshwater and salt marshes, sandy beaches, mud and sand flats, rocky shores, shallow open waters, seagrasses and oyster reefs.

Coastal habitats

Coastal habitats are found in the area that extends from as far as the tide comes in on the shoreline out to the edge of the continental shelf. These habitats include the intertidal zone that may contain coastal salt marshes, tidal mud flats, mangroves, sandy beaches, gravel/cobble beaches, rocky shores, and armored (bulkhead/riprap) shores. Near-shore demersal (bottom) habitats may include bare mud or sand flats, low- and high-profile hard substrate, seagrass beds, macroalgae forests, and coral reefs.

Oceanic habitats

Open ocean habitats are found in the deep ocean beyond the edge of the continental shelf. These habitats can be divided into pelagic and demersal habitats.

PLATE 2 | Fishing communities on the coast of Ghana use sea-going canoes to fish up to 60 kilometers (km) from land. **Credit: Ted Pollett**

Pelagic habitats, which are found near the surface or in the open water column away from the bottom of the ocean, are dynamic, always shifting depending on what ocean currents are doing. An organism living in a pelagic habitat is said to be a pelagic organism. Demersal habitats are near or on the bottom of the ocean. , An organism living in a demersal habitat is said to be a demersal organism.

2.2 PHYSICAL ENVIRONMENT

There are a number of attributes that are common to the physical environments of lacustrine, riverine, and marine fish habitats, including shoreline/riverbank characteristics, water quality, substrate, and light penetration. In addition, there are several habitat-specific attributes for each environment, such as those related to the movement of water. Both common and habitat-specific attributes should be included in any description of an area's physical environment (see Table 2.1).

2.3 BIOLOGICAL ENVIRONMENT

As with the physical environment, there are both common and unique attributes in the biological environments of lacustrine, riverine, and marine fisheries. The biological environment includes both flora and fauna resources, ranging from plankton to fish to water-dependent mammals. The principal parts of a fishery's biological environment are described below.

Plankton

At the bottom of the food chain are plankton, which is a term applied to any drifting organisms (animals, plants, protists, or bacteria) that inhabit the water column. Plankton includes both phytoplankton and zooplankton.

Phytoplankton: Phytoplankton comprises a variety of plants, as well as photosynthetic protists and bacteria. Through the process of photosynthesis, phytoplankton convert solar energy, inorganic carbon, and nutrients to biomass, thereby forming the basis of almost all marine food webs on earth. One of the key roles of plankton is thus to provide food for species higher up the food chain, including commercially important fish species. Phytoplankton populations vary from region to region, based on nutrient concentrations, climatic conditions, and currents, and are also highly responsive to seasonal variations in sunlight and temperature. Tropical waters have much less plankton than the cooler temperate waters, because the warm surface water of the tropics keeps nutrients trapped down below in the depths. Even with ample sunlight, plankton growth is severely limited in tropical waters. In temperate latitudes, by contrast, phytoplankton populations typically show explosive growth (blooms) in spring as water warms up and solar radiation increases. As the season progresses, the large population of plankton depletes the concentration of dissolved nutrients in the water, which, in combination with grazing by zooplankton, curtails the bloom. In autumn, as temperatures decrease and winds increase, water mixing may increase the supply of nutrients; in combination with reduced grazing pressure, this leads to a second (usually less extreme) bloom. Tropical waters tend to have fewer phytoplankton blooms.

Zooplankton: Zooplankton, which is the animal component of plankton, can include *holoplankton* (animals that spend their entire life in the plankton) or *meroplankton* (animals that spend only part of their life in the plankton, usually eggs and larvae of larger invertebrates or fish). A zooplankton community may consist of freshwater, brackish, and marine species; the species diversity will be a key indicator of the productivity. The species composition and the abundance of the zooplankton change with the seasons, but in marine environments it is generally dominated by copepod crustaceans. Freshwater zooplankton are dominated by four major groups of animals: protozoa, rotifers, and two subclasses of the *Crustacea*, the cladocerans and copepods. Because phytoplankton is ultimately the primary food source of zooplankton, there is far less zooplankton during the winter months in temperate waters. Zooplankton take advantage of the abundant food of a spring phytoplankton bloom and thus peak in abundance following a short delay. The zooplankton biomass reaches its peak during late summer and early autumn, when the waters are still warm. During this time, the predation pressure from larger animals feeding on zooplankton reaches its peak. During the early autumn months, zooplankton abundance decreases, due to slowing reproduction rates and predation.

TABLE 2.1 | Characteristics of the Physical Environment of Lacustrine, Riverine, and Marine Fish Habitats

WATER BODY TYPE				
LACUSTRINE	**RIVERINE**	**MARINE**		
		ESTUARINE	COASTAL	OCEANIC
Ecoregion ▸ Latitude ▸ Altitude ▸ Size ▸ Depth	Ecoregion ▸ Latitude ▸ Altitude ▸ Gradient	Ecoregion ▸ Latitude ▸ Size ▸ Depth	Ecoregion ▸ Latitude ▸ Near-shore slope ▸ Continental shelf	Ecoregion ▸ Latitude ▸ Continental shelf
Shoreline zone ▸ Total impervious area ▸ Shoreline condition (armored or natural)	Watershed conditions ▸ Total impervious area ▸ Natural drainage network ▸ Number of stream crossings ▸ % habitat accessible	Shoreline zone ▸ Inter-tidal ▸ Shallow sub-tidal ▸ Estuary type	Shoreline zone ▸ Inter-tidal ▸ Shallow sub-tidal ▸ Long-shore sediment transport (erosion/ accretion) ▸ Feeder bluffs ▸ Shore forms	
Lake bed ▸ Substrate size distribution ▸ Bathymetry ▸ Sediment deposition ▸ Chemical composition of sediments	Channel conditions ▸ Stream bank condition ▸ Residual pool depth ▸ Substrate size distribution ▸ Natural barriers ▸ Material transport	Estuarine bed ▸ Substrate size distribution ▸ Bathymetry ▸ Chemical composition of sediments	Coastal bed ▸ Substrate size distribution ▸ Bathymetry ▸ Chemical composition of sediments	Sea bed ▸ Sea-bed substrate size distribution ▸ Bathymetry ▸ Chemical composition of sediments
Water balance ▸ In-flow variations ▸ Out-flow variations	Flow hydrology ▸ Flow variations ▸ Floodplain accessibility ▸ Artificial drainage network	Flow hydrology ▸ Flow variations ▸ Floodplain accessibility ▸ Artificial drainage network	Physical oceanography ▸ Tides ▸ Currents ▸ Winds ▸ Waves	Physical oceanography ▸ Tides ▸ Currents ▸ Winds ▸ Waves
Seasonal stratification	Seasonal flows and flood plain connectivity	Seasonal flows and flood plain connectivity	Seasonal weather and long-shore drift	Seasonal upwelling
Light ▸ Penetration/ absorption	Light ▸ Riparian shading	Light ▸ Penetration/ absorption	Light ▸ Penetration/ absorption	Light ▸ Penetration/ absorption
Water quality ▸ Temperature ▸ Dissolved oxygen ▸ Nutrient cycling (C, N, P, SO_4) ▸ Turbidity ▸ Salinity ▸ Toxicity	Water quality ▸ Temperature ▸ Dissolved oxygen ▸ Nutrient cycling (C, N, P) ▸ Turbidity ▸ Salinity ▸ Toxicity	Water quality ▸ Temperature ▸ Dissolved oxygen ▸ Nutrient cycling (C, N, P, Si) ▸ Salinity ▸ Turbidity ▸ Toxicity	Water quality ▸ Temperature ▸ Dissolved oxygen ▸ Nutrient cycling (C, N, P, Si) ▸ Salinity ▸ Turbidity ▸ Toxicity	Water quality ▸ Temperature ▸ Dissolved oxygen ▸ Nutrient cycling (C, N, P, Si) ▸ Salinity ▸ Turbidity ▸ Toxicity

Note: C = carbon, N = nitrogen, P = potassium, Si = silicon, SO_4 = sulfate.2.3 Biological Environment

Benthos

The term *benthos* refers to the flora and fauna that live on or in the bottom of the water body. Benthic communities include both macrophytes, which are plants, and zoobenthos, which are animals. Benthic communities are composed of both epifauna (living on or above the bed) and infauna (living within the bed). Sediment type is an important factor in determination of the species in the benthos.

Even though an actual river may not be altered, some projects (e.g. gravel mining or a project well that draws large quantities of groundwater) could affect the hyporheic zone, a region beneath and alongside a stream bed where there is mixing of shallow groundwater and surface water. The flow dynamics and behavior in this zone (termed hyporheic flow or underflow) is recognized to be important for surface water/groundwater interactions, as well as fish spawning, among other processes. The assemblage of organisms that inhabit this zone (called hyporheos) include life stages of invertebrates that provide critical food for fish. The flow dynamics are controlled by the variations in pressure that arise on the streambed when the flowing water is diverted by the shape of the streambed created by benthic fauna, moving sediment and other obstacles. The mechanism of hyporheic flow can be triggered also by groundwater flow into or out of the stream from the surrounding land.

Coral reefs

Coral reefs, which form some of the most diverse ecosystems on Earth, are a mosaic of many species. They are most commonly found at shallow depths in tropical waters, but deep water and cold water corals also exist on a smaller scale in other areas. Coral reefs deliver ecosystem services to tourism, fisheries, and shoreline protection. The three principal reef types are:

- fringing reef, which is directly attached to a shore, or borders it with an intervening shallow channel or lagoon;
- barrier reef, which is separated from a mainland or island shore by a deep channel or lagoon; and
- atoll reef, which is a more or less circular or continuous barrier reef that extends all the way around a lagoon without a central island.

Fish

Ecologically, the several thousand fish species can be divided into the following groups, according to their importance/value or key function in a community or ecosystem:

- keystone species, which are those species that are fundamental to the integrity of food chains, etc., even if they are not a commercial or rare species, such as forage fish species;
- indicator species, which are those species that act as indicators of ecological change;
- economically exploited species (which should include the top ten by weight and value landed);
- endangered, threatened, or protected species, which may also fall into the above categories. Protected species will include those listed by the country, regional treaties or a recognized international system, such as the International Union for the Conservation of Nature (IUCN) "Red List"; and
- invasive species, which are not native to the area.

Key characteristics that define a fish population include species, seasonality of spawning and migration patterns, and ecology of key fish species.

Associated wetlands

Wetlands connected to lakes, rivers, and marine estuaries (salt marshes) have a variety of biological habitat functions for fish resources. In addition, scientists also recognize hydrologic and water-quality functions related to the physical environment elements discussed above. Wetland functions are a process or series of processes that take place within a wetland. These functions, which include the storage of water, transformation of nutrients, growth of living matter, and diversity of wetland plants, have value for the wetland itself, for surrounding ecosystems, and for people. Functions can be grouped broadly as habitat, hydrologic, or water quality, although these distinctions are somewhat arbitrary and simplistic.

Wetlands are among the most productive habitats in the world. They provide food, water, and shelter for fish, shellfish, birds, and mammals, and they serve as a breeding ground and nursery for numerous species.

Many endangered plant and animal species are dependent on wetland habitats for their survival.

Hydrologic functions are those related to the quantity of water that enters, is stored in, or leaves a wetland. These functions include the reduction of flow velocity, the role of wetlands as groundwater recharge or discharge areas, and the influence of wetlands on atmospheric processes. Water-quality functions include the trapping of sediment, pollution control, and the biochemical processes that take place as water enters, is stored in, or leaves a wetland.

Not all wetlands perform all functions, nor do they perform all functions equally well. The location and size of a wetland may determine what functions it will perform. For example, the geographic location may determine its habitat functions, and the location of a wetland within a watershed may determine its hydrologic or water-quality functions. Many factors determine how well a wetland will perform these functions, including climatic conditions, quantity and quality of water entering the wetland, and disturbances or alteration within the wetland or the surrounding ecosystem. Wetland disturbances may be the result of natural conditions, such as an extended drought, or human activities, such as land clearing, dredging, filling or the introduction of non-native species.[3]

Mangroves

Mangroves are salt-tolerant plant species that grow in intertidal or estuarine areas; there are more than 12 families and 50 species of mangroves worldwide. These habitats are found in warmer areas along the tropical and subtropical coasts of Africa, Asia, Australia, and North and South America. Mangrove plants have a tangle of roots, which are often exposed above water, leading to the nickname "walking trees." The roots of mangrove plants are adapted to filter salt water and their leaves can excrete salt, allowing them to survive where other land plants cannot. Together, individual mangrove plants provide several habitat services, including protection of the shoreline, cover for juvenile fish and shellfish, and organic matter for the ecosystem. They also provide building materials and firewood for coastal communities.

Seagrass beds

Seagrasses are flowering plants (angiosperms) that live in a marine or brackish environment. There are about 50 species of true seagrasses worldwide. Seagrasses are sometimes found in patches, which can expand to form huge seagrass beds (or meadows) made up of one or multiple seagrass species. Seagrasses require a lot of light, so the depths at which they occur in the ocean are limited by light availability. Seagrasses are found in protected coastal waters, such as bays, lagoons, and estuaries, and in both temperate and tropical regions.

Seagrasses attach to the ocean bottom by thick roots and rhizomes (i.e., underground horizontal stems with shoots pointing upward and roots pointing downward). These roots help stabilize the ocean bottom. In addition, seagrasses help with water clarity by trapping sediments and small particles in the water column, and help boost local economies by supporting functions that contribute to artisanal fishing opportunities. Seagrasses provide an important habitat to a number of organisms, some of which use seagrass beds as nursery areas, while others seek shelter there for their whole lives. Larger animals, such as manatees and sea turtles, feed on animals that live in the seagrass beds. Organisms that make the seagrass community their home include bacteria; fungi; algae; invertebrates such as conch, sea stars, sea cucumbers, corals, shrimp, and lobsters; a variety of fish species; seabirds; sea turtles; and marine mammals such as manatees and bottlenose dolphins.

Birds

Many species of shore birds and aquatic waterfowl, especially those associated with wetlands, are of significant social, economic, or cultural importance to local communities. Most sea birds are predators or scavengers of fish and shellfish resources. A few species are taken as food for humans and opportunistically by large marine organisms.

Mammals

Mammals that are highly dependent on freshwater bodies include otters, muskrats, and beavers, while freshwater-dependent cetaceans are among the most threatened species groups of large mammals. The

[3]U.S. Geological Survey, 1996.

effects of climate change on these animals have not been rigorously assessed, but could lead to population or even species extinctions, especially considering the cumulative impacts of climate change and other threats, such as dam construction, hunting, and by-catch. Marine mammals may include whales, dolphins, seals, manatees/dugongs, sea otters, etc. Key attributes include population status, breeding/rearing grounds, and migratory patterns.

Endangered, threatened, and protected (ETP) species

In addition to those that fit into the categories above, additional ETP species will likely include turtles and other reptiles and amphibians.

Invasive species

Invasive species are non-native species whose introduction into a specific environment may cause environmental harm to existing ecosystems, hamper the economic use of the fish resource or even represent a risk to human health. Such species can induce considerable changes in the structure and dynamics of aquatic ecosystems, and successful establishment in a new ecosystem is nearly always permanent. Non-native species may be introduced during construction, pre-commissioning and operation of the proposed project.

In lakes and rivers, non-native aquatic vegetation may get caught on propellers or trailers of small boats and be transported to areas where it did not exist before. Under the right conditions, these invasive species may establish themselves in the lake and spread to nearby areas within that bioregion.

In the marine environment, organisms such as barnacles, mussels, sponges, algae, and sea squirts attach themselves to the hulls of ships. This is commonly referred to as biofouling. These organisms then "hitch a ride" from one port to the next, thus entering new bioregions. Invasions can occur when fouling organisms come in contact with structures in a new port or release their larvae into its waters. Under the right conditions, these species may establish themselves in the new port and spread to nearby areas within that bioregion. Historically, hull fouling was considered a primary vector for transporting species. However, the use of metal hulls and antifouling paints, as well as decreased time spent in port and faster ship speeds have reduced this method of invasion.

Invasive species can also enter an ecosystem through ballast water. Ballast water is carried by ships to provide stability and adjust a vessel's trim for optimal steering and propulsion. The use of ballast water varies among vessel types and with cargo and sea conditions. Ballast water often originates from ports and other coastal regions that host rich planktonic assemblages. As part of normal ship operations, ballast water can be discharged in ports, along coastlines, and at sea, resulting in a diverse mix of organisms that may be transported and released around the world. Ballast water appears to be the most important vector for marine species transfer throughout the oceans of the world.

In some cases, different fish species are intentionally introduced to an area for commercial interests. While these species may originally be stocked in "net pens" in different fish culture systems, they can escape to the surrounding waters where they can cause detrimental ecological effects.

3. FISHING-BASED LIVELIHOODS AND SMALL-SCALE SUBSISTENCE AND ARTISANAL FISHERIES

While there is no universal definition of "subsistence and artisanal fisheries," there is a common understanding that subsistence and artisanal fishing activities share certain characteristics, including:

- the small-scale and often decentralized nature of operations;
- a predominance of small vessels;
- a predominance of traditional fishing gear (but may include trawl, seine, gill-net, and long-line vessels);
- fishing trips that are generally, but not always, short and near-shore; and
- primacy of subsistence, although there may be some commercial component.

This chapter provides an overview of the nature of fishing-based livelihoods in lake-based, riverine, and marine fisheries, as well as the broad range of fishing, processing, distribution, and marketing activities practiced by communities engaging in small-scale subsistence and artisanal fisheries in these areas. It discusses the range of individual, household, and community fishing activities, the diversity of arrangements associated with operating fishing activities, the potential roles and responsibilities of household members, and the linkages to an extended value chain associated with processing, distribution, and marketing. The chapter also describes the constraints that small-scale subsistence and artisanal fishermen often face in the operation and development of their fishing activities.

3.1 FISHING-BASED LIVELIHOODS

3.1.1 Livelihood Systems Involving Lake-Based Fisheries

The scale of a resource determines the nature of lake-based fisheries activities and their significance to household and community livelihoods. Fishing activities in small lakes and wetlands (including endorheic pans, ox-bow lakes, swamps, and marshland) are likely to be

PLATE 3 | Fishing boats and village on the shore of Lake Albert, Uganda, are likely to be impacted by exploitation of recent local oil and gas discoveries. **Credit: Ted Pollett**

PLATE 4 | Small-scale trout farming, Lake Titicaca, Peru. **Credit: Ted Pollett**

one component of a diversified livelihood system and primarily serve subsistence needs. Fishing activities may involve shoreline hunter-gathering, canoes, and the use of lines, traps, and nets. A wide array of harvestable products, including snails, frogs, turtles, fish, birds, etc. is common. While fishing activities may not provide significant contributions to the household economy, they play an important role in household nutrition and food security.

Larger lakes and wetland systems can support more intensive, larger-scale fishing activities that meet both household subsistence and income needs, making fishing a more important part of livelihood systems. Accordingly, settlements located close to the shoreline of large lakes are often considered as fishing communities or villages, where the majority of households are involved in the harvesting, processing, distribution, marketing, and sale of fish resources. Both shoreline and offshore fishing activities occur. Close to shore, fishing activities may involve the use of lines, traps, nets, and captive areas for fish, as well as the harvesting of snails, turtles, birds/bird eggs, etc. Offshore activities may involve a range of vessels, including canoes and small boats for near-shore activities and larger, motorized vessels for offshore fishing. Often, lake shoreline fishing communities benefit from more developed infrastructure and delivery of services and utilities (compared to marine-coastal communities), and as such there are fewer basic challenges to the operation of fisheries activities.

3.1.2 Livelihood Systems Involving Riverine Fisheries

The relative significance of riverine fisheries for household and community livelihoods is largely dependent on the nature of the river system. Such systems may range from drains, rice paddies, or minor river systems supporting relatively small populations of resources (fish, snails, frogs) to major river systems that support higher levels of resource use intensity and dependence. In areas with heavy seasonal rainfall, flooding can inundate wetlands and floodplains, creating seasonal fish resources.

For minor river systems, fisheries typically comprise diurnal hunter-gathering activities aimed at collection of edible products, including freshwater shrimp, snails, frogs, turtles, etc., and undertaken by individuals or small groups of women as part of a broader repertoire of harvesting of forest products (e.g., vegetables, fruit,

PLATE 5 | Children fishing with a cast net from the banks of a river, Laos. **Credit: Ted Pollett**

PLATE 6 | Artisanal fishing with gill nets, Nile River, Egypt. **Credit: Ted Pollett**

etc.). These fishing activities generally involve hand-held nets (in shallow waters) and use of line fishing and traps in deeper waters. Occasionally, naturally occurring poisons or pesticides and explosives may be used. These fishing activities generally are subsistence-oriented and complement a broader rural land-based livelihood strategy involving agriculture. As with lake-based fisheries, while fishing activities may not provide significant contributions to household economy, their value in maintaining household nutrition and food security should not be underestimated.

With major river systems, individuals, households, and communities may be more heavily engaged in and dependent upon fisheries. Small-scale fishing activities (such as those described for minor river systems) may be implemented on the many tributaries of the major river system, while on the larger tributaries and the river itself, fishing activities may involve canoes and motorized vessels with the use of line fishing, traps, nets, etc. While small-scale fishing activities tend toward meeting the subsistence needs of households, the larger-scale fishing activities may have a commercial aspect, allowing for processing, distribution, and sale. Typically, the majority of households in settlements close to major rivers participate in fishing activities and own fishing resources. However, most of these households typically operate diversified livelihoods, including land-based agricultural activities and possibly commercial business interests, and only a relatively small number of households specialize in fisheries.

3.1.3 Livelihood Systems Involving Marine Resources

Fishing is generally a major component of livelihoods in estuarine and coastal communities. While this underscores the relative importance of fisheries, it is important to note that, where opportunities exist, these communities often operate diversified livelihood systems that involve a broad range of livelihood activities, including agriculture (i.e., crop and livestock production), small and medium enterprise, and employment. Both enterprise and employment may be associated with proximity to coastal roads and towns, (e.g., the operation of roadside business ventures such as grocery stores, restaurants, etc.), or they may be associated with

larger-scale enterprises that employ a sizable workforce. Communities that are close to urban areas may also participate in the urban economy, and remittances from family members engaged in an urban economy may also be important.

Estuarine, coastal, and oceanic fishing may involve a broad range of activities. Many fishing activities are seasonal in nature, reflecting both changes in the productivity of the fisheries and changes in weather conditions that make fishing both less productive and/or less safe. Such seasonality often corresponds with crop production seasons, thereby allowing households to operate a fishing-agriculture-based livelihood system.

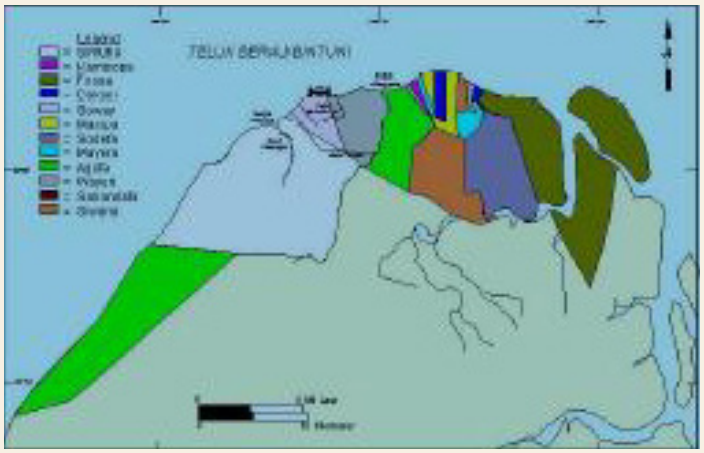
Fishing activities may be more or less structured and require different levels and modes of participation from different household members. For example, oceanic fisheries typically require larger boats, larger crews, and more inputs and, as a result, are often group-based, relying on the regular participation of a selected number of households. Shoreline and near-shore fishing, including casting of nets and setting of lines and traps, are typically individual activities that are more opportunistic in nature. Collection of mollusks is often a group women's activity, as is post-catch processing and marketing.

3.2 OWNERSHIP OF FISHING GROUNDS

Traditional systems that define ownership, access to, and use of fish resources have been in use for hundreds of years. In recent years, national laws have overtaken these traditional systems in many countries, although law enforcement is generally weak. Under national laws, ownership and governance of systems may be poor, and over-exploitation of the resource is common,

PLATE 7 | In Bocolo (a fishing community located at the northern tip of the Sereia Peninsula, at the mouth of the Congo River, Angola) households participate in various fishing activities, including using canoes to access the bay and mangrove system in order to place traps, fishing nets, and lines, as well as group-based oceanic fishing up to 60 km from the coastline. **Credit: AngolaLNG**

BOX 3.1 | OWNERSHIP AND USE OF FISHING GROUNDS AMONG THE SUMURI IN PAPUA, INDONESIA



The resettlement of households from Tanah Merah Village villagers during development of the Tangguh Liquefied Natural Gas (LNG) Project in West Papua, Indonesia, affected lands belonging to clans of the Sumuri tribe. An investigation of the ownership and governance of the fishing grounds as part of the baseline assessment of resettlement impacts revealed that the Sumuri clans' claims to territory also extended to the fishing grounds (see map below) and that a usage tax (to be paid to the clan) was deducted from fishermen at the point of sale. Hence, the project impacted clans' ownership of fishing grounds and revenue streams associated with such ownership, as well as individual and household access to and use of the fishing ground.

particularly where industrial fisheries interact with artisanal fish resources. In practice, it is common to find that traditional and national systems of tenure, access, and use coexist.

Traditional tenure and use rights may be encountered at the tribe/clan and/or village levels. There are often individual or, more commonly, group-based claims to stretches of river, estuary, or shoreline and areas immediately adjacent to them, particularly in West Africa, East Asia, and Melanesia (see Box 3.1), while farther offshore, fishing grounds may be common property or open access resources accessible to all.

With regard to marine resources, national laws commonly stipulate national ownership and management responsibilities for "national" fisheries, which are defined as occurring at a given distance from the shoreline. In some countries, such as Indonesia and Papua New Guinea, laws may acknowledge the rights of coastal fishing-based communities and subsistence and artisanal fishermen to utilize near-shore fishing grounds for subsistence and small-scale commercial activities. As nationally recognized administrative units, villages may lay claim to the area (and hence the fishing grounds) located immediately adjacent to their lands.

3.3 GOVERNANCE OF FISHING ACTIVITIES

While some fisheries may be considered open-access resources, at the community level they are more likely to be recognized as common-property resources, with established governance systems that determine access, utilization and, to a lesser extent, management of the resource and fishing activities.

More typically, however, specific operational systems are established in relation to ownership of fishing equipment and credit lines provided by traders. The majority of fishing activities are directly implemented by individuals at the household level. As the scale and cost of fishing equipment (particularly boats and motors and related inputs) increases, there is increasing scope for differentiation among households. For example, there are systems where the owners of fishing equipment either operate as owner-operators or do not participate directly in fishing activities, but instead rely on an established crew to operate vessels and fishing activities, with the resultant catch being shared between the owner/operator and the crew through an established sharing agreement or mechanism (i.e., percentage of the catch). Young fishermen who lack the financial resources to

acquire fishing equipment and the social connections to become established crew members often have to work on a stand-by basis on different boats with different crews, until a permanent opportunity arises.

Village-level traders, who are often the source of fishing equipment and inputs, often also function as marketing agents. Such traders commonly provide lines of credit to fishermen (in cash or in-kind), binding those fishermen to sell their catch to the trader, often at reduced prices.

3.4 TYPOLOGY OF FISHING ACTIVITIES

For the purposes of this handbook, a typology of fishing activities is useful to illustrate the range of possible activities and their characteristics. Table 3.1 provides a summary description of fisheries activities for lacustrine-, riverine-, and marine-based fisheries.

TABLE 3.1 | Typology of Fishing Activities

FISHERY TYPE	LOCATION	DESCRIPTION	PARTICIPANTS
LACUSTRINE		Access to near-shore areas supporting hand collection of mollusks, crustaceans, amphibians, small reptiles, and waterfowl eggs	Household (men and women, depending on the activity)
		Near-shore fixed structures supporting fish-farming	
		Placement of fixed lines and traps, and casting baited hook and lines	Household (men, women and children)
		Fishing with beach seine nets	Household or community
		Canoes and small vessels powered by paddle or motors to access deeper waters; fishing using combination of traps, lines, and nets	Household (typically men, but also women)
RIVERINE		Near-shore fixed structures (typically platforms or weirs) allowing daytime fishing activities	Household (typically men)
		Placement of fixed lines and traps, and casting baited hook and lines from shore	Household (men, women and children)
		Canoes and small vessels that are powered by paddle or motors to access fishing areas; fishing using combination of traps, lines, and nets	Household (typically men, but also women)
MARINE (estuarine, coastal, and oceanic)	SHORELINE	Placement of fixed lines and traps and casting baited hooks and lines	Household (men, women and children)
		Tidal access to near-shore areas supporting collection of mollusks, crustaceans, and other marine life (sea urchins, sea cucumbers)	Household (men and women, depending on the activity)
		Fishing with beach seine nets	Household or community
	ESTUARINE/ NEAR-SHORE	Canoes and small vessels typically powered by hand (paddle) to assist in placement of traps, fixed lines, and nets	Household (men and women)
		Near-shore fixed structures (typically platforms) allowing day and nighttime fishing activities	Household (typically men, but also women)
		Canoes and small vessels that are powered by hand (paddle), wind (sails), or motors to access near-shore fishing grounds; fishing using combination of traps, lines, nets, and fish attracting devices (FADs)	Household (typically men, but also women)
	OCEANIC	Sea-faring motor-driven vessels (including large ocean-going canoes) that travel up to 60-to-100 kilometers from shore to deep-sea fishing grounds in search of oceanic fish species; fishing using a combination of nets and lines	Household with crew; small groups comprising 3-to-5 members; cooperative

PLATE 8 | Fishermen pulling in a beach-seine net, Colombia. **Credit: Jorge Villegas**

PLATE 9 | Chinese fishing (lift) nets located in Kochi, Kerala, India. **Credit: Gul Buyukbay**

PLATE 10 | Fisherman placing drift (gill) nets during incoming and/or outgoing tides to harvest prawns, Tangguh LNG Project, Teluk Bintuni, Papua/Indonesia. **Credit: Robert Gerrits**

PLATE 11 | Fishing boats on the shoreline of Lake Albert, Uganda, where there have been recent oil and gas discoveries. **Credit: Ted Pollett**

PLATE 12 | Net repair, Senegal River estuary, Senegal. **Credit: Ted Pollett**

3.5 PROCESSING, DISTRIBUTION, AND SALE OF FISHERIES PRODUCTS

Each step in the value chain for fisheries products, from harvest to market, may be associated with a variety of actors and additional activities that generate different fish products and added value. Thus, projects that impact fish resources and habitats and fisheries activities may also inadvertently impact a value chain (and the actors therein) that reaches well beyond the immediate location of the project's impacts and footprint.

Consequently, mapping of value chains to identify potentially impacted stakeholders is an essential component of any baseline assessment. The nature of the value chain is situation-specific, and fish processing may occur as a matter of necessity or of choice. For example, while for certain fish species the intended (marketable) product is dried fish, in many areas the lack of markets, services (i.e., cold storage, transportation), and utilities (electricity) requires the use of salting, drying, and smoking to allow for storage and later sale of fish harvests at more distant markets. Areas with higher population densities, close to urban areas, or located on transportation routes may have a value chain that allows for immediate sale (fresh fish) or processing, preparation, and sale of food (e.g., grilled fish, calamari) on streets with high traffic or residential uses, in roadside stalls or restaurants. Markets for fresh and processed fish may include:

- middlemen (often local village traders who provide credit and inputs and have cold storage facilities);
- community fish-marketing cooperatives;
- street sales (either by door-to-door marketing or a roadside table or stall);
- local wet markets; and
- established clients, including traders and end users (e.g., restaurants).

Finally, where established markets, services, and utilities exist, there may be cold storage facilities that allow for alternative market linkages.

PLATE 13 | Drying fish in the sun, Lake Albert, Uganda. **Credit: Ted Pollett**

PLATE 14 | Selling fresh fish on the street, Fakfak, Papua/Indonesia. **Credit: Robert Gerrits**

PLATE 15 | Selling smoked fish on the street, Fakfak, Papua/Indonesia. **Credit: Robert Gerrits**

PLATE 16 | Fresh fish food stall/restaurant, Fakfak, Papua/Indonesia. **Credit: Robert Gerrits**

3.6 NEEDS FOR THE OPERATION AND DEVELOPMENT OF SMALL-SCALE SUBSISTENCE AND ARTISANAL FISHERIES

Fishing communities (and fish markets) in rural areas in developing countries generally remain largely local in nature, with limited development of supporting infrastructure, inputs, and markets, and limited provision of systematic national development and support programs aimed at improving management and operation of fishing activities. This general and sector-specific lack of development means that artisanal fishermen face a relatively consistent set of obstacles that need to be addressed in order to support their development, including organization, the establishment of support infrastructure, improvements in input supply and the development of markets.

Organization

Lack of organization of fishermen and their communities is a major constraint to development and implementation of project interventions and delivery of benefits.

Support infrastructure

The lack of support infrastructure for the delivery, storage, and distribution of inputs and the storage and processing of produce limits development of small-scale subsistence and artisanal fisheries. For example, a lack of infrastructure, including roads, electricity, fuel distribution, etc., may limit scale and commercialization of fishing activities. Roads affect the supply of inputs, their availability, and cost and also provide options for marketing. Electricity allows for the operation of ice-making and cold storage facilities, while fuel is essential for motorized vessels.

Inputs

Fishing requires a range of inputs, including equipment (boats, motors, and fishing equipment, such as cold storage boxes, nets, lines, hooks, etc.), fuel, and ice. A lack of access to these supplies can limit the development of small-scale subsistence and artisanal fisheries.

For example, a lack of fuel and electricity (whether unavailable or involving unreliable supplies at greater cost) may limit the ability to fish, and the frequency, distance, and duration of trips, as well as the operation of ice-making and/or cold storage units (including freezers) for storing their catch. Without ice, fishermen may have to limit both the frequency of their trips and the time spent at sea, as they are unable to store their catch for extended periods of time. In addition, in the absence of transportation vehicles with cold storage units, fishermen will be unable to transport fresh fish produce to more distant markets. A lack of fresh water supplies may also adversely affect fish processing and quality and limit ice production, thereby affecting storage of fish.

The lack of knowledge and access to information related to good practices in boat construction, engine maintenance, fishing gear design, planning, and safety is also a major gap, as is the limited availability of skilled people and spare parts for equipment maintenance and repair. Poorly constructed vessels have shorter life spans, nets left in the sun can be degraded by ultraviolet (UV) rays, and incorrect maintenance reduces the life of engines and boats. Safety equipment (including life jackets, emergency communication devices, flares, etc.) are seldom used by small-scale subsistence and artisanal fishermen, and accidents resulting in loss of life of fishermen can have severe impacts on fishing households and communities.

Markets

Structured markets and distribution systems (i.e., an established value chain) allow for storage, distribution, and sale of produce over a wider geographic area and, by implication, to a larger market. In remote areas with limited access to markets, fishermen may be reliant on selling their catch to "middle men," who control prices and who may pay "in-kind" through supply of fishing equipment, general groceries, etc. While wet markets may be available in small towns, allowing fishermen to sell their catch to a larger grouping of buyers, without established storage and marketing channels, fishermen and their wives and children often must process their fish (e.g., smoking, drying, and salting) and engage in street-level marketing of their catch.

The general lack of development and the specific issues described above may limit a project's options to mitigate impacts, or alternatively, the mitigation of impacts may require investment in the general development of the fisheries sector. Further, projects impacting small-scale subsistence and artisanal fisheries are often asked to go beyond mitigating their impacts by fishing communities who seek support for more general development of the fisheries sector. These issues – which pose significant dilemmas for private sector projects – are addressed in subsequent chapters.

4. PROJECT IMPACTS ON FISH RESOURCES, FISHERIES, AND FISHING-BASED LIVELIHOODS

Projects can have both positive and negative impacts on fish resources and small-scale subsistence and artisanal fisheries and fishing-based livelihoods. While each project is different, there are a variety of common impacts that can result from project activities. It is important to understand these potential impacts in order to be able to effectively predict, assess, and manage[4] them. This chapter reviews the range of both positive and negative impacts to fish resources, fisheries, and fishing-based livelihoods that may occur in the project-affected area.

4.1 POSITIVE IMPACTS

A project may have both direct and indirect positive impacts on small-scale subsistence and artisanal fisheries. Most commonly, such impacts are associated with the development and/or improvement of area support infrastructure and services that also inadvertently benefit fisheries, including:

- improved access to fresh water (for production of ice, fish processing);
- improvement of road access and quality (for inputs and markets);
- improved fuel supplies and docking facilities;
- provision of electricity (for production of ice, cold storage); and
- improved communications (allowing better linkages between fishermen and markets and also for communication in the event of emergencies while fishing far offshore in marine and lake environments or in remote areas).

Positive impacts may also include improved availability of key inputs, such as equipment and fuel, resulting from the expansion of local-level trading through improved accessibility and the higher levels of disposable income associated with project employment. In addition, higher allocations and improved delivery of fuel supplies from regional fuel storage depots that are associated with project development and operations may also benefit local fisheries.

Finally, the presence of a project may lead to expanded markets for fish resources, as a result of:

- demand from the project construction and operations phase workforce;
- increased levels of disposable income that promote changes in consumption; and
- increased populations associated with project-induced in-migration and development.

4.2 NEGATIVE IMPACTS

Project development and operations can also have a wide range of negative impacts on fish resources, fisheries, and fishing-based livelihoods, including environmental impacts on fish resources, reduction in area of and/or access to fisheries, increased risk to life and equipment, physical displacement of communities, indirect impacts from increases in population and behavioral changes, and ultimately a loss of livelihoods (i.e., economic displacement). Each of these potential negative impacts has a high probability of evolving into a challenge for the project if not properly managed. This section discusses each potential impact in more detail.

At the outset, it is important to recognize and address both actual and perceived negative impacts of project development. To maintain positive relations between the project and affected communities, it is important to ensure that the affected population is aware of and understands the dynamics of local fisheries and the potential project impacts, allowing the project to be a recognized stakeholder promoting improved sustainable fisheries management, including management of indirect impacts and externalities (see Box 4.1).

[4]IFC PS1 recommends that such management follows the mitigation hierarchy, requiring projects to, in order of preference, avoid, minimize, and as a last resort, compensate/offset residual impacts.

BOX 4.1 | THE NEED TO ADDRESS LOCAL PERCEPTIONS OF IMPACTS: A CASE STUDY FROM BPZ/PERU

BPZ Energy is an independent oil and gas exploration and production company operating in northwest Peru, near the border with Ecuador. The company is developing its main offshore asset in Peru, including exploration activities (such as seismic surveys ot map its offshore hydrocarbon resources) and oil production.

In 2009, BPZ attempts to start offshore seismic activities on the back of the approved ESIA (identifying concerns regarding fish, dolphins and whales) but prior to completion of consultations with local fishing communities met with strong opposition from these fishing communities.

Upon receiving a new environmental permit, BPZ restarted its offshore seismic activity on February 8, 2012. This action led local artisanal and industrial fishermen to implement a two-day blockage of the Pan-American highway close to the company's operations, to raise concerns that seismic surveys would negatively impact fish resources and their fisheries activities. At the same time, local media and blogs began to report that dead dolphins were washing ashore on the beach of Lambayeque, located 500 km south from the coast of Tumbes in northern Peru where BPZ operates. They argued that the dead dolphins were a result of BPZ's seismic offshore testing, linking loud ocean noises to disorientation and ear and organ damage in marine mammals. IMARPE, Peru's Institute of Oceanic Studies, conducted field studies and found no scientific evidence linking the deaths to the seismic activity. In March 2013, IMARPE invited international specialists from the National Oceanic and Atmospheric Administration to assess the cause of death mammals and who stated that death of mammals may have been associated to morbilivirus, a viral infection, and to algae.

In the aftermath of this incident, BPZ stepped up its stakeholder engagement efforts and created a community participatory monitoring program (Proyecto Escolta) to monitor impacts on marine mammals while the company conducted seismic surveys. The program promoted the participation of community observers, including artisanal fishermen associations, to monitor any potential adverse impacts of the seismic surveys and halt testing if dolphins or other large mammals were observed to be in the area where seismic activities were nbeing implemented. The monitoring program was implemented by a third-party contractor, and training was provided by BPZ. The first phase of the program, from February-April 2012, included 1,623 beach monitors, approximately 50 percent of whom were women, and 303 crew members. A second phase, from September 2012-February 2013, included 3,696 beach monitors and 367 crew members. The monitors submitted daily monitoring reports describing any on- and off-shore events to the company.

Key findings from this program included:1) the implementation of the BPZ seismic survey was not associated with any death of mammals on the coast to extending to Tumbes; 2) beach monitors and crew member were not all witnesses but acted as allies and spokespersons of measures taken by the company on the operation with respect to measure of environmental concerns; 3) communications, based on scientific information and observation, helped communities' awareness and understanding of seismic activities and eased their concerns about environmental impacts; 4) statistics showed that there was no reduction in artisanal fishermen's catch during the seismic survey.

continued on next page

Local participation in the program helped change the perception of communities toward BPZ's seismic surveys. As a result of this process, a new dialogue mechanism was set up with the 22 artisanal fishermen associations thereby leading to: 1) the setting up of a Fund to promote sustainable and inclusive projects associated to their extractive activities; 2) helped them to act as social entrepreneurial leaders for their communities managing funds for social campaigns; 3) the establishment of new levels of communication to validate the coexistence between oil and fishing activities. Including community participation in overseeing the BPZ's behavior during seismic surveys helped the company to improve community perceptions and understanding of its operations. Rody Gamboa, leader of an artisanal fishermen's association in Grau, stated that "we thank BPZ for letting us participate on the Proyecto Escolta. We did not know anything about a seismic survey and by participating as observers; we were able to see that whales, dolphins and sea mammals were not affected by this operation".

4.2.1 Environmental Impacts on Fish Resources, Habitats, and Productivity

Project development and operations may lead to changes in the physical environment, destroying the biophysical resources that support fisheries, disrupting the fisheries habitat, and adversely affecting fish resources.

In some cases, construction and operations activities may be associated with irreversible loss of fish habitat, for example:

- conversion of mangrove forests, which serve multiple functions, including providing a nursery for many fish species, coastal protection, buffering of fluctuations in sea level associated with storms, king tides, etc.;
- the development of jetties and breakwaters that affect currents and the deposition of sands;
- dam construction and operation that results in changes in downstream flow regime, altering river ecology and affecting livelihoods downstream;
- development of mines in watersheds;
- development of roads and utilities that cross streams;
- laying of pipes in rivers;
- development and installation of facilities on lake shores;
- use of surface water and groundwater;
- increased presence of water-impervious surfaces;
- earthworks that lead to the in-fill of near-shore environments, such as wetlands, and changes to coastlines; and
- dredging to create, expand, or reinforce channels for shipping

Physical disruption may also lead to disruption of processes linked to fisheries, all of which may affect the stock, quality, and productivity of fish resources. Project activities may be associated with increased turbidity and acoustic disturbance, leading to alterations in the benthic habitat and negative effects on benthic fauna[5], fish avoidance, and fish mortality. Finally the disposal and discharge of project waste products may negatively affect fish habitat by creating adverse conditions for fish.

Dam construction, the development of roads and utilities that cross streams and shorelines, and near-shore infrastructure (e.g., piers) may block or impair fish migration, as well as associated spawning or rearing. In addition to the physical structure itself,

[5]Organisms that live in the bottom of the sea and bay area.

noise, vibration, toxic spills, and increased turbidity associated with construction can disrupt migration and spawning behavior and may cause acute or latent mortality of eggs, larvae, and juvenile stages of many species. New piers, even if on pilings, will impact small or juvenile fish migrating along the shore. Many such species will not move through dark shadows cast by an overwater pier and may attempt to go around it, being forced into deeper water where they are more vulnerable to predation. Also, predatory species can hide under piers or around pilings to ambush small migrating species.

Habitat conversion

Conversion of aquatic and marine habitats, such as estuarine habitats, mangrove forests, seagrass beds, and coral reefs, contributes to the loss of ecosystem services that these habitats provide, both directly and indirectly, to artisanal fisheries. Even upland conversion of natural habitats can result in increased runoff and unnatural turbidity and elevated pollution, thus negatively affecting aquatic habitats.

Estuarine conversion: Depending on the biophysical characteristics of an estuary and the scope of the project, conversion of estuarine habitats can result in significant loss of ecosystem services to artisanal fisheries. Conversion activities may include fill, shoreline hardening, draining of associated wetlands, and dredging. Estuaries are important rearing/feeding areas for juvenile fishes and shellfish, as well as migratory corridors for many species of fish that depend on the riparian cover along the shoreline, the water quality and quantity, buffering, and organic inputs provided by wetlands, and the natural seasonal cycles of sediment transport and salinity along the bed of the estuary. All conversions of estuary areas directly reduce habitat upon which marine resources depend.

Mangrove forest conversion: Nutrients and carbon from mangrove forests provide essential support to other near-shore marine ecosystems, including coral reefs and seagrass areas, and enrich coastal food webs and fishery production. The physical presence of mangroves along the coast and estuaries also provides the first line of defense against high winds and storm surges. They are also important nursery areas for many freshwater and reef fishes, which in turn attract a whole host of predators, including the mangrove jack and sharks and a wide variety of snakes, turtles, crocodiles, and small mammals. Mangroves also directly support household livelihoods, providing building material for housing, fuelwood and various other products, including dyes and food (mangrove seeds, etc.). The conversion of mangroves results in the loss of these functions and services, and where the converted area is large, the impacts can be diverse and significant.

Seagrass bed conversion: Seagrass beds function as vital habitat, spawning substrate and nursery grounds for numerous ecologically important fish and shellfish species that are directly important to artisanal fishermen. Indirectly, seagrasses also play a major role in the nutrient and carbon cycles, provide an important food source for fish and waterfowl, and stabilize bottom sediments. Conversion of seagrass beds by filling, shading (from overwater structures), or dredging (both construction and maintenance) represents long-term, and sometimes permanent, loss of ecosystem services for artisanal fisheries.

Coral reef conversion: Reefs provide cover, spawning substrate, and food for thousands of species of fish and shellfish. Conversion of coral reef habitat by trenching for pipe laying, overfilling for dock or airplane runway extensions, or dredging for construction of new deepwater channels will proportionately reduce ecosystem services to artisanal fishermen. Furthermore, removal of or damage to reefs may lead to colonization of certain algae species, which may harbor ciguatera-poison-producing organisms in tropical areas. Artisanal fishermen are most likely to harvest fish containing high concentrations of ciguatera, and as a result will be at increased risk from this impact.

Disruption of processes by physical infrastructure

Disruption of habitat-forming processes by construction and operation of physical infrastructure projects, such as roads, dams, jetties, and breakwaters, will have both direct and indirect negative effects on artisanal fishermen.

Road construction: Road construction that blocks the flow of water in flood plains during rainy seasons can impact on fisheries.

Dams[6]: Natural, unaltered rivers have properly functioning habitat pathways (e.g. water quality, habitat access, habitat elements, channel conditions, and flow hydrology), but the construction and operation of dams disrupts the functioning of each of these pathways. The most direct effect is cutting off habitat access to fish movement upstream, and many times downstream, even with modern fish passage facilities installed. Dams also create an unnatural flow regime that changes stream habitat elements (e.g., blocking downstream sediment and large woody debris migrations). The upstream reservoir will inundate the existing riparian corridor and shoreline refugia, and create an artificial lake habitat with different temperatures and likely new fish species composition. Dam construction can also have social impacts on fisheries, resulting from declining fish catches, loss of fishing nets, and increased difficulties with transportation.[7]

Jetties: Many projects require construction of temporary and permanent jetties (or piers, causeways or docks) in order to transport commercial commodities between land and cargo vessels. The length and width of these facilities will depend on the near-shore bathymetry and the cargo being loaded.

Some projects include solid jetties, using fill for construction. This type of structure has the most significant effect on local artisanal fisheries for several reasons: It permanently converts near-shore fish habitats that may include mangroves, sand flats, seagrass beds, and coral reef. It will disrupt long-shore drift, causing the accumulation of sediments up-drift and starvation of sediments down-drift, which may result in changes to existing mangrove forests or sandy beaches suitable for sea turtle nesting. Such a structure could also disrupt near-shore fish migration and local fishing patterns.

Other jetties are constructed on pilings, which may have less significant impacts, depending on the design. Long, wide overwater structures create shade, which can eliminate any marine vegetation habitat and may create migration barriers to juvenile near-shore pelagic fish. Well-spaced pier bents and minimum diameter piles can partially mitigate the effects of the structure on long-shore drift. The piles will also function as a vertical attachment habitat that may allow establishment of fouling organisms upon which fish could feed. Because it is common to establish exclusion zones around such structures, their presence will disrupt local artisanal fishing patterns.

Breakwaters: Breakwaters may be required at near-shore loading facilities, to protect transportation vessels from wind and waves and allow them to safely berth. Breakwaters may be either solid, using fill for construction, or made by installation of sheet pile. Such structures permanently convert near-shore fish habitats, including sand flats, seagrass beds, and coral reefs. In many cases, it is argued that these structures create habitat for reef species of fish and shellfish, but most have exclusion zones around them that do not allow fishermen access to species attached to such structures. Depending on their physical characteristics and their location (i.e., distance from shore), breakwaters may also affect long-shore drift and erosion patterns on adjacent beaches.

Increased turbidity

Construction and operations phase project activities, including earth movement and potential erosion, dredging, pile-driving and filling operations, drainage systems, and channelization, may stir up bottom sediments and increase the turbidity[8] of the water. Barging and service vessel movements in waterways can also contribute to turbidity, particularly through wave motion on banks or shores and prop-wash[9] in shallow waters.

Increased turbidity, with high concentrations of particulate matter, may be associated with avoidance behavior by some fish species, thus directly affecting the productivity of fishing activities. High turbidity can modify light penetration, cause shallow lakes and bays to fill in faster, and smother benthic habitats, impacting both organisms and eggs. Reduced light penetration may decrease photosynthesis and lead to reduced growth of

[6]The assessment and mitigation of impacts associated with dam construction is beyond the scope of this handbook. Readers are referred to key publications and/or case studies.

[7]Other social impacts associated with dam construction and operation include loss of dry-season drinking water sources, loss of fertile lands, and loss of the resource base for agriculture.

[8]Turbidity refers to the amount of total suspended solids (TSS) in the water. The higher the level of TSS, the murkier the water appears and the higher the measured turbidity.

[9]Current of water, created by action of a propeller, that is expressed as wave action in shallow and/or confined water bodies.

macrophytes, thereby impacting organisms dependent upon them for cover and food. Reduced photosynthesis can also result in a lower daytime release of oxygen into the water. As particles of silt, clay, and other organic materials settle to the bottom, they can suffocate newly hatched fish larvae and fill in spaces between rocks that could have been used by aquatic organisms as habitat. Fine particulate material can also prevent proper egg and larval development, potentially interfere with particle feeding activities, clog or damage sensitive gill structures, and decrease species resistance to disease. Reduced oxygen levels and a reduction in food sources alters the fish habitat, which may favor certain species over others or ultimately lead to a total loss of fish.

High levels of chronic turbidity and associated sedimentation can also affect or damage critical habitats, such as corals reefs and seagrass meadows.

Corals: Individual species of coral are resistant to sediment stress up to certain critical levels. These differences in tolerances will be directly reflected in the changes in ecology of a stressed reef. For example, the risk and severity of process impacts from dredging and port-construction-related activities on corals are directly related to both intensity and duration of exposure to increased turbidity and sedimentation. Frequent short-term exposure or chronic long-term exposure to high sedimentation or high turbidity events can result in the mortality of many coral species.

Sediments are a natural part of the reef environment, and reef corals have adapted to them to an extent, but at levels above the low, natural input of sediment, there is energy drain that stresses the coral. Temperature, salinity, wave regime, ambient light, and relatively pure water quality are requisites for reef growth, and thus reefs have developed primarily in low-sediment input areas (while some reefs are found near river outlet environments, those reefs are existing at a toleration limit). Some of the problems associated with the influx of sediment into a reef system include:

- smothering of the reef by sediment;
- scouring of the reef by sediment-laden waters;
- loss of bottom area suitable for settlement of larvae; and
- reduced light intensity due to turbidity.

Reduced light intensity results in shifting of the zonation and an upward migration of depth limitations. The loss of light is more critical to deeper coral assemblages, and a chronic increase in turbidity can be expected to reduce coral growth in deeper water and cause changes in the species dominance. Further shifts in the ecology result from differences in tolerance to direct sediment application by different corals.

A change in the environmental parameters beyond tolerable limits, or even to a point of adaptable stress, will shift the entire ecosystem and may result in a new and less-competitive coral assemblage that has less chance of survival if threatened by other problems. In studies of the recovery of coral reefs from extreme siltation, reefs have recovered only where the faster growing, shallow water types of coral were present. One of the major problems of sedimentation is the reduction of the potential for future establishment of coral. As the old coral surface dies, it is covered with algae, including the filamentous greens that trap and hold sediment to form an algal mat, making the surface completely unsuitable for colonization.

Seagrass beds: For seagrasses, the critical threshold for turbidity and sedimentation, as well as the duration that seagrasses can survive periods of high turbidity or excessive sedimentation, vary greatly among species. Larger, slow-growing climax species with substantial carbohydrate reserves show greater resilience to such events than smaller opportunistic species, but the latter display much faster post-dredging recovery when water quality conditions return to their original state.

Light is one of the key environmental resources needed for the growth and survival of seagrasses. The amount of light that reaches a seagrass leaf is determined by the natural water color, concentration of suspended solids, phytoplankton concentration, and epiphyte cover of the leaf. Water transparency (which determines the depth penetration of sunlight) is the primary factor determining the maximum depth at which seagrasses can occur. Reduction in light due to turbidity has been identified as a major cause of loss of seagrasses worldwide.

Several studies have documented deterioration of seagrass meadows by smothering due to excessive sedimentation. The consequences of this enhanced

sedimentation for seagrass plants depend on several factors, including depth of burial and life history of the species involved. Seagrass species that develop vertical shoots may respond to fluctuations in sediment depth by modifying their vertical growth to relocate their leaf-producing meristems closer to the new sediment level, but there are limits to the level of sedimentation that seagrasses can tolerate.

Acoustic disturbance from dredging and shipping

Underwater acoustic disturbance, for example from pile driving or increased shipping, may cause avoidance behavior by marine resources, injury, and even mortality. For example, pile driving for marine structures can drive certain species of fish away during the construction period. In general, the zones of influence of a sound source depend on the frequency, sound pressure or decibels (dB), the character of noise (continuous or sudden), and the physical conditions of the environment. Water currents bend noise waves upward when propagated into the current and downward downstream when observed over long distances. Noise waves bend toward colder, denser water, and bottom topography and underwater structures can block or refract noise waves. Marine mammals are especially sensitive to underwater sound, as are schooling forage fish species.

Disposal and discharge of project waste products

Project activities may also affect fish resources through the unintentional and intentional discharge of waste products, waste by-products or effluents, such as tailings disposal, ballast water discharges, drill cuttings, produced water, and petroleum and chemical spills.

Tailings disposal: Mine tailings are the materials left over after the process of separating the valuable fraction from the uneconomic fraction of an ore. Tailings are distinct from overburden, which is the waste rock or materials overlying an ore or mineral body that are displaced during mining without being processed. The extraction of minerals from ore can be done two ways: placer mining, which uses water and gravity to extract the valuable minerals, or hard-rock mining, which uses pulverization of rock and then the addition of chemicals. In the latter, the extraction of minerals from ore requires that the ore be ground into fine particles, so tailings are typically small and range from the size of a grain of sand to a piece of dust. Mine tailings are usually produced from the mill in slurry form (a mixture of fine mineral particles and water). Common minerals and elements found in tailings that are toxic to fish and aquatic life include arsenic, cadmium, copper, cyanide, hydrocarbons, mercury, radioactive materials, zinc, and various acids.

To prevent the uncontrolled release of tailings into the environment, mines usually have a disposal facility, often a dam or pond. However, failure of the retaining wall holding the tailings in this facility can result in a massive release of tailings. Tailings release and subsequent damage to the environment can also occur without a catastrophic failure of the storage facility. These kinds of releases are subtle, and may include acid drainage or dry tailings dust being blown away from the storage area, which can be toxic to resources downstream. Riverine tailings disposal (RTD), which involves the release of the tailings into river systems, is not a preferred practice. Globally, as of 2005, only three mines operated by international companies continued to use river disposal; all three are located in New Guinea. This method is used in these cases because of seismic activity and landslide dangers, which make other disposal methods impractical and dangerous.

Submarine tailings disposal (STD) or deep-sea tailings disposal (DSTD) involves conveying tailings to the marine disposal area using a pipeline and discharging them so that they eventually descend into the depths. Practically, these methods are not ideal, as the close proximity of mines to off-shelf depths is rare. When STD is used, the depth of discharge is often what would be considered shallow, and extensive damage to the seafloor can result from covering by the tailings product or pollution that is harmful to fisheries resources. It is also critical to control the density and temperature of the tailings product, to prevent it from travelling long distances or even floating to the surface.

Ballast (water) discharge: Ships carry ballast to provide stability. While ballast primarily consists of water, it typically is also full of stones, sediment and thousands of living species. Over 3,000 marine species travel around the world in ships' ballast water on a daily basis. While it is common for such water to be discharged upon arrival at the intended destination,

uncontrolled discharge can introduce nonnative species into the new environment, leading to economic and environmental damage. Invasive nonnative species may feed on or outcompete native species, thus eliminating a vital part of the native food chain. International shipping industries are responsible for the majority of these nonnative species invading foreign waters.

Drill cuttings: Drill cuttings are any material (typically called solids) removed from a borehole while drilling petroleum wells. Although sand, clays, and shale make up the majority of the cuttings encountered while drilling a well, depending on the location, any number of formations will actually be encountered. Where oil and gas exploration rigs and production installations are allowed to dump drilling wastes unchecked, the effects on marine life can be extensive and biologically significant. The ecological effects may extend for several kilometers from some platforms and can be detected up to 10 km from discharge points. These cuttings piles smother seabed life and remain toxic for many years, mainly because of the hydrocarbons they contain.

Oil or fuel spills: In the short-term, oil or fuel released to the water may smother fish and may also be noxious, thereby causing immediate mass mortality and contamination of fish and other food species. However, the long-term ecological effects may even be worse. Oil or fuel spills can impact sensitive marine and coastal organic substrate, interrupting the food chain on which fish and sea creatures depend, and on which their reproductive success is based. This can permanently affect commercial fishing enterprises.

4.2.2 Reduction in Area of and/or Access to Fisheries

Project development may entail modifying coastlines, the development of infrastructure such as jetties and ports, ensuring operational access for shipping (e.g., establishment and maintenance of access canals, turning basins, breakwaters, and safe mooring), the development of offshore facilities, and the enforcement of exclusion zones, all of which may reduce the area of fisheries and/or people's access to and use of these resources.

Projects often require the establishment of exclusion zones adjacent to their coastal project locations, around both offshore activities and offshore infrastructure (e.g., submarine pipes, drilling platforms, and oil and gas rigs). Exclusion zones are designated to (a) ensure the safety of local people, including fishermen and commuters; (b) avoid accidental damage to or loss of fishing equipment; (c) promote the safety of people working on, or in the immediate vicinity of, the installation; (d) ensure the protection of the project infrastructure against damage or sabotage by local people; and (e) meet national or international security requirements covering port facilities, waterways, and particular types of vessels while loading or unloading.[10]

These zones may be associated with construction or operations, may be temporary or permanent, and may be moveable or fixed. For example, dredging operations associated with construction are typically associated with a short-term, moveable safety zone around the dredgers. Fixed permanent safety zones are typically associated with construction and operation of offshore facilities projecting above the sea level at any state of tide and may also be associated with subsea installations, including underwater pipelines. Fixed permanent exclusion zones may be associated with areas involving high levels of project traffic (e.g., project jetty/port, established sea lanes, turning basins for large ships, etc). In many cases, marine exclusion zones will be defined by a national maritime authority, the coast guard, or the navy. In these circumstances, project sponsors may have limited capacity to influence the nature of such restrictions or the kind of concessions that might be provided for local fishermen.

The establishment of such zones may be associated with a reduction in the total area of fishing grounds and the accessibility of and/or mobility within and across established fishing grounds. In addition, these zones may also affect general shipping, including the disruption of local transportation practices and routes (see Box 4.2).

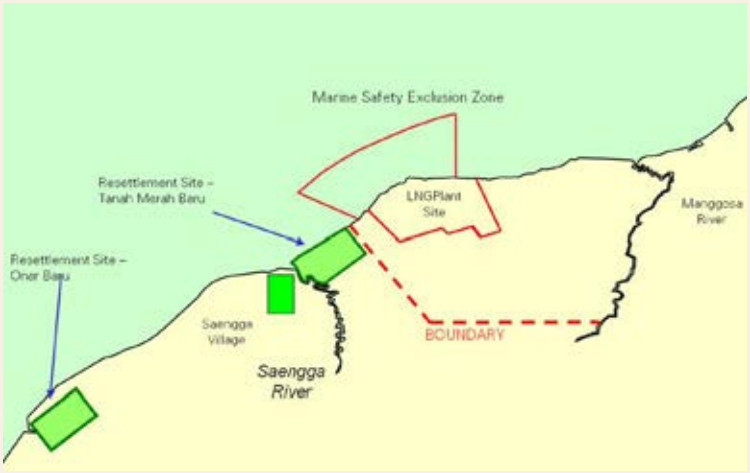
4.2.3 Disruption of Fishing Activities and Increased Risks to Life and Equipment

In addition to posing threats to the habitats and fish resources in an area, the presence of project activities can also cause direct, increased risks to people and equipment involved in the fishing sector.

[10]See, for example, the International Ship and Port Facilities Security Code (ISPS Code).

BOX 4.2 | THE IMPACTS OF AN EXCLUSION ZONE IN THE TANGGUH LNG PROJECT

The exclusion zone established during development of the Tangguh LNG Project in West Papua, Indonesia, resulted in the almost complete loss of access to the most proximate fishing grounds closest to the old Tanah Merah village, which was relocated as a result of the project.



The exclusion zone also restricted access to traditional fishing grounds lying east of Tanah Merah village and forced both fishermen and commuters to make an extended detour out to sea, increasing the cost of transportation and the time needed to circumnavigate the exclusion zone, and also exposing local people to hazardous conditions in adverse weather.

Physical relocation to areas near existing villages also resulted in increased fishing intensity, as a larger population began to harvest resources from the same area. This impacted the villagers' fishing activities, as greater numbers of canoes laid out larger numbers of nets to harvest prawns, and reportedly negatively affected prawn harvests and collection of mollusks.

To address some of these concerns, the project developed a terrestrial bypass of the project site (i.e., footpath), allowing villagers to have land-based access to traditional fishing grounds to the east of the plant. Outboard motors were provided to fishermen so that they could gain more rapid access to alternative, more distant fishing grounds.

Safety of fishermen and commuters

Project construction and operational phase activities may threaten the safety of fishermen and commuters, the latter potentially coming from a much larger area than the immediate project area of influence. The most significant safety risks to the activities and lives of fishermen and commuters are associated with an increased number of vessels, their movement, and the impacts associated with their movement (e.g., waves from outboard motors, size of bow wave), together with a higher risk of accidental collisions. In addition, the establishment and enforcement of exclusion zones may inadvertently increase safety risks.

Safety concerns primarily arise from the operation of project vessels and shipping traffic. For example, projects often use high-powered motorboats to transport personnel and enforce security. These boats travel at high speeds, create large washes, and require specific docking and mooring at jetties. It may be difficult for operators to see fishermen in a timely fashion, resulting in potential boat collision, capsize, and loss of life. Similarly, while docking and mooring, the large size of the vessels may increase risks to fishermen operating smaller traditional fishing boats, potentially leading to boat damage, injuries, or death.

Increased shipping activities during the construction and operation phase may also impede livelihood activities and increase safety hazards. First, it may be considerably more difficult to observe the activities of artisanal fishermen from the decks of larger vessels. Second, while these vessels may travel more slowly than high-powered motorboats, large ships also have large bow waves and large washes that may affect the safety of fishermen. Third, where there are established shipping channels, the increased number of vessels may impede local communities' ability to cross the channel safely. Finally, where construction, production, and general operational schedules involve lengthy waiting periods, the vessels may anchor outside the project's designated footprint, thereby considerably increasing

the actual affected area. During this period, the project footprint and potential impact on fisheries may be significantly expanded.

Project exclusion zones may also disrupt local transportation routes (for example through the imposition of a shoreline exclusion zone) and require substantial detours for commuters and fishermen. This may be associated with safety concerns, particularly where vessels suited for near-shore use are forced to move into more exposed waters to navigate around marine structures and their exclusion zones (see Box 4.2). It may also contribute to higher fuel costs that reduce the returns for artisanal fishermen.

Increased risks of disruption and safety concerns may encourage fishermen to utilize other fishing grounds, possibly impacting neighboring fishing communities and increasing pressure on limited fish resources in specific areas. Such displacement may involve increased distances and travel times and as such may increase costs and risks (e.g., if storms occur, if motors breakdown, etc.).

Security

Security forces may be engaged by the project or the government to ensure the enforcement of exclusion zones, the security of onshore and near-shore infrastructure, and the continuity of project operations. Project security may be provided by a project security force, contracted security forces, and/or public security services (i.e., coast guard, maritime police, navy). Host nation maritime security forces are often the least well-equipped and trained of the nation's public security forces. The provision of project security and especially the enforcement of exclusion zones may negatively impact affected communities by disrupting livelihood activities, including transportation, fishing, etc., and threatening the safety of affected communities. For example, project marine security forces, both public and private, are typically equipped with larger vessels capable of travelling at high speeds. Inappropriate operation of these vessels in the vicinity of traditional fishing boats may increase the risk of damage to boats, capsizing, and drowning. Finally, the security arrangement may sour the relationship between the project and the affected communities, thereby affecting the project's "social license to operate." This is especially the case where there is a history of negative relations between security forces and local communities. In such cases, the security presence may exacerbate the inclination to pressure the project for a broad range of concessions.

Damage to equipment

Without an understanding of local fishing practices, the transit of speedboats and larger ships through common access channels and across fishing grounds is often associated with accidental damage to equipment, most commonly damage to lines, fish traps, and nets. Less frequently, accidental collisions between fishing boats and ships or between fishing boats and other project equipment (e.g., underwater lines, buoys) may result in loss of equipment (e.g., motors), damage to equipment (motors, boats), and loss of lives. The presence of submarine pipes and increased levels of industrial debris on the seabed may negatively affect trawling, with limits to fishing grounds and damage to nets, depending on the fishing techniques commonly used by fishermen.

4.2.4 Severance

Severance refers to impeded or lost access between the fishing communities and nearby towns through which the communities secure access to markets (selling fish, purchasing food and other household supplies), government, and services (including education, health, etc.), and which may be important for maintaining social networks.

4.2.5 Physical Displacement

While the previous sections focused on project impacts causing economic displacement, project development may also sometimes lead to physical displacement, requiring the resettlement of impacted fishing communities. Such displacement may occur as a result of project land take or where the severity of project impacts on fisheries is significant and cannot be mitigated (i.e., fishing-based livelihoods are no longer viable in the current location). IFC Performance Standard 5, Land Acquisition and Involuntary Resettlement, and its associated guidance notes define standards and provide guidelines for the development of a resettlement plan and for livelihood restoration plans. Further guidance for management of physical displacement of fishing communities is provided in Section 6.2.5.

4.2.6 Indirect Impacts[11]

In addition to the direct impacts that a project may have on an area's environment and communities, there are a number of indirect, project-induced impacts that can occur as a result of the project's presence in the region. While some of these indirect impacts, such as local and regional development, improved infrastructure and support, improved availability of equipment and inputs, and improved markets, may have benefits for artisanal and small-scale fishermen, these same changes also have the potential for direct negative impacts on fishing communities. Many of these negative impacts result from population growth and demographic changes that occur with an increase of in-migration to the area.[12] Some of the most important migration-related issues include:

- **High levels of in-migration in anticipation of project-related employment and improved trade opportunities (associated with higher levels of disposable income in communities in the project area of influence):** Such project-induced in-migration is often associated with migrants settling in villages close to the project site and engaging in various activities while waiting for employment or entrepreneurial opportunities to arise. In fishing communities, migrants often participate in fishing activities, increasing competition for what may be scarce resources. Furthermore, migrants who come from more developed areas and have connections with traders may have greater access to equipment, inputs, credit, and markets, allowing larger catches, greater returns, and ultimately market control. While such participation does not necessarily have negative impacts, increases in fishing activity may threaten the sustainability of local fisheries. Tangible differences in local and migrant fisheries productivity and returns from fishing activities may also create unwelcome tensions within the community.
- **Increase in availability and consumption of alcohol, drugs, gambling, and prostitution:** The interaction of construction, operational, and shipping personnel with affected communities may involve the sale of food, alcohol, and drugs and the development of gambling and prostitution sectors. While such interaction may be of less significance in coastal towns with long-established harbor and port facilities, project development often occurs in more remote and isolated locations, where such interaction with village communities may cause a range of negative impacts, including social tensions, unplanned pregnancies, sexually transmitted diseases, alcohol and drug abuse, etc. These issues inevitability escalate into security threats and may lead to vandalism and sabotage. This should be a major concern for the project operator, even where the majority of shipping is provided through contractors, as use of third-party contractors provides little protection in the court of local public opinion.
- **Behavior change among fishermen as a result of project development and impact management:** The knowledge that a project will compensate for or replace damaged equipment on an ongoing basis, provide compensation for economic displacement, or provide fuel or tow boats in case of extreme need, may encourage opportunistic behavior among fishermen. For example:
  - larger numbers of fishermen may claim traditional use of a project-impacted fishing ground (which is commonly very difficult to verify and quantify) in the hope of receiving compensation;
  - fishermen may deliberately use broken equipment in the vicinity of project activity, in the hope of subsequently claiming that the equipment was damaged by the project and that compensation is due; or
  - fishermen may travel farther out to sea, in the direction of offshore facilities (which can provide attractive habitats for fish), based on the knowledge and expectation that the project will assist them if needed.

  Increased opportunism and risk-taking behavior are associated with increasing risks to fishermen's lives and equipment and increased cost to the project. In turn, they may sour relations between the project and the affected communities by creating expecta-

[11]Indirect impacts are not addressed in IFC PS5. Rather, where they occur they should be assessed and addressed under IFC PS1. They are included here, as indirect impacts have the potential to affect the success of livelihood restoration initiatives and, as such, they should be factored into the design and delivery of livelihood restoration initiatives.

[12]Refer to IFC 2009, "Projects & People, A Handbook for Addressing Project-Induced In-Migration," 2009.

tions, tension, and distrust between the project and affected fishing communities, thereby threatening the project fisheries impact management plan.

- **Movement of fishing activities from one fishing ground to another:** Project development may lead to the movement of fishing activities to other fishing grounds, increasing the number of people affected by project development and also placing increased pressure on fisheries that may already be overexploited. For example, this may occur when project activities affect commercial fisheries that consequently move (often illegally) to artisanal fisheries.
- **Higher disposable income increasing pressure on fisheries:** Increased levels of disposable income associated with project employment may lead to higher investment in and participation rates in fisheries, and increased consumption of fish rather than less expensive grains and other agricultural produce. Similarly, project-induced local and regional development may also encourage higher participation rates in fisheries. Both of these induced changes may affect the sustainability of fisheries and threaten the success of project fisheries impact management plans.
- **Increased movement away from fishing activities:** The ease of entry/exit to fisheries allows for ready movement of local households in and out of fisheries. Employment opportunities provided by the project may encourage a temporary migration of households away from fishing activities. Where such fishing activities contribute to household subsistence and nutrition, households may experience a decline if incomes earned from wage labor are not used to substitute for this contribution.
- **Unforeseen and unintended impacts of project interventions:** Well-intentioned project interventions and social responsibility initiatives can have unforeseen and unintended impacts, some of which can be severe. Prioritization of local employment and the provision of health facilities, schools, improved water supply, electricity, and improved road access can typically result in an unplanned influx of people from outlying communities seeking to share in these benefits. Often, the influx population engages in fishing activities, thereby increasing pressure on fish resources. Another example of unintended negative impacts is the spraying of wetlands and marshes with pesticides to eliminate mosquitoes and reduce the incidence of malaria, which can negatively impact fish-spawning areas and food supplies for fish fingerlings. In efforts to help control malaria, the distribution of mosquito nets to local households has severely exacerbated existing impacts on the fishery of Lake Albert, Uganda (see Box 4.3).

BOX 4.3 | UNINTENDED CONSEQUENCES: IMPACTS TO THE FISHERIES OF LAKE ALBERT, UGANDA, EXACERBATED BY THE PROVISION OF MOSQUITO NETS

Oil exploration companies, international aid organizations and NGOs have participated in a campaign to distribute mosquito nets to rural communities near Lake Albert, Uganda, as part of a wider initiative to eradicate malaria in the area. However, local communities have also used the free or subsidized nets for fishing, rather than protection from mosquitoes.

The small mesh size of the nets has resulted in a significant increase in the number of immature fish caught and a large by-catch, including species critically important as food for fish. This has significantly exacerbated already severe overutilization of the fish resources and will have major consequences for long-term sustainable management of the fishery.

PLATE 17 | Mosquito nets used as fishing nets at Lake Albert, Uganda. **Credit: Ted Pollett**

4.2.7 Aggregate Impacts on the Costs and Benefits of Fishing-Based Livelihood Activities

Taken together, the impacts described in the above sections can all have a direct impact on the economic benefits and costs of fishing for households and communities whose livelihoods include fishing. Reduced benefits may result from a decrease in the catch per unit of effort for each fisherman. For example, prior to the project, a fishermen may have caught four kg of fish per day, but following project development, this may decrease to two kg of fish per day for the same level of effort. Such a reduction may be attributable to loss of fishing grounds leading to the concentration of more fishermen in a smaller area, greater time spent in accessing fishing grounds, loss of productivity as a result of reduced fish populations, etc. For small-scale commercial fisheries, the imposition of safety zones (both sea-level and subsea zones) may affect their ability to fish using established practices, and the reduced area and reduced catch may make fishing less viable.

Even if a fisherman is able to secure the same level of productivity as before the project, negative project impacts may increase the costs of doing so. For example, as a consequence of the imposition of safety zones around offshore installations or exclusion zones around coastal infrastructure, a fisherman may elect to travel to other fishing grounds so he can fish without disturbance. While these fishing grounds may be equally productive, the fisherman will incur additional costs (i.e., cost of large motor, fuel, time) to access the other fishing grounds. There may also be concerns regarding safety that will force the fisherman to have to buy a larger boat.

These livelihood impacts are associated with a range of potential impacts on the well-being of fishermen, their families, and the communities in which they reside. Where the fish catch is an essential component of household subsistence, a reduction in the catch may affect the nutrition, food security, and health of families (and livestock). Where the fish catch is sold at market and serves as a source of income, decreased catches may reduce the availability of other types of food, clothing, education, and health care for affected households. Furthermore, depending on market linkages, a reduced fish catch may affect households that rely on fish processing (e.g., smoking, drying, and salting of fish) and households involved in the marketing of fish. Commercial fishing activities may also become increasingly aggressive or exploitative, and ultimately unviable.

5. ASSESSING PROJECT IMPACTS ON FISH RESOURCES AND HABITATS, FISHERIES, AND FISHING-BASED LIVELIHOODS

This chapter discusses the key steps of the impact assessment process, namely screening, scoping, parameter definition, baseline assessment, and impact assessment (see Figure 5.1). The environmental and social impact assessment (ESIA) process should begin early, such that initial results may be used to inform design (i.e., preference for alternatives) and/or contractor requirements (e.g., for dredging it may be necessary to add control strategies such as limiting the plume size, addition of pipelines to areas outside fishing areas, etc.).

5.1 SCREENING

The first step in assessing potential project impacts on fish resources and habitats, fisheries, and fishing-based livelihoods is to screen the project to determine potentially significant impacts. Screening should be conducted sufficiently early to:

1. allow the project to explore options to alter its location and/or the design of project components to avoid or otherwise minimize significant impacts; and
2. ensure adequate time is allowed for assessment of fish resources and fisheries.

5.2 SCOPING

Once the general existence and nature of project impacts on fish resources and habitats, fisheries, and fishing-based livelihoods is determined, a scoping exercise provides a high-level description of the key characteristics of the resources and habitats and the fisheries in the area, thereby allowing for a better determination of the potential project impacts. This analysis results in context-specific identification of the key issues to help define the parameters that will guide the more thorough impact assessment study (see Box 5.1).

FIGURE 5.1 | Impact Assessment Flowchart

SCREENING

Rapid assessment to determine existence of potentially significant impacts

SCOPING & RAPID ASSESSMENT

Rapid assessment of fish resources and habitats; identification of project-affected fishing activities; assessment of project's potential impacts on fisheries and fishing-based livelihoods; and identification of key fisheries stakeholders within project-affected area

DEFINE KEY PARAMETERS

- Define project construction- and operational-phase activities with potential impacts on fish resources, fisheries, and fishing-based livelihoods
- Define boundaries of impacted fish resources and fisheries
- Define affected households, communities, and activities/enterprises dependent on or associated with fisheries
- Define impacted fish resources, fisheries systems, and fishing-based livelihoods

BASELINE ASSESSMENT

Establish baseline of fish habitats and resources, fisheries, and fishing-based livelihoods.

IMPACT ASSESSMENT

Potential project impacts on:

- fish resources and habitats
- fisheries
- fishing-based livelihoods
- transportation
- safety
- health
- security
- environment

BOX 5.1 | THE IMPORTANCE OF CAREFUL SCOPING AT THE OUTSET

The initial scoping and preliminary environmental and social impact assessment of the Sadiola Gold Mine, which is located in the Sahel region of landlocked Mali, approximately 150-to-200 km south of the Sahara Desert, was undertaken in the middle of the dry season. There was no surface water in the area at the time, and the nearest perennial river (the Senegal River) was 70 km from the project. Comprehensive stakeholder focus groups and household livelihood and food security questionnaires failed to elicit any mention of fish consumption in the area.

The researchers subsequently returned to the project site in the middle of the wet season to find that the previously dry tributaries of the Senegal River at the project site were flowing intermittently and contained significant fish populations (which had migrated upstream from the Senegal River) that were being harvested by local Bambara households and migrant Bozo fishermen. The fishing season was short, but provided important supplemental food supplies for local households. Thus it was recognized that it was important to assess the impacts of the mine on local seasonal stream catchments.

PLATE 18 | Tributary of the Senegal River in the wet season. **Credit: Arjun Bhalla**

5.2.1 Rapid Assessment of Fish Resources and Habitats, Fisheries, and Fishing-Based Livelihoods

Once a project's key impacts have been identified, the project should undertake a rapid, high-level assessment of fish resources and habitats, fisheries, and fishing communities located within the project area of influence.

The objectives of this exercise are to:

- generate a basic understanding of the project-affected fish resources and habitats, fisheries, and fishing-based livelihoods, including fishing grounds, fishing practices, and the value chain; and
- identify all relevant stakeholders and initiate stakeholder engagement processes relevant to the establishment of a baseline, assessment of impacts and, ultimately, the design and delivery of mitigation measures.

The key outcome of the rapid assessment is definition of the project-affected fish resources and habitats, fisheries, and fishing-based communities, and identification of key stakeholders.

Table 5.1 provides a generic questionnaire to be used as a guide during the rapid assessment.

Relevant stakeholders who should be engaged during the scoping process may include:

- the project-affected fishing communities;
- local institutions involved in the organization of fishermen and management of the fisheries value chain;
- development NGOs engaged in fisheries development projects;
- small and medium enterprises involved with the provision of inputs and the marketing of produce;
- proximate enterprises and projects with impacts on fisheries that may already have fisheries impact assessment and mitigation activities; and
- local and regional government, including local and federal/national resource agencies.

Community-level assessment using established techniques (i.e., participatory rural appraisals involving direct observation and discussion with key informants and focus groups, participatory mapping of fish resources and habitats and related activities, season-

TABLE 5.1 | Generic Questionnaire to Guide Rapid Assessment of Fish Resources, Fisheries and Fishing Communities

TOPIC	REFERENCE IN HANDBOOK	KEY QUESTIONS	METHODOLOGY AND STAKEHOLDERS
DEFINITION OF FISH RESOURCES AND HABITATS	CHAPTER 2	• Where do fisheries activities occur? • What physical and biological habitat pathways may be affected by the project, and to what extent? • What are the main species harvested? • Which species are economically and ecologically important, and what is the trend in the stock? • What other threats to the fish habitat or resources exist, and what is their relative importance?	• Literature review • Community leaders • Key informants • Participatory Rural Appraisal (PRA) techniques with fishermen groups (men and women) • Reconnaissance-level surveys • Sketch maps developed through site visits with Global Positioning System (GPS)
CONTROL AND MANAGEMENT OF FISH RESOURCES AND HABITATS	SECTIONS 3.2, 3.3	• What government regulations are in place with respect to fisheries management, and is there evidence of their effectiveness? • What governmental habitat protection laws are in place, and what is the capacity to monitor and enforce them? • Are there existing tenure systems at family group, clan and community levels?	• Local and federal natural resource agencies • Community leaders • Key informants • PRA techniques with fishermen groups (men and women) • Traders
ACCESS AND USE OF FISH RESOURCES AND HABITATS	SECTIONS 3.2, 3.3	• Who controls current access to fishing grounds? • What is the nature of such controls? • How is such control exercised? • What additional access controls would be implemented by the project?	• Contact local and federal natural resource agencies • Community leaders • Fishermen groups (men and women) • Project proponents
DESCRIPTION FISHERIES-RELATED ACTIVITIES ENTERPRISES	SECTION 3.4	• What are the prime fishing grounds by area, gear and season? • What are the primary and secondary fisheries activities? Do these activities include line fishing, traps, nets, diurnal, nocturnal with light, fish farming, etc.? • What is the harvest of key species by gear, area and season?	• Contact local and federal natural resource agencies and NGOs • Key informants • PRA techniques with fishermen groups (men and women) • Survey and photography when catch is landed on shore
DESCRIPTION FISHERIES-RELATED STAKEHOLDERS	SECTION 3.4	• Who are the relevant stakeholders involved with inputs to, maintenance and repair and, outputs of, fishing activities?	• Canoe/boat builders and repairers • Net makers and repairers • Fish trap makers • Input and equipment suppliers (boats, motors, fuel, ice, nets, etc)
POST-HARVEST PROCESSING AND SALE	SECTION 3.5	• What is the disposition of the landings by species, product type, and price? • What is the nature of the value chain associated with fisheries?	• Fishermen groups • Women • Fish markets • Traders • Transportation groups (bicycle, motorbike, truck delivery)
CONTRIBUTION OF FISHERIES TO LIVELIHOODS	SECTION 3.1	• What is the quantitative and qualitative role of the fisheries sector compared to other economic sectors?	• Literature review • Local and federal natural resource agencies • Local NGOs • Community leaders • Key informants • PRA with women, households

ality diagrams, Venn diagrams, historical narrative summaries, round-robin key issue identification with stakeholder groups, etc., and participatory livelihood assessment.) should be used to develop a basic understanding of the project-affected fish resources and habitats, fisheries, and fishing-based livelihoods, including fishing grounds, fishing practices, and the value chain. The assessment should ensure consultation with key stakeholder groups, both generally (i.e., village leaders, tribe/clan leaders, owners and operators of fishing vessels, fishermen, women) and with regard to key activities (i.e., equipment and input supply, fishing, processing, marketing).

5.2.2 Identification of Project Activities Impacting Fish Resources and Habitats, Fisheries, and Fishing-Based Livelihoods

The next step in the assessment process is to identify and describe project activities that are likely to impact upon fish resources and habitats, fisheries and fishing-based livelihoods. All project activities (including exploration, construction, operational, and closure) that have the potential to impact fish resources and habitats, fisheries, and fishing-based livelihoods should be defined in terms of their location, scale (both in terms of area and number of people involved), duration, schedule, and potential impacts.[13] Table 5.2 provides a tool to facilitate such an assessment. The table should be completed for every phase of project activity. Note that the structure of the table deliberately makes the settlement, the affected community and the impacted fish resource and fisheries activity the key variables, rather than the project activity. Based on this analysis, it may be possible to identify options to avoid or otherwise minimize potential project impacts through alternative design.

5.2.3 Scope of Baseline Assessment of Fish Resources and Habitats, Fisheries, and Fishing-Based Livelihoods

Together, the rapid assessment exercise and the identification of the potential impacts of project activities on fish resources and habitats and fisheries will provide the basis for determining the parameters that will guide the larger assessment process. Key parameters ot be defined include: (i) the boundary of the impacted area, (ii)affected stakeholder groups, (iii) the scope of the baseline assessment, and (iv) the appropriate level of effort for assessment.

Boundary of the project-impacted fishing system and/or fishing activities

Assessment of impact and definition of avoidance, minimization or mitigation and compensation measures requires definition of the boundaries of the impacted system, fisheries and related activities. From an environmental point of view, knowledge of ecosystems, species, and project activities will inform the boundaries at which specific impacts are reasonably expected to have dissipated or not occur. From a social point of view, there is a need to reconcile the boundaries of environmental impacts with "social boundaries," considering where the project impacts on fisheries and associated activities occur, the origin of fishermen, value chains, governance systems, administrative boundaries, etc. (see Box 5.2). Although the tendency is generally to focus on the physical location of actual impacts and fishing activities, it is worth noting that, from an environmental point of view, it is feasible to impact "upstream" resources located some distance from actual fishing activities, while from a social point of view, a wider definition may be both necessary and strategic.

Scope of the baseline assessment

The rapid assessment exercise and the identification of the potential impacts of project activities on fish resources and habitats, fisheries, and fishing-based livelihoods inform and help define the requisite scope of the baseline assessment of fish resources, fisheries and fishing-based livelihoods. Together, definition of the boundary and the scope determine the requisite breadth and depth of the assessment, specifically which of the various attributes of artisanal fishing and fishing-based livelihoods described in Chapter 3 will need to be investigated.

[13]Such activities might include seismic, drilling, and exploration camps during the exploration phase; infrastructure development, including project settlements, access roads, pipelines, power lines, ports, jetties, offshore platforms, etc.; transportation of project personnel; shipping; establishment of exclusion zones; use of security forces; water use and management; and waste management.

TABLE 5.2 | Assessment of Potential Project Impacts on Fish Resources, Fisheries, and Fishing-Based Livelihoods

Village:

Project Phase: ☐ Exploration ☐ Construction ☐ Operations ☐ Expansion ☐ Closure

Description of project activity: [Provide basic description of activity (who, what, when, where, why, how). Include associated support activities, such as operation of camps, transportation requirements, local employment, etc.]

A. Identification of Potential Impacts on Fish Resources and Habitats

IMPACT ON HABITAT AND/OR RESOURCE-FORMING PROCESSES	YES/NO	DESCRIPTION
LOSS/CONVERSION OF HABITAT		
PHYSICAL DISRUPTION OF HABITAT		
INCREASED TURBIDITY		
ACOUSTIC DISTURBANCE		
ACTIVITY WASTE PRODUCTS/POLLUTION		

B. Identification of Potential Impacts on Fisheries, Productivity and Fishing-based Livelihood Activities

POTENTIAL IMPACT ON FISHERIES AND FISHING-BASED LIVELIHOOD ACTIVITIES	YES/NO	DESCRIPTION
LOSS OF PHYSICAL AREA (% OF TOTAL FISHING GROUNDS)		
DISRUPTION OF/REDUCED ACCESS TO FISHING GROUNDS		
INCREASED TRAVEL TIME		
INCREASED INPUT REQUIREMENTS		
PROCESSING AND MARKETING (VALUE CHAIN)		
EQUIPMENT		
SAFETY		
SECURITY		

C. Description of Potentially Impacted Fisheries Activities

ACTIVITY	LOCATION	NATURE AND DURATION OF IMPACT (Temporary/ Permanent; months, season)	NO. OF PARTICIPANTS (Individual, Households, etc.)	AREA	PRODUCTIVITY	LIVELIHOOD SIGNIFICANCE	IDENTITY OF AFFECTED POPULATION Affected fisherman, fishing groups, associated groups (boat builders, net makers, etc.), and/ or communities within project area of influence (e.g., number of participants in the activity, village name, etc.
NO. 1							
NO. 2							
NO. 3							
NO. 4							

BOX 5.2 | ASSESSING THE SOCIAL BOUNDARIES OF PROJECT FISHING IMPACTS

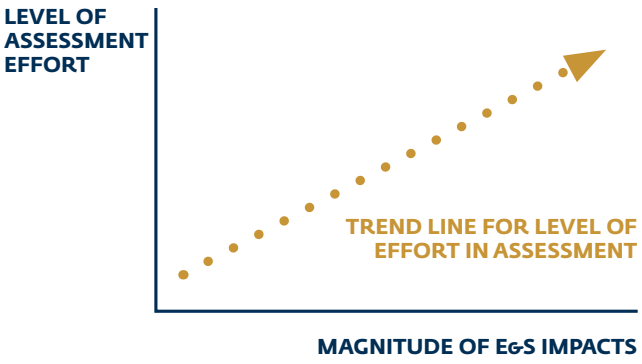
Initial assessment of impacts on fishing activities around the Tangguh LNG Project in West Papua, Indonesia, derived from work being conducted to assess the impacts of resettlement on the Tanah Merah community. As a consequence, the assessment focused on the villagers' prawn-harvesting activities that occurred offshore and directly in front of the village. This activity relied on the use of small canoes, which were paddled, sailed or motored up to one kilometer into the bay, where driftnets were cast and the canoe and net allowed to drift with the incoming/outgoing tide; less frequently, a sail was used on the canoe. The fishermen would then return later in the day with the aid of the reverse tide. (Various other fishing activities were not assessed, including the value chain for prawns and women's activities involving the harvesting of bivalves from the muddy shoreline.)

After relocation, when the Tanah Merah community settled into their new village located opposite the host village Saengga and the project commenced construction and enforcement of an exclusion zone, the Saengga community protested that they too were entitled to compensation regarding fishing impacts, claiming, rightfully, that they had used the same fishing grounds and were thus also impacted by the imposition of the exclusion zone. As a consequence, Saengga households also received compensation in the form of outboard motors that allowed them to more readily access alternative fishing grounds. This issue would have been identified earlier if the environmental and social impact assessment had conducted a more thorough assessment of fisheries activities proximate to the proposed LNG site and recognized that households from neighboring villages made use of the same fishing grounds.

Appropriate level of effort in assessment

As previously noted, fish resources and habitats and fisheries are complex, and assessment can be both time-consuming and costly. In principle, the level of effort in assessment should be correlated with the nature and significance of the project's potential impacts—the higher the expected impacts, the higher the effort level (see Figure 5.2). However, use of an impact-based approach can be problematic in a number of circumstances as demonstrated by the following. In situations where the where the geographical extent of social impacts is considerably larger than the extent of physical impacts, more efrfort will be needed to ensure all potential social impacts are assessed. In situations where there has been a long-term and progressive decline in fisheries productivity (either through unsustainable resource use practices or due to impacts associated with the development and operation of industry), stakeholders often assign responsibility for all of the perceived decline to the incoming project, as the entry of the project promotes both greater awareness of impacts and potential new opportunities for compensation.

FIGURE 5.2 | Level of Effort in Assessment



In other situations, for example where extensive development has preceded the project, a precedent in the rationale for and level of compensation provided may discourage acceptance of or rejection of an impact-based approach. Finally, in some contexts, the use of an impact-based approach may overlook issues of ownership and use rights to the affected areas, i.e., impacts on fish resources and fisheries may be minimal, but ownership and use rights may be affected. While early stakeholder engagement is critical in all projects, it is even more so where there is a high likelihood that projects will be held responsible for all fish resource and habitat and fisheries issues (see Box 4.1). In any event,

adoption of an impact-based approach should also verify that key stakeholders agree that assessment, mitigation and compensation should be based on measurable (rather than perceived) impacts.

Assuming that an impact-based approach is acceptable, the potential significance of adverse impacts should be analyzed in terms of environmental and livelihood impacts:

- **Environmental impacts:** An understanding of the physical and biological environment, combined with early knowledge regarding the magnitude of impacts (duration, scale, intensity) and the sensitivity of receptors will determine the significance of impacts and requisite baseline. In addition, there are several significance triggers, including protected areas, keystone species, and endangered and threatened species, that would trigger the requirement for a more comprehensive baseline assessment. See Figure 5.3 and Section 5.3.1 for more details.
- **Livelihood (socioeconomic) impacts:** Assessment of the significance of socio-economic impacts should investigate the relative importance of fisheries activities in affected people's livelihood systems, to help determine the level and significance of economic displacement that may be associated with project impacts on fish resources and habitats, fisheries, and fishing-based livelihoods. Where livelihood impacts are potentially significant, a more comprehensive assessment is required. In addition, it is important to consider the magnitude of impacts, including the duration of the impacts (temporary, permanent, or ongoing), the scale of the impacts (related to both the area affected and the number of fishermen/households/communities affected), and their effect on productivity (insignificant to significant). Figure 5.4 illustrates different scenarios—based on various permutations of factors influencing the magnitude of impacts—that may warrant more substantive assessment. Typically, because a project will affect multiple fish resources and habitats and different resource users, different intensities and methods of assessment may be required. Section 5.3.2 provides more details on assessment.

FIGURE 5.3 | Decision Tree Addressing the Nature of Environmental Impacts on Fish Resources

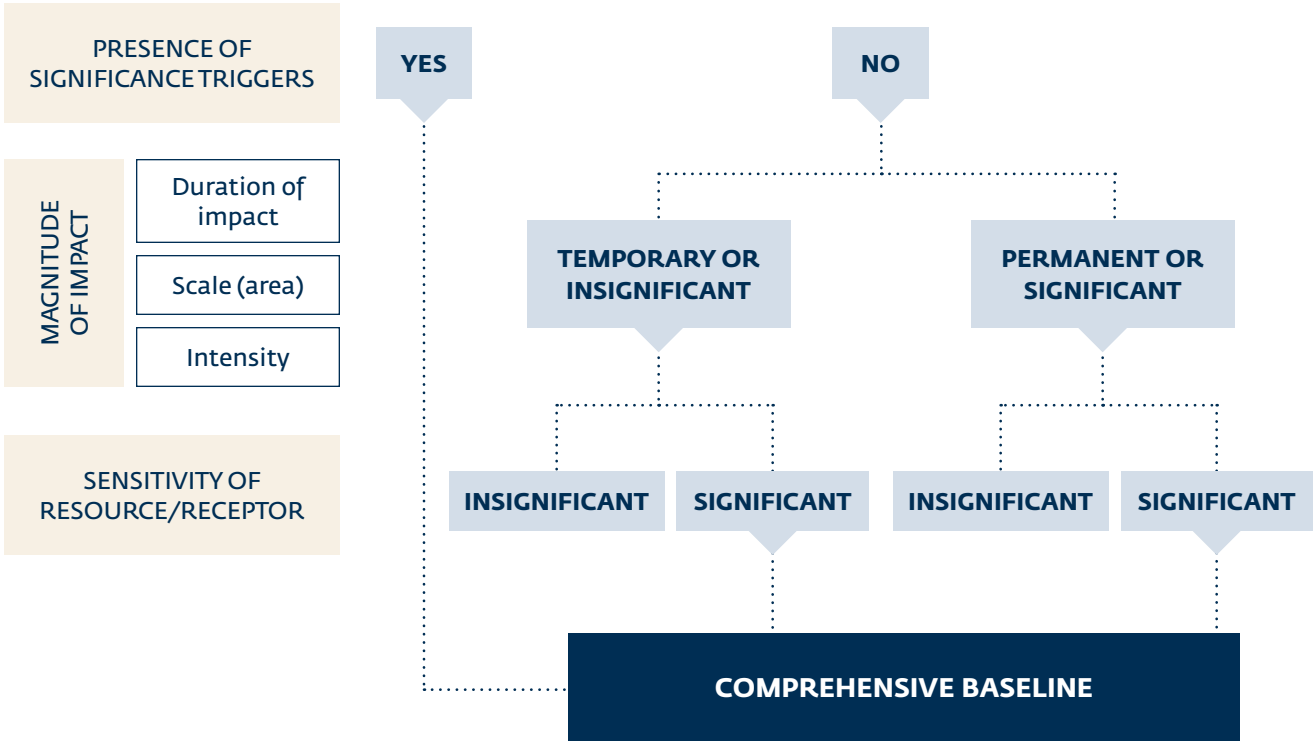
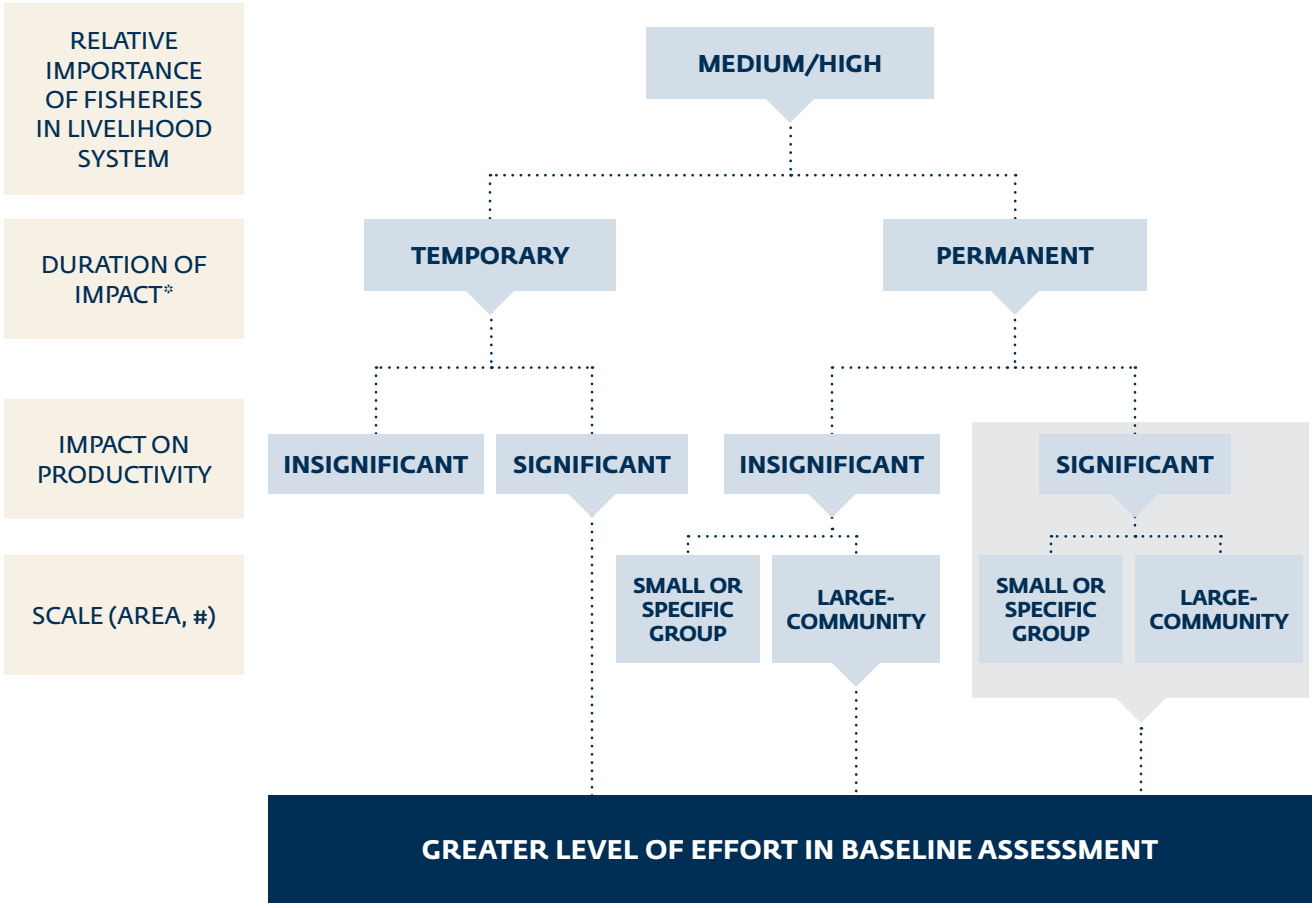


FIGURE 5.4 | Decision Tree Addressing the Nature of Socioeconomic Impacts on Fish Resources, Fishing and Fishing-Based Livelihoods



*Ongoing impacts, such as damage to boats, equipment, etc., should be identified and characterized in terms of type, likelihood, key locations, etc.

5.3 BASELINE ASSESSMENT

A baseline assessment aims to identify the existing fish resources and habitats and fisheries in an area, in order to more easily characterize and measure changes that might result from project activity. As noted previously, the establishment of a comprehensive pre-project baseline is especially important in situations where there has been a long-term and progressive decline in fisheries productivity (either through unsustainable resource use practices or due to impacts associated with the development and operation of industry). This section discusses the specific characteristics of the physical and biological environment, as well as the human element (in terms of fishing activities), that may be assessed and recorded before impact assessment begins.

Baseline assessment should be conducted as early as possible to allow for an adequate period of data collection to account for the diverse and changeable nature of the resource and its use. A key challenge for the majority of projects is lack of information to inform baseline and impact assessment.

5.3.1 Baseline Assessment of Fish Resources and Habitats

The objective of the baseline assessment of fish resources is to adequately characterize both the physical and biological environment of the system being impacted. The product of this effort will be the definition of the most significant elements of the fish habitats and status of the key populations of organisms.

The first step in the baseline characterization process is to gather and synthesize the available information. Sources of this data will include:

- national and regional natural resource agencies;
- scientific literature;
- gray literature, including previous environmental impact assessment (EIA) reports from the area or similar projects;
- international experts;
- regional universities;
- fishing organizations; and
- publications from multinational agencies and NGOs, e.g. International Union for Conservation of Nature (IUCN), World Wildlife Fund (WWF).

Once all available existing information is assembled, it needs to be examined to determine if there are significant data gaps. Where gaps exist, the proponent may need to commission marine surveys to fill them. Survey methods for each element are available in the literature. Experienced experts will be required to design and implement a statistically reliable sampling scheme that can estimate inter-seasonal and inter-annual variation using a full range of sampling gear.

Physical environment baseline

The baseline report should explain the geographic context of the body of water that will potentially be affected, describing key bathymetric parameters. For linear projects (pipelines), it may be appropriate to define ecoregions (estuaries, near-shore, continental shelf, continental slope) that will have different salinities, depths, substrates, flora and fauna, etc. For such projects, applying this approach will facilitate identification of mitigation measures that may be applied most effectively at differing points along the linear project route.

For proposed projects that directly or indirectly affect the shoreline/riparian zone (e.g., wharves, land falls of pipelines), descriptions of the existing conditions are needed. Characterization will be in terms of shore type (see Table 5.3) and the associated vegetation, such as wetland/marsh vegetation, mangroves, water plants, and riparian zone.

TABLE 5.3 | Possible Characterizations of Shoreline and Near-Shore Environments

SHORELINE	NEAR-SHORE
SHORELINE MARSH/MANGROVES	Mud/sand
MUD FLATS	Gravel/rocks
SAND BEACH	Reefs
GRAVEL/COBBLE BEACH	
ROCKY SHORE	
ARMORED (BULKHEAD/RIPRAP) SHORE	

Note: A riprap is rock or other material used to armor shorelines, streambeds, bridge abutments, pilings, and other shoreline structures.

The physical environment should be described, including wind, precipitation, and air quality, as well as tides, currents, waves, and salinity and temperature stratification.

Characterization of the water column will include descriptions of dissolved oxygen regimes, nutrients (primarily nitrogen, phosphorus, and silicon), and chemical composition (metals and organic pollutants). Benthic habitat elements should include a summary of the lake, river, or seabed structure and processes, and chemical contaminants in the surficial and sub-surface sediments. The results should be presented with comparisons to internationally recognized standards for chemical threshold effect levels (TEL), probable effect levels (PEL), and other criteria appropriate for the type of project (e.g., those of the U.S. Environmental Protection Agency, Environment Canada, or the OSPAR Commission[14]).

Some proposed projects (e.g., breakwaters, filled causeways, large diameter pipes) may degrade access to various life stages of fish resources, especially for spawning and juvenile rearing. The baseline discussion related to this topic will be addressed in the next section.

[14]OSPAR is the mechanism through which 15 governments of the western coasts and catchments of Europe, together with the European Union, cooperate to protect the marine environment of the northeast Atlantic. See http://www.ospar.org/

Biological environment baseline

The biological baseline will describe the fauna and flora resources likely to be directly or indirectly affected. The biological baseline should begin with a short overview of the ecosystem of the body of water where the project will be located. It should also include a description of the food web and identification of "keystone species" that are critical to the functioning of the whole system. Such species might include wetland species, mangroves, seagrasses, forage fish, and corals.

The biological baseline describes the food chain, including plankton, benthos, forage fish, target fish and shellfish species, shore and sea birds, waterfowl and marine mammals, as well as any endangered, threatened, and protected species. It focuses on those species and life stages that could be most affected by the project construction and operation. The baseline document should list all species (common/local and scientific names) known in the project vicinity, both residents and migrants. It should also describe the seasonality of spawning and migration patterns and the ecology of key fish species. Ideally multiyear harvest statistics should be displayed, and trends in stock status discussed.

5.3.2 Baseline Assessment of Fisheries and Fishing-Based Livelihoods

A baseline assessment of fisheries and fishing-based livelihoods aims to develop a comprehensive understanding of the affected population's fishing, processing, distribution, and marketing of fish; the productivity of these activities; and their contribution to livelihoods. This information is necessary to:

- develop a comprehensive understanding of the pre-project situation;
- understand and quantify the project's potential impacts on fishing and associated activities and fishing-based livelihoods;
- identify affected people and the project's impacts on their activities; and
- design and implement appropriate avoidance, minimization, and/or alternative mitigation and/or compensation strategies.

Based on the project boundary and scope and the baseline work, various attributes of household and community livelihoods, including the household's fishing activities, food security, nutrition, health, income, alternative livelihood activities, etc., will need to be included in the assessment.

Assessment of livelihoods

While focused on fishing activities, the assessment must utilize a household and community livelihood perspective to ensure that the relative importance and contribution of fishing to overall household livelihoods can be assessed. Fishing communities typically practice livelihood systems that include not just fishing, but also associated fishing activities, such as canoe/boat building and repair; net and fish trap manufacture and repair; marketing and transportation; agriculture; employment; and business and trade. The assessment should include a description of the different livelihood activities, participation rates, relative contributions to household income and welfare, and key issues, such as the nutritional contribution of fisheries and the role of fisheries in promoting stability and resilience (or reducing the vulnerability) of livelihoods. While avoidance, minimization, and compensation options are likely to focus on fishing, the possibility that it may be more strategic to invest in other components of local household livelihood systems should be investigated.

Assessment of fishing activities

The description of fisheries should address (i) an outline of system components, (ii) relationships between components, (iii) the location and spatial scale of the fishery and the degree of constancy of this scale over time, and (iv) the temporal outlook of the fishery (see Chapter 3). The assessment should include individual, household, and community fishing activities—including specific consideration of men's and women's distinct but related roles (see Boxes 5.3 and 5.4)—and should include consideration of:

- location of fishing grounds;
- ownership and governance of fisheries resources, access to and utilization of fisheries, and organization of fishermen (e.g., associations, cooperatives, etc.);
- typology of fishing and catch;
- seasonality of fishing activities;

BOX 5.3 | SOCIOECONOMIC BASELINE ASSESSMENT: POWER STRUCTURES, GENDER AND HUMAN RIGHTS ISSUES

The socioeconomic baseline assessment of fishing communities should include an assessment of social networks, including leadership, power structures/relations, and governance issues. Fishing communities are often not homogenous or cohesive and can include seasonal and temporary migrants from communities further afield, which can lead to tensions and conflict. Gender and human rights issues should also be considered in the assessment.

These issues could potentially result in reputational risk for projects that seek to engage with local communities and implement strategic community development initiatives (e.g., some fishing communities along the coast of West Africa use bonded labor and child labor to assist with fishing, processing, boat and net maintenance, etc.).

PLATE 19 | The socioeconomic baseline assessment of fishing communities should also address gender and human rights issues, including the possible use of bonded labor and child labor. **Credit: Ted Pollett**

- seasonal variation in species, productivity, etc.;
- fishing techniques;
- equipment and inputs, including ownership, availability, etc.;
- associated fishing activities (canoe/boat building and repair, net and fish trap manufacture, transportation, marketing, etc.);
- household participation rates;
- productivity of fishing activities based on fish catch studies (catch per unit of effort) and assessment (as much as possible, quantitative and with the participation of local fishermen);
- relative contribution to household income and welfare; and
- value chain analysis, including fish processing, marketing, and sale (distribution and sale, including traders, sources of credit, buying agents, wet markets, etc.).

The assessment of fisheries—especially quantifying people's access to and use of fisheries, their catch and its contribution to fishing-based livelihoods – is both complex and difficult (see Box 5.5). The main difficulty is related to the ease with which individuals can enter/exit small-scale and artisanal fisheries, meaning that quantifying participation in fisheries (specifically the development of a baseline and enumeration of participation rates) needs careful consideration. Most importantly, in fishing communities the rates of participation in fisheries may be indicative of the availability of alternative income-earning activities. Where alternatives are available (e.g., project employment, urban employment, commercial enterprises), participation rates may decline, only to recover once such opportunities cease to exist or the fisheries sector benefits from development interventions. In this sense, fisheries can be seen to be an important contributor to the resilience (reduced vulnerability) of households. Furthermore, distinctions between occasional, part-time, and full-time fishermen are likely to be arbitrary and, as such, should be agreed with the affected communities.

Other characteristics of fishing-based livelihood systems that contribute to the complexity of assessing small-scale and artisanal fisheries include:

- Fishing activities may vary substantially by season, in terms of the type and level of fishing activity, the target species, etc. Often, observed seasonality is less related to the characteristics of the fisheries resources and more related to the relationship between weather, marine conditions, equipment, and safety.

BOX 5.4 | INTEGRATING GENDER CONSIDERATIONS INTO FISHERIES ASSESSMENT

At the Tangguh LNG project in West Papua, Indonesia, the key fishing activities of residents of Tanah Merah village comprised drift net fishing for prawns and fish, line fishing and collection of shellfish on the tidal mudflats. Drift net fishing involves the use of small canoes (powered by paddles and sails or outboard motors to reach the fishing grounds) that drift along the shoreline on the incoming/outgoing tides. Harvested prawns were sold to traders in the village. This activity was male-dominated (until project employment removed men from village-level economic activities). However, collection of shellfish on mudflats near the village, which was carried out by small groups of women and children, involved little more than a digging stick and bucket. For unknown reasons, the assessment of fishing activities only identified the driftnet fishing activities of the affected households, despite completion of a baseline household survey.

While efforts to address the combined impacts of the project exclusion zone and greater resource utilization stemming from the combination of the host village and resettlement village population were belatedly addressed by the project through the provision of outboard motors to households, there was no assessment of the importance of shellfish harvesting, the capacity of the resettlement site to support the activity or, ultimately, the impact of resettlement on the activity.

PLATE 20 | Fishing communities are not always homogenous and can include part-time and seasonal migrants from communities farther afield. Cape Coast, Ghana. **Credit: Ted Pollett**

- While full-time and part-time fishermen may have established and predictable practices, in many situations people are only part-time fishermen, and their fishing activities are changeable and unpredictable.
- Fishermen may access and utilize multiple fishing grounds, making prediction of their travel routes, intensity of usage, etc. difficult.
- Even within the same community, there may be considerable variability among fishing vessels as to how costs, catch, and income are shared between the vessel owner and crew members.
- There may be several kinds of fishing activities (shoreline, near-shore, and oceanic) reliant on the use of different techniques and equipment, as well as household and community participation. Different people (either different household members or other households) may engage in these activities, as well as postharvest processing (cleaning, drying, smoking, and salting) and marketing. The value chain – and hence the potential effects or project impacts on fisheries – may extend considerably beyond the point of direct impact on fishing activities.
- Fishing may be one of several livelihood activities, and it may contribute to the household's subsistence and cash income requirements as well as to household resilience. The intensity of fishing at any given time may vary according to the demands of other livelihood activities, the need for cash income, the availability of inputs, the existence of markets, etc.
- The interface between industrial and artisanal fisheries increases the complexity of assessment and management. For example, export of high-value fish may drive more affluent businesses to invest in cold storage and packing facilities, using artisanal fisheries as the main supplier of raw material.
- Project-induced impacts, including improved infrastructure, increased availability of inputs and services, improved markets, and in-migration, may lead to changes in traditional fishing-based livelihoods.

As a result of these difficulties, surveys to establish baseline household participation rates and productivity may either under- or overestimate rates and harvests, depending on the availability of alternative economic opportunities at the time the survey is conducted. This can be problematic, because household members may consider themselves to be fishermen, even though they may not be participating in fishing activities at the time at which a baseline survey is conducted. This can lead to a project definition of compensation and development programs that may be based on incorrect data. The exclusion of these household members from the baseline assessment may cause significant conflict when a project defines and implements its mitigation and development programs.

Determining participation rates and eligibility of fishermen

The open access/common property nature of the resource allows for both ready entry and exit from fishing, as well as variation in the intensity of participation, depending on the availability of alternative economic opportunities. Hence, although households may elect to participate in economic opportunities outside fishing at one point in time, that does not necessarily imply that they are not fishermen and not reliant on the fish resources as an important contribution to the stability and resilience of their livelihood systems. Accordingly, one of the biggest challenges in determining the level of impact that a project will have on local fisheries and fishing communities is defining who should be considered a fisherman in the impacted area over specific periods of time; as shown below, the definition of who is a fishermen may be affected by the nature of the project impact.

Assessing Participation Rates

When assessing participation, it is important to consider both temporal and spatial variation in participation. For example, on a day-to-day basis, households may engage in fishing on an occasional, part-time or full-time basis (including sometimes at night when nocturnal fishing conditions are favorable). On an annual basis, participation rates may vary considerably for various reasons, including household life cycle, household demographic status, existence of other economic opportunities, etc. Assessment of annual variation and its inclusion into

BOX 5.5 | DETERMINING FISHERMEN'S ACCESS TO AND USE OF BAY FISHING GROUNDS, ANGOLALNG, SOYO, ANGOLA

AngolaLNG has developed an LNG plant in the Baia do Diogo Cão, Soyo, Angola (the photo above provides a satellite image of the location). Development of the project required reclamation of a X hectare site within the bay and dredging of the shipping channel and ship-turning basin (see Map B5.1 below). As part of the environmental, social and health impact assessment (ESHIA) for the project, the livelihoods and fishing activities of the communities located on the peninsula and adjacent to the bay and/or within the mangroves was assessed to determine the project's potential impacts on the artisanal fisheries.

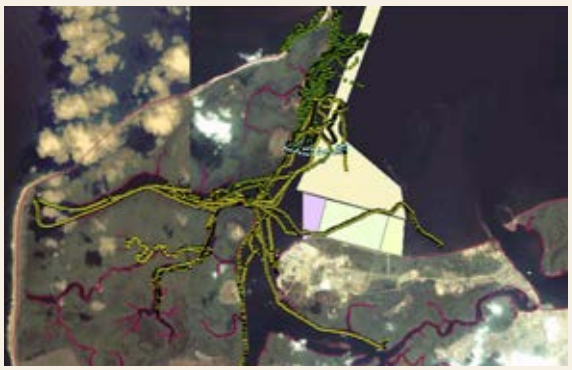
Both scoping and the establishment of a baseline helped to define and describe two types of fishing activities: (i) mangrove and near-shore fishing within the bay by fishermen using canoes and (ii) offshore fishing using larger motorized boats. In addition, it was recognized that community members traversed the project area to gain access to Soyo. To better understand fishermen's use of mangrove and near-shore areas, as well as communities' access to the nearby Soyo town, the project used GPS technology to track canoes (see Map B5.2 below).

The information derived from scoping, a baseline assessment describing the fishing-based livelihood system and the GPS mapping, led to the following generalizations regarding local fishermen's use of the bay:

- The majority of the small canoe activity is along the eastern shore of the Sereia peninsula, although there are fishing areas in the main channel northeast of Bocolo, north of Moita Seca I, opposite Kwanda Base (Figo and Vindi) and on the eastern end of the land reclamation area (Zola, Mbubu). These eastern fishing grounds fall within the environmental boundary of the dredging but lie, in the main, outside the operations boundary.
- Paddled canoes are not used to travel long distances and tend to stay close to the shore.
- Fishing nets are set in the shipping channel in some locations, e.g., at the north of the channel.
- Fishing is undertaken at night.
- The route taken to Soyo (by motorized canoe) is dependent on weather, and under rough conditions, the boats may use a more southerly route through the turning basin. Paddled canoes also seek shelter in rough conditions by passing along the shore of Kwanda Island.

In summary, it appears that fishermen make limited use of the shipping area and the area assigned to the dredging and land reclamation activities for fishing. However, as a cautionary note, the validity of these conclusions is affected by the extent of monitoring (both in terms of the total number of measurements and their distribution among villages), the seasonality of fishing, and the extent to which monitoring covered all seasons.

MAP B 5.1 | Project development plans showing shipping channel and turning basin (in green)



MAP B 5.2 | Location of project shipping channel and turning basin and movement of canoes tracked using GPS technology

compensation frameworks is an essential component of fisheries management plans (see Box 5.6).

Whether a project should assess both seasonal and annual variation in participation rates depends on whether the impact is temporary or permanent. Where impacts are temporary in nature, only individuals and households currently active need to be included in mitigation and compensation measures. Where impacts are permanent, the project should consider both seasonal and annual variation in participation rates. Accordingly, household surveys should assess both past and current participation rates to determine eligibility for compensation. Survey data can be strengthened by assessment and direct observation of ownership and condition of fishing equipment and triangulation.

Spatial variation in fishing participation occurs when fishermen access different fishing grounds and harvest different products from different environments. Projects can use a participation matrix, such as the one below, to characterize the day-to-day participation of a fisherman or household:

PARTICIPATION	LOCATION OF FISHING ACTIVITY		
	Fishing Ground A	Fishing Ground B	Fishing Ground C
OCCASIONAL			
PART-TIME			
FULL-TIME			

Assessment of short- and medium-term trends in household participation in fisheries can lead to improved understanding of the dynamics of fishing and allow consideration of how this affects assessment of impacts and the design and implementation of avoidance, minimization, compensation, and development programs.

Assessing Eligibility

With regard to eligibility for any kind of compensation (or other mitigation measures), the key question is how to define a fisherman. As suggested above, eligibility should be defined by consideration of the nature of the impact (temporary or permanent) rather than current participation rates. For short-term and temporary impacts, current participation rates may be appropriate to define eligibility, while long-term or permanent impacts will require consideration of seasonal and annual variation in participation rates. Although it is best to have multiyear participation data, often only proxy indicators may be available, e.g., ownership of fishing equipment. Where evidence indicates that households that are identified as not being active in fisheries in the year of the survey, have a record of participating in fisheries activities as part of their livelihood strategies (i.e., over the last three-to-five years), they should be offered the same compensation for long-term or permanent impacts as those identified as participating in the year of the survey.

BOX 5.6 | DETERMINING FISHING PARTICIPATION RATES AT THE TANGGUH LNG PROJECT

At the Tangguh LNG project site in West Papua, Indonesia, the Tanah Merah community members practiced diversified livelihoods comprising fishing, agriculture, hunting and gathering, and employment. Key informants described the evolution of livelihood activities and participation rates in terms of economic opportunity – whereas fishing has always been part of their livelihood strategy, participation rates have varied in accordance with the availability of alternative economic opportunities.

In the early 1990s, participation rates in fishing increased with the establishment of a local prawn processing facility and increased demand for prawns from Sorong-based traders. However, participation rates declined as project-related wage labor opportunities became available. As such, depending on when an assessment is conducted, assessment of household fishing activities through surveys of household participation rates and resource use intensity could yield markedly different results from household surveys documenting ownership of assets and equipment for fishing. Nonetheless, the vast majority of households would have identified themselves as fishermen, irrespective of their day-to-day participation in the activity.

The process through which participation is assessed and eligibility determined typically relies on categorization of fishermen as occasional, part-time, or full-time. This can be problematic, especially when affected communities see significant differences in compensation among different categories of eligibility. Efforts to categorize fishermen may also benefit from engaging impacted communities prior to defining minimization, compensation, and/or development measures, so as to better understand how the affected communities characterize the diversity of fishing activities present within the community. Further ensuring support from affected populations and key stakeholders (e.g., government) in definition of and assignment to categories can help address this concern.

As part of the assessment process (but perhaps separately from the description of fisheries and collection of baseline data), the affected fishing community should be engaged in a participatory process, to provide and validate information regarding project development, project activities that may impact fisheries, etc. The views of the affected communities, especially their concerns, should be documented. Typically, such engagement elicits various responses, including project-specific concerns, requests for project assistance to address common constraints, etc. The most common concerns include:

- shoreline development may reduce ability to moor boats, set sail, and return to shore;
- project development may lead to reduction of fishing grounds;
- project development may lead to reduced access to traditional fishing grounds;
- project activities, including shipping, infrastructure, and waste disposal, may lead to reduced productivity by damaging fishing grounds or reducing participation, access, and fishing time;
- project activities, including shipping, infrastructure, and waste disposal, may lead to damage to and loss of equipment;
- changes in transportation routes and/or increased traffic for personnel movement as well as shipping may lead to accidents and loss of life; and
- project activities may distort fish population densities, attracting fish into restricted areas (e.g., artificial reefs, breakwaters, jetties, illuminated loading docks).

Methodology to Assess Fisheries, Participation, Categorization, and Eligibility

Participatory Rural Appraisal and Participatory Livelihood Appraisal methodologies can be used for assessment of household (and community) fishing activities and livelihoods. Approaches involve specific tools and a range of consultation approaches including: direct observation, household surveys, key informant and focus group interviews with fishermen and others stakeholders (e.g., traders, sources of credit, buying agents), and secondary sources.

Information and data sources identified during the rapid assessment can be used as secondary sources. Discussions with government agencies, development NGOs, and projects should seek information regarding:

- the legislative and regulatory framework governing artisanal and oceanic fishing;
- national or regional fisheries development programs;
- the status of artisanal fisheries, including information regarding key aspects related to productivity, e.g., mangrove breeding grounds; and
- key mitigation and development interventions.

Table 5.4 illustrates how the characteristics of fishing activities and resources impact on assessment of key data and highlights various approaches used to address these complexities. Quantification can be a complex, time-consuming, and expensive exercise (this issue is further addressed in Chapter 6). A project must consider whether or not the cost of securing detailed information is justified, when utilization of more general and aggregated data may be more efficient and effective in relation to design and delivery of project mitigation measures.

TABLE 5.4 | Approaches to Assessment of Fishing-Based Livelihood Activities

REQUIRED DATA	CHALLENGES	POTENTIAL APPROACHES
ACCESS AND USE (I.E., PARTICIPATION RATES)	• Ease of entry/exit • Accessing multiple fishing grounds • Occasional, part-time and full-time users • Seasonal and annual variation	• Determine whether there are any customary or other rules determining traditional ownership or rights to use fishing areas, and map boundaries. • Use GPS and geographic information system (GIS) technology to identify and map fishing grounds. • Use GPS technology to track fishing boats, thereby allowing confirmation of fishing grounds, fishing practices/behavior (e.g., accessing multiple fishing grounds on a single trip, length of fishing trips), intensity of use of different fishing grounds, etc. • Observe and/or undertake surveys of shoreline users (Who are they? Where do they come from? What activities are they undertaking? What are they harvesting? What do they do with their harvest?). It is important to record the weight of catch by species from each trip. Catch per unit of effort by fishing ground is a vital statistic for quantifying potential project impacts.

IDENTIFICATION OF FISHERMEN AND THEIR LABOR ALLOCATION (continued on next page)	• Categorization—occasional, part-time, and full-time users
	• Seasonality
	• Ease of entry/exit
	• Multiple actors in value chain
	• Eligibility and cut-off dates
		• Identify and consult with fishermen's associations, fishing cooperatives or other organizations that may maintain records of active fishermen.
		• Undertake a survey of fishing boats (type, size, engine capacity) in villages or settlements in the project area of influence.
		• Ensure that early scoping work provides an overview of the individual, household and community fishing, processing, and marketing activities, allowing key aspects (e.g., seasonality) to be defined. This information must inform survey approaches to assessing participation, productivity, and income.
		• Ensure baseline assessment considers trends in participation, productivity and income throughout the year and over the last three-to-five-year period, seeking reasons for periods of increased/reduced participation, etc. Correlate household and community responses with assessment of recent development of coastal enterprises.
		• Ensure that early scoping work and analysis of baseline assessment take account of (i) family structure and poverty in relation to capacity to participate in fishing activities (for example, young families, elderly families, or families with a single head of household may be temporarily limited in their ability to participate in fishing activities) and (ii) relative availability of alternative livelihood activities that may have short-to-medium-term impacts on defining who is a fisherman.
		• Correlate permanence of project impacts with determination/assignment of participation rates. Where permanent impacts occur, the identification of fishermen should be based on a three-to-five-year timeframe.
		• Ensure integrated survey approaches that simultaneously assess household ownership of fishing assets and equipment and household participation rates, productivity and income, thereby allowing correlation (and verification) of different data sets.
		• Engage in proactive consultation with community to determine acceptable approaches through which to (i) identify fishing activities and fishermen and (ii) categorize individual and household participation in fishing activities.
		
		Once the project areas of impact are known:
		• Undertake a census and survey of affected fishermen. Collect such information as:
		  • whether the fisherman is a boat owner or crew;
		  • the basis used for sharing costs/distributing catch or income;
		  • the amount of time spent fishing versus other productive activities;
		  • seasonal activities and locations, fishing times;
		  • fishing techniques and equipment;
		  • dominant species and composition of catch;
		  • quantity and quality of fish caught;
		  • self-consumption versus cash sales;
		  • avenues for marketing;
		  • challenges and constraints; and
		  • involvement of other family members in fishing, catch processing, or marketing, etc.
		
		(continued on next page)

REQUIRED DATA	CHALLENGES	POTENTIAL APPROACHES

IDENTIFICATION OF FISHERMEN AND THEIR LABOR ALLOCATION (continued from previous page)		(continued from previous page)
		• Where applicable, undertake a survey and inventory of project-affected fish gear. Collect information on parameters such as:
		  • the owner of the gear;
		  • type and number of gear (affected and unaffected);
		  • photographs and records of GPS locations;
		  • number of times the gear is inspected during the peak and slack season;
		  • seasons during which gear is used;
		  • dominant species and composition of catch;
		  • quantity and quality of fish caught;
		  • fishing trip duration;
		  • fish behavior that is used for catching the species;
		  • typical prices of the fish and shellfish;
		  • longevity of the traps/availability of materials for replacing them; and
		  • availability or replacement area for resetting.

CATCH	• Occasional, part-time and full-time users • Access to multiple fishing grounds • Seasonality • Estimating harvest/yield • Lack of information regarding catch	• Ensure that early scoping work provides an overview of the individual, household and community fishing activities, allowing key aspects (e.g., seasonality) to be defined. This information must inform survey approaches to assessing participation, productivity, and income. • Collect fishing participation and productivity data through use of catch diaries[15] or similar for not less than one full year prior to start of project, using participatory approaches with affected populations. Catch per unit of effort data must be collected to quantify livelihood impacts. • Develop and distribute voluntary fisher logbooks and collection of data. • Ensure that catch and harvest data are collected for shoreline users. • Sample fish harvest/catch and yields over time and seasons if survey time allows. • Distribute standard containers and use photography (in coordination with GPS) to generate better estimates of harvest. • Record local and regional market prices for principal types of fish, shellfish, and other catch covering one or more years prior to project commencement. • Use proxy indicators to verify information. For example, if fishing is the primary source of income, does reported catch/income correlate with expenditure (food, health, education, clothing, etc.)? If fish are used in subsistence, use surveys of household diets as proxy measures of catch. • Use triangulation to verify information. For example, seek information from players further down the value chain to verify reported catch and sales. • Consider establishment of a control village outside the project-affected area if conditions are sufficiently similar to those within the project-affected area.
INCOME	• Ease of entry/exit • Occasional, part-time, and full-time users • Multiple actors in value chain • Lack of information regarding income (in-kind and cash)	• Ensure that early scoping work provides an overview of the individual, household, and community fishing activities, allowing key aspects (e.g., seasonality) to be defined. This information must inform survey approaches to assessing participation, productivity, and income. • Surveys should record both self-consumed and sold-for-income components of the catch. • Use proxy indicators to verify information. For example, if fishing is the primary source of income, does reported catch/income correlate with expenditure (food, health, education, clothing, etc.)? • Use triangulation to verify information. For example, seek information from players further down the value chain to verify reported catch and sales.

Note: Daily catch and level of effort by boats or individuals should be recorded by a fisheries specialist or by local enumerators who have been trained in species identification, weighing, and recording. A sampling regime should be designed to cover a representative number of fishermen and to capture the full range of their seasonal activities.

[15]Daily catch and level of effort by boats or individuals should be recorded by a fisheries specialist or by local enumerators who have been trained in species identification, weighing, and recording. A sampling regime should be designed to cover a representative number of fishermen and to capture the full range of their seasonal activities.

5.4 ASSESSING PROJECT IMPACTS

Once a baseline has been established, the next step is to fully assess the level and type of project impacts, in order to understand the effect the project will have on that baseline. This section discusses the assessment of impacts on fish resources and the activities of the affected population, as well as some other project risks and impacts that may be more difficult to quantify, including risks to safety and security and indirect project-induced impacts.

5.4.1 Assessing Project Impacts on Fish Resources and Habitats

Potential project proponents will need to understand the resource system present in an area, in order to evaluate potential impacts associated with project activity. Table 5.5 summarizes the relevant ecological components that may be impacted by a project.

TABLE 5.5 | Environmental Components Associated with a Proposed Project

ENVIRONMENT	RESOURCE OR RECEPTOR
PHYSICAL ENVIRONMENT	Physical processes
	Water column
	Benthic habitat
	Atmosphere
BIOLOGICAL ENVIRONMENT	Plankton
	Benthos
	Fish
	Birds
	Mammals
	Nature conservation areas

Assessing the potential impacts on this resource system requires (i) defining the scope of the project and its impacts, (ii) identifying the magnitude of impacts and the sensitivity of resources and receptors, and (iii) determining the significance of any expected impacts.

Scope

Scope refers to both the spatial scope of the affected area and the temporal scope of the project activities.

Spatial scope: The spatial scope of the assessment details the geographic area that may be affected by the proposed project. For linear projects (e.g., transmission lines or pipelines), the locus of potential impact along the route fluctuates in terms of the environmental conditions (e.g., sediment types, bathymetry, etc.), the specific resource or receptor (e.g., water column, marine mammals, etc.), and the impact of concern (e.g., increase in turbidity, noise, and vibration, etc.). As such, the locus of impact may extend from the corridors themselves to a number of kilometers on either side of the corridors. The sensitivity of each potentially affected resource/receptor and the distance over which a related impact may propagate can serve as the basis for determining the spatial scope of impact assessment (e.g., the harbor porpoise may be sensitive to noise within 10 km of the construction area, while an oil spill may affect a larger area by spreading across country exclusive economic zone boundaries). The presence of pathways, such as the atmosphere and the water column, along which impacts may spread causing secondary environmental impacts, should also be considered. The spatial scope of each impact on a particular resource/receptor is detailed in this section of the assessment.

Temporal scope: The temporal scope of the assessment is defined by the four project phases: construction, pre-commissioning and commissioning, operations, and decommissioning. The vast majority of the environmental impacts will be experienced during the construction and, to a lesser extent, the pre-commissioning and commissioning, and operation phases.

It is noteworthy that impacts during the construction and pre-commissioning and commissioning phases will not occur within the entire area of the project footprint at the same time, but rather will be restricted to specific areas as construction proceeds. Impacts on the physical and biological environment should be assessed in each ecoregion of the project.

Level of impact

The results of scoping and impact identification guide the design of methodology, the classification and relation of impact variables, the values associated with each variable, and the techniques used in their assessment. Impacts should be assessed from two different perspectives: magnitude and sensitivity.

Magnitude of impacts: The predicted magnitude of an impact is defined and assessed in terms of a number of variables, including the scale, duration, and intensity of the impact, which cumulatively indicate the magnitude of the change to the physical, biological, and social environment (see Table 5.6). While assigning values to these variables is for the most part objective, assigning a value to intensity requires professional judgment, as the extent of change is difficult to define. Expert judgment and prior experience of the environmental impact assessment (EIA) team can ensure a reasonable degree of consensus on the value placed on an impact variable. For social/socioeconomic impacts, the magnitude is viewed from the perspective of those affected, taking into account the likely perceived importance of the impact and the ability of people to manage and adapt to the change.

Various methods can be used to determine the value of the variables that make up the magnitude of an impact, including:

- the results of desk studies and field surveys on resource/receptor presence and sensitivity;
- the use of geographic information systems (GIS) to plot resources/receptors in relation to a project's footprint and the sphere of influence of an impact (determined by modeling, previous studies, and available literature);
- statistical evaluation;
- the use of modeling techniques to determine the extent of interaction between a project activity and the receiving environment; and
- prior experience of the assessment team.

TABLE 5.6 | Magnitude of Environmental Impacts on Fish Resources and Habitats

MAGNITUDE (DURATION, SCALE, AND INTENSITY)	PHYSICAL IMPACTS	BIOLOGICAL IMPACTS
LOW	A temporary or short-term impact on a physical resource/receptor that is localized and detectable above natural variations but not regarded as imparting an order of magnitude change. The environment will revert back to pre-impact status once the impact ceases.	An impact on a species that affects a specific group of localized individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself.
MEDIUM	A temporary or short-term impact on a physical resource/receptor that may extend beyond the local scale and may bring about an order of magnitude change in the quality or functionality of a resource/receptor. It does not, however, threaten the long-term integrity of the resource/receptor or any receptor/process dependent on it. A medium-magnitude impact multiplied over a larger area would be regarded as a high-magnitude impact.	An impact on a species that affects a portion of a population and may bring about a change in abundance and/or a reduction in the distribution over one or more generations, but does not threaten the long-term integrity of that population or any population dependent on it. The size and cumulative character of the consequence is also important. A medium-magnitude impact multiplied over a wide area would be regarded as a high-magnitude impact.
HIGH	An impact on a physical resource/receptor that results in an order of magnitude change on the local or larger scale that is irreversible and above any applicable limits. The change may alter the long-term character of the resource/receptor or another receptor/process dependent on it. An impact that persists after the activity ceases is a high-magnitude impact.	An impact on a species that affects an entire population or species in sufficient magnitude to cause a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependent upon it, to its former level within several generations, or when there is no possibility of recovery.

Sensitivity of resources/receptors: It is also important to place some form of value (low, medium, or high) on a resource or receptor that could potentially be affected by project activities (see Table 5.7). Expert judgment and stakeholder consultation can help ensure a reasonable degree of consensus on the intrinsic value of a resource or receptor. The allocation of a value to a resource/receptor allows for the assessment of its sensitivity to change (impact). Various criteria are used to determine value/sensitivity, such as resistance to change, adaptability, rarity, diversity, value to other resources/receptors, naturalness, fragility, and whether a resource/receptor is actually present during project activity. The assessment of a habitat's value/sensitivity is a combination of the variables applicable to both the physical and biological environment. A level of value/sensitivity is assigned to each resource and receptor within the environmental baseline section.

Assessing the significance of impacts

Since there is no statutory definition of significance, the determination of significance is necessarily subjective. Criteria for the assessment of the significance of impacts stems from the previous evaluation of the magnitude of the impacts and the sensitivity of the resource or receptor. In addition to magnitude and sensitivity, it is important to consider the status of compliance of each impact, in terms of its conformity to the relevant government legislation, standards, and limits; its degree of alignment with the applicable policies and plans; and whether any guidelines, environmental standards, and company/industry policies are pertinent to the potential impact.

Impacts can be defined as either insignificant, or of minor, moderate, or major significance:

- **No impact or insignificant:** Impacts are indistinguishable from the background/natural level of environmental and social/socioeconomic change.
- **Minor significance:** Impacts of low magnitude, within standards, and/or associated with low- or medium-value/sensitivity resources/receptors, or impacts of medium magnitude affecting low-value/sensitivity resources/receptors.
- **Moderate significance:** Broad category within standards, but impact of a low magnitude affecting high-value/sensitivity resources/receptors, or medium magnitude affecting medium-value/sensitivity resources/receptors, or of high magnitude affecting medium-value sensitivity resources/receptors.
- **Major significance:** Exceeds acceptable limits and standards, is of high magnitude affecting high- or medium-value/sensitivity resources/receptors or of medium magnitude affecting high-value/sensitivity resources/receptors.

TABLE 5.7 | Sensitivity to Impacts

SENSITIVITY OF RESOURCE/ RECEPTOR	PHYSICAL IMPACTS	BIOLOGICAL IMPACTS
LOW	A resource/receptor that is not important to the wider ecosystem functions/services, or one that is important but resistant to change (in the context of project activities) and will naturally and rapidly revert back to pre-impact status once activities cease.	A species (or habitat) that is not protected or listed. It is common or abundant, is not critical to other ecosystem functions (e.g., as prey to other species or as predator to potential pest species) and does not provide key ecosystem services (e.g., coastal stabilization).
MEDIUM	A resource/receptor that is important for wider ecosystem functions/services. It may not be resistant to change, but can be actively restored to pre-impact status, or will revert naturally over time.	A species (or habitat) that is not protected or listed, is globally common but rare in the project water body, is important to ecosystem functions/services, and is under threat or the population is in decline.
HIGH	A resource/receptor that is critical to ecosystem functions/services, not resistant to change, and cannot be restored to pre-impact status.	A species (or habitat) that is specifically protected under local or national legislation and/or international convention (e.g., the Convention on International Trade in Endangered Species, CITES); is listed as rare, threatened or endangered by IUCN; and is critical to ecosystem functions/services.

TABLE 5.8 | Criteria for Assessing Significance of Impacts

IMPACT	LOW-MAGNITUDE	MEDIUM-MAGNITUDE	HIGH-MAGNITUDE
LOW VALUE/SENSITIVITY	Minor	Minor	Moderate
MEDIUM VALUE/SENSITIVITY	Minor	Moderate	Major
HIGH VALUE/SENSITIVITY	Moderate	Moderate	Major

Table 5.8 shows how magnitude and value/sensitivity are combined to yield significance.

5.4.2 Assessing Project Impacts on the Fishing Activities of the Affected Population

Similar to the assessment of impacts on fish resources and habitats , assessment of project impacts on fishing activities requires consideration of (i) the scope of the project and its impacts, (ii) the relative importance of fisheries, (iii) the magnitude of impacts, and (iv) the significance of any expected impacts.

The scope of the project and its impacts should be described in terms of both spatial and temporal scope, the former describing the affected area and the latter including consideration of all project activities in recognized project phases. The project-affected area should include the specific location of fishing activities, the communities engaged in the fishing activities, and actors associated with the value chain for the specific products. Furthermore, if displacement of affected fishermen to neighboring fishing grounds can reasonably be anticipated to occur, these areas should also be assessed in terms of potential impacts.

The relative importance of fisheries to livelihoods determines the importance of assessment and mitigation of impacts. Relative importance is greater with higher dependence on fisheries for household employment, food security, nutrition, and income.

Assessment of the magnitude of impacts should include consideration of the duration of impacts, the scale of impacts (i.e., the area impacted and the number of fishermen/households/communities affected), and project impacts on their productivity (both fisheries resource and fishing activity) (see Table 5.9). A key consideration is whether or not fishermen have access to alternative fish resources that they can utilize during the construction and/or operations period.

Assessment of the significance of any impacts requires an understanding of the relationship between activity-level impacts and livelihood systems.

Finally, it must be emphasized that environmental impacts on fish resources are not necessarily directly correlated with social impact on fisheries and fishing-based livelihoods. Consequently, high-level environmental impact assessment for fish resources tends

TABLE 5.9 | Magnitude of Socio-Economic Impacts

MAGNITUDE (DURATION, SCALE, AND INTENSITY)	
LOW	A temporary or short-term impact, limited in geographic extent and number of fishermen impacted, and with limited impacts on productivity.
MEDIUM	A temporary or short-term impact that extends beyond the local scale and is associated with an order of magnitude change in productivity of fisheries. It does not, however, threaten the long-term integrity of fisheries and livelihoods dependent on them. A medium-magnitude impact multiplied over a larger area would be regarded as a high-magnitude impact.
HIGH	An impact that is irreversible, has a large geographical extent, and affects larger numbers of fishermen (i.e., multiple communities) OR is focused on a specific geographic area and subgroup of fishermen and is associated with an order of magnitude change in productivity of fisheries OR a medium impact occurring over a large area. The change may alter the long-term productivity of fisheries. An impact that persists after the activity ceases is a high-magnitude impact.

to overlook species-specific human interactions, and there is the risk that what is assessed to be low environmental impact (i.e., low intensity, operating on a small scale and/or of short duration) may nonetheless result in significant disruption of fishing-based livelihoods. In other words, standard environmental impact assessment may be too blunt an instrument to pick up specific local impacts that have potentially significant social impacts. As such, it is good practice to ensure that environmental and social baselines are conducted independently (but simultaneously inform one another during their implementation) and that specific environmental assessment be conducted when it is known that certain species are locally important to fishing-based livelihoods.

5.4.3 Livelihood Systems Involving Fishing

Ensuring a comprehensive understanding of livelihoods that involve fishing is critical to proper identification of impacts and selection of possible mitigation measures. Based on the project boundary and scope and the baseline work, consideration should be given to various attributes of community and household livelihoods, including the full range of the household's livelihood activities (including any potential alternative livelihood activities), food security, nutrition, health, and income. Due consideration should be given to the role of fisheries in promoting both stability and resilience of livelihoods (or, conversely, reducing vulnerability).

5.4.4 Additional Considerations Related to Project Risks and Impacts

In addition to the impacts to fish resources and habitats, as well as the impacts on the fishing activities of affected populations, there are several other risks that should be evaluated in a full assessment of potential impacts. These include risks to safety and security, severance of access to markets and services, and the effects of project-induced in-migration and behavior changes among local populations.

Safety

Depending on the affected communities' access to and use of the freshwater (lake or riverine) or marine environment, and the nature, scale, and duration of project activities, it may be necessary to conduct a risk-based shipping traffic assessment. This assessment should be based upon existing records of accidents involving fishermen and related to shipping routes and traffic and the presence of industrial infrastructure, exclusion zones, etc. The results of this assessment can be used to inform development of a shipping traffic management plan, as well as guidelines for operators addressing local community and fishermen health and safety measures.

The assessment can also provide a basis for understanding the type of assistance that could be provided to fishermen to improve their existing safety precautions, as part of a strategic community investment program to earn a "social license to operate" (see Box 5.7). Artisanal fishermen typically take few, if any, safety precautions, and assistance with the provision of training, life jackets, and emergency communication devices (including flares, radios, or mobile phones) can markedly reduce accidents, injuries, and loss of life, all of which can have severe and lasting impacts on fishing households.

Security

A project security assessment should include consideration of fishermen and their activities, particularly in relation to their interaction with (i) project-related shipping, construction, and operations; (ii) the establishment and enforcement of exclusion zones; (iii) affected communities' experience with security forces; (iv) appropriate approaches for enforcement of security; and (v) exceptions in the case of emergencies, etc. (e.g., demands for access to, or transit across, hazardous and otherwise restricted areas). Participatory measures and approaches should be used to involve local fishermen in the planning of security measures and ensuring and monitoring compliance.

BOX 5.7 | IMPROVED SAFETY FOR FISHERMEN AND LOCAL ENTREPRENEURIAL DEVELOPMENT: EARNING A "SOCIAL LICENSE TO OPERATE"

Tullow Oil is engaged in oil exploration in the vicinity of Lake Albert, Uganda. As part of their strategic community investment initiative, the company assisted in the training and establishment of a local women's interest group to manufacture life jackets for use by local fishermen. Tullow also funded the establishment of a Lake Rescue Unit (with rescue boats and staff) and a telecommunications system, so that fishermen could call for assistance in case of emergency, and provided training and guidance. The initiative has significantly reduced injuries and loss of life among local fishermen and has proved to be extremely popular.

PLATE 21 | Lifejackets made by a local women's interest group for use by artisanal fishermen, Lake Albert, Uganda. **Credit: Ted Pollett**

Severance

Loss or reduction of access to markets and services (education, health, etc.), as well as increases in the length, duration, or hazard associated with journeys, should be assessed, and appropriate mitigation measures developed.

Indirect project-induced impacts

Project-induced impacts, which result indirectly from the project's presence in an area, should be considered in any impact assessment. These impacts can result from interaction of shipping personnel with affected communities, behavior change among local fishermen, in-migration of more capable and better-resourced migrants, displacement to other fishing grounds, increased levels of disposable income, and project-induced local and regional development (see Section 4.2.6 for more details).

The majority of these potential induced impacts are livelihood and/or project risks that require management rather than exhaustive assessment. The baseline assessment should have determined to what extent these phenomena have been observed in other projects or in fishing communities within the project area of influence, in order to evaluate the potential risk from the current project and any management options. Such assessment is in line with the need to correlate baseline data on fishing activities and livelihoods with broader environmental, social, and economic trends within the environment, to help understand the current status of fish resources and fisheries and their likely trajectory going forward.

6. MANAGING PROJECT IMPACTS ON FISH RESOURCES AND HABITATS, FISHERIES, AND FISHING-BASED LIVELIHOODS

Once the range of potential project impacts on fish resources and habitats, fisheries, and fishing-based livelihoods has been assessed, the next step is to determine ways to mitigate those impacts. The generally accepted mitigation hierarchy for project risks and impacts stipulates that projects should follow these steps (in order of preference):

1. anticipate and avoid impacts;
2. where avoidance is not possible, minimize impacts;
3. restore project-affected environment and/or enhance the remaining environment, and;
4. where residual impacts remain, compensate/offset for risks and impacts on the environment and affected people.

Projects impacting fish resources and habitats and fisheries should apply this hierarchy to the environmental and social impacts associated with their activities. The first two sections of this chapter discuss ways to manage impacts on (i) fish resources and habitats and (ii) fisheries and fishing-based livelihoods. The final sections of the chapter address general measures regarding safety, security, and indirect project-induced impacts.

6.1 MANAGING IMPACTS ON FISH RESOURCES AND HABITATS

Avoidance: In accordance with the accepted mitigation hierarchy, whenever possible preference should be given to impact avoidance and prevention over minimization, restoration, and offsets. Avoidance and mitigation measures to protect natural habitats are designed to achieve no net loss of biodiversity in natural habitats. Avoidance and prevention may be achieved through careful site or route selection and timing of the construction schedule to avoid the sensitive ecological seasons. During the process of impact assessment and management, a robust alternatives analysis and close collaboration with design engineers is critical to assess technically feasible project options that can meet the objectives of avoidance/prevention.

Minimization: Where avoidance is not possible, a range of impact reduction measures should be adopted to minimize the extent of the project's impacts on biodiversity. For example, if a pipeline route crosses sensitive biological environments and no feasible option is available to re-route the pipeline, key measures to minimize impacts could include the use of a single trench for two pipelines (to limit the spatial extent of impacts) or construction of both pipelines within a single construction period (to limit the temporal extent of impacts). Other examples include the use of horizontal directional drilling (HDD) to avoid impacts on coral reefs, mangrove systems, river banks, etc. where pipelines come ashore. Physical and/or computer modeling should be used to predict the impacts of marine structures and dredging on coastal processes so that adverse impacts on sensitive habitat areas and communities can be predicted and avoided. General protection of flora and fauna during construction activities should be addressed in the construction management plans (CMPs) related to actions such as dam building, pier construction, seabed intervention, pipe laying, munitions removal and landfall construction.

Post-operation restoration of habitats: Where opportunity exists, projects can restore impacted habitats, for example, by restoring a stream bank or lakeshore riparian zones, restoring wetlands temporarily affected (both plants and hydrology), or re-planting mangroves and seagrasses. Any restoration plan should have specific restoration objectives, performance standards, a monitoring plan (with specific time intervals), and a list of contingencies in case performance standards are not met.

Offset of biodiversity losses through the creation of ecologically comparable biodiversity gains: After the mitigation hierarchy has been followed and appropriate avoidance, minimization, and restoration measures have been applied, residual impacts of the project on biodiversity values may be offset through conservation actions or measurable conservation outcomes. This

could include creation of habitats similar to those that were destroyed (e.g. wetlands), the building of artificial reefs, reforestation, or other actions that will result in gains for the biodiversity values lost due to the project. Such mitigation will generally be at a higher ratio than 1:1. Any offset development should have specific objectives and methods, performance standards, a monitoring plan (with specific time intervals), measurable indicators for biodiversity losses and gains in the field, and a list of contingencies in case performance standards are not met.

Table 6.1 provides more detail on specific measures for managing impacts on fish resources and habitats.

6.2 MANAGING IMPACTS ON FISHERIES AND FISHING-BASED LIVELIHOODS

As discussed in Section 4.2, impacts on fishing-based livelihoods almost always involve economic displacement, and less frequently include physical displacement as well. Management measures to mitigate these impacts should focus on the restoration and development of fisheries activities of project-affected households, fishermen groups, and/or communities and also consider interventions related to improving opportunities for other non-fishing livelihood activities, sustainability of the fisheries system, and physical relocation (see Box 6.1).

BOX 6.1 | CAUTION BAY COMMUNAL RESOURCE PLAN, PNG LNG PROJECT

The Caution Bay Communal Resource Plan (CRP) focuses on economic displacement of artisanal fishing activities that may result from construction and operations activities for the Papua New Guinea Liquefied Natural Gas (PNG LNG) Project (Project) facilities in Caution Bay, Papua New Guinea.

Caution Bay is considered a traditional fishing ground, and the artisanal fisheries are an important livelihood and income source for the four villages near the LNG Plant site: Boera, Lealea, Papa, and Porebada. Each village regularly fishes and maintains a specific fishing ground on the barrier reefs. In addition, the onshore fringing reefs, mangrove areas, and freshwater swamps around each of the villages have customary boundaries that each village respects and fishermen do not cross. The types of boats and fishing equipment used also influence the types of fishing areas that fishermen access and use.

Esso Highland Limited (EHL) is aware that construction activities will cause some short-term inconvenience to foot and boat traffic near offshore pipeline and jetty construction activities. This loss of access may have a minor impact on some villagers' livelihoods, with Papa villagers predominantly affected. EHL is committed to mitigating impacts to the Caution Bay villages by minimizing the project footprint, working in close consultation with communities, rehabilitating or restoring disturbed resources and providing communities with access to training and technical assistance. EHL has also initiated discussions with the relevant PNG authorities regarding jetty operations and has received approval to permit village vessels to transit under the jetty and to fish within the state lease area, with limited exclusions. The operations phase marine exclusion zone, as currently approved, will not impede access to the shoreline or fringing reef. Specifically, fishermen will be able to access the fringing reef and the fishing areas of Konekaru and the Vaihua River, along with the mangrove areas. As the exclusion zone is minimal, no significant impacts to local fisheries have been identified because of normal jetty operations.

EHL will ensure that those who may have experienced partial loss of livelihoods will be given the opportunity to restore their livelihoods. Livelihood restoration will focus on short-term economic restoration opportunities and long-term sustainable fisheries projects. Impacts of reduced access to fisheries resources and mangroves will be addressed through in-kind mangrove and fisheries habitat restoration projects and diversification of fishing methods training.

TABLE 6.1 | Typology of Fishing Activities

TYPE OF IMPACT	SPECIFIC MEASURES	DESCRIPTION
HABITAT DESTRUCTION	Site to avoid sensitive areas	Perform alternative site analysis
	Minimize area destroyed	Keep construction within well-marked boundaries
	Use pilings instead of fill for in-water structures	Engineer structure to minimize pile diameter and spacing
	Use construction systems that minimize the area of disturbance and need for clearing	
	Restore impacted habitat	Restore riparian zone with native overhanging vegetation, implement approved wetland restoration plans
	Develop offsets	Install artificial reefs, remove/restore hardened shoreline
	Introduce resource management capacity building	Provide education and resources to local fisheries managers for research, analysis and enforcement, so they can manage existing and/or created resources to reduce risk of overfishing
	Rehabilitate mangroves	Have pre-grown mangrove seedlings available for timely revegetation
ECOSYSTEM DISTURBANCE	Time dredging and other marine disturbance to avoid critical periods in the spawning and migration cycles of locally important fish	Manage timing of works to avoid or at least minimize disruption to fisheries resources, e.g., fish migration, spawning, seagrass flowering, etc.
NOISE/ VIBRATION	Use noise-dampening methods	Use vibratory hammers for pile driving when possible, or wood blocks on percussion hammers when not; use bubble curtains around piles to dampen vibration
	Control the timing of blasting	Do not conduct blasting during key local species' spawning/ migration seasons
	Optimize work windows	Do not conduct in-water work during key local species' spawning/ migration seasons
EXCESSIVE TURBIDITY	Implement erosion and sedimentation control	Implement standard measures such as silt fences, isolate excavation area with sheet pile, cover exposed soil, etc.
	Optimize work windows	Avoid rainy seasons for earthworks
	Re-vegetate the area	Implement re-vegetation plan using appropriate native vegetation
POLLUTION	Prevent spills	Implement standard best management practices (BMPs); follow the International Convention for the Prevention of Pollution from Ships (MARPOL) and other international protocols
	Use nontoxic coatings	For pipelines or pilings, use only approved nontoxic coating
INTRODUCTION OF INVASIVE SPECIES	Implement a ballast water exchange protocol	Follow MARPOL and other international protocols
DIRECT KILLING OF FISH	Re-stock key lost species	Use fish culture (hatcheries or net pen culture) to supply replacement resources, install artificial reefs
DERELICT MUNITIONS EXPLOSIONS	Neutralize munitions	Survey and identify munitions; select appropriate removal techniques
	Minimize direct impacts to resources	Survey area for mammals and fish schools; use pingers to scare resources from area; time removals to avoid spawning migrations
MONITORING	Conduct frequent monitoring and consultation with local fishermen to promptly identify and respond to unforeseen impacts on fisheries	

The key issue for projects seeking to address economic (and physical) displacement of fishermen is determining what constitutes adequate mitigation and compensation (where this is determined to be appropriate). Typically, determination of the adequacy of mitigation and compensation is based on a reasonable assessment of the economic displacement of an individual, household, or other relevant unit. However, as indicated in Section 5.2.2, there may be substantial variation in participation rates (occasional, part-time, full-time fishermen). Furthermore, while catch should be positively correlated with effort (see Figure 6.1), even within a single group, considerable variation in resource use intensity and productivity of fishing activities may exist, resulting in significant variation in catch per unit of effort. This variability may be attributable to a wide range of factors, including household life cycle, household demographics, alternative livelihood activities, expertise/capacity, technology used, or social and recreational use of the resource.

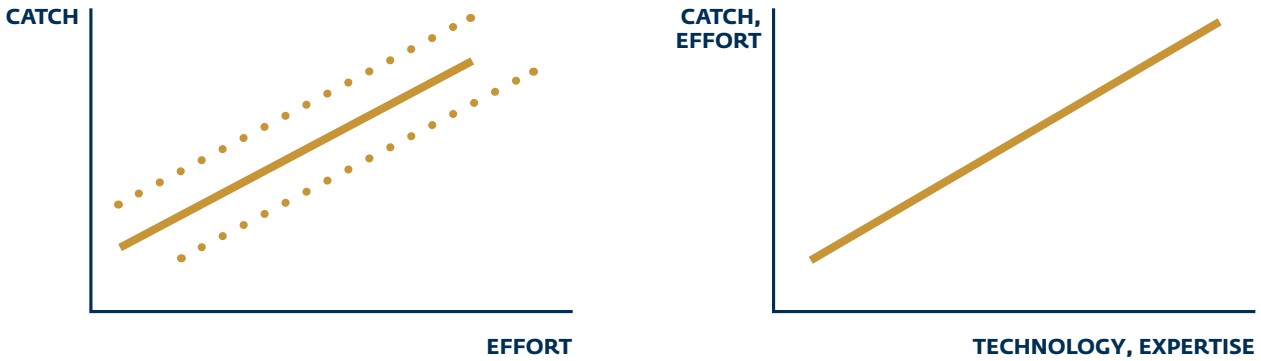
All things being equal, mitigation measures should aim to maintain or restore a sustainable catch per unit of effort. Depending on circumstances, this might be achieved through training to improve capacity, the provision of improved motors and/or boats to allow timely access to more distant fishing grounds, improved fishing equipment, or other means. However, since many of these mitigation/development interventions involve operational, maintenance, and replacement costs, in some cases it may in fact be better to aim to maintain or restore catch per unit of cost (including the cost of labor). For example, the use of motors is dependent on availability and cost of fuel and oil, the ability to maintain engines, etc.; thus, while motors can reduce the time needed to access more distant fish resources, this time savings must be combined with a larger catch per unit of effort to offset the additional costs of using a motor.

A cost-benefit analysis combined with identification of minimum conditions should be applied to all interventions considered. Finally, the recognition that variability in catch per unit of effort is related to a large number of factors suggests that baseline assessment should focus on collecting data on eligibility, participation rates, and catch per unit of effort and correlate this data to more general demographic and socioeconomic data, in order to understand the reasons underlying the observed variability. Compensation should be calculated on the basis of categorization of fisherman productivity around the mean.

The lack of a single accepted approach to determining adequate mitigation and compensation suggests the need to identify guiding principles that can be applied in different circumstances. These include:

- aim to maintain or restore a sustainable catch per unit of effort or catch per unit of cost;
- ensure that interventions focusing on improved access and capacity are correlated with studies of the sustainability of the resource;

FIGURE 6.1 | Correlation Between Catch and Unit Effort



- recognize the importance of fishing activities in fishing-based livelihoods (including stability and resilience);
- recognize the need to have inclusive, broad (i.e., multi-year assessment of participation in fishing) definitions of eligibility for mitigation measures when addressing permanent impacts;
- recognize variability in participation rates and inherent variability in resource use intensity, and ensure that baseline assessment focuses on collecting data on eligibility, participation rates, and catch per unit of effort;
- minimize shifts in equipment, technology, and practice reliant on building capacity and on services and support (to be provided by other stakeholders); and
- recognize that evolution of the broader socioeconomic environment contributes to the status of fishing activities and the significance of fisheries in livelihoods. Ensure that the baseline work includes efforts to correlate data to more general environmental and socioeconomic data. The objective is to understand the status of the fish resource and fisheries and their trajectory at the time of project entry.

Table 6.2 provides an overview of a range of mitigation and compensation options that focus on addressing project-related economic displacement of fishermen. These options are also discussed further in Sections 6.2.1-6.2.6 below. The suitability and application of these options may be complicated by several factors, including eligibility, categorization, and determination of mitigation/compensation due, as well as the ability to ensure exclusivity of mitigation and compensation for the affected groups. In addition, the general development-oriented nature of many of the interventions means that to successfully and sustainably address impacts, there is a need to promote the overall development of the system. As a result, many of the options described in this chapter may also be considered by strategic community investment and corporate social responsibility programs aiming to promote the general development of fish resources, fisheries, and fishing-based livelihoods.

6.2.1 Compensation and Livelihood Restoration Frameworks

In some cases, a company or project may elect to promote the development and implementation of national-, sector- and/or project-level compensation and livelihood restoration frameworks with the affected population. For example, a company may have substantial interests in coastal resources within a country or may foresee on-going project development within the specific area. The aim of developing a compensation and livelihood restoration framework is to promote the establishment of a formally recognized framework whose application facilitates and guides individual project-level negotiations with impacted stakeholders.

Such frameworks should be developed through multi-stakeholder engagement processes with relevant government authorities, (e.g., Ministry of Fisheries, regional government), recognized stakeholders, and potentially impacted populations. The framework should ensure that impacts serve as a benchmark for the development of the framework. Their development should consider the existence of regional and national benchmarks, precedence set up by projects impacting fish resources and fisheries, etc. A framework could also commit stakeholders to the development of sustainable fisheries. Through the same process, agreement should be reached on monitoring frameworks.

6.2.2 Compensation[15] – Cash or In-kind

The provision of compensation (cash or in-kind) is appropriate to address various project impacts, including ownership, access and use of the fish resource. In most countries, near-shore and offshore resource ownership and use is considered under the control of the state, and while subsistence and artisanal fishing may be recognized as a legitimate activity for households whose livelihoods are based on fishing, legislation does not necessarily recognize or support compensation for loss of ownership, access, and use.

[15]Compensation is defined as payment in cash or in-kind for loss of an immoveable asset or a resource that is acquired or affected by the project. Compensation should be used only in the context of the loss of an immoveable asset. It does not include allowances paid or provided in respect of various inconveniences not directly related to the loss of an immoveable asset or vulnerability, nor should it include livelihood restoration allowances or activities.

TABLE 6.2 | Fisheries Livelihood Restoration and Compensation Measures

CATEGORY OF INTERVENTION	SPECIFIC MEASURES	DESCRIPTION
COMPENSATION AND LIVELIHOOD RESTORATION FRAMEWORKS		National-, sector-, and/or project-level compensation and livelihood restoration frameworks should be developed through stakeholder engagement processes with the affected population, as well as relevant government authorities (e.g., Ministry of Fisheries). The framework should ensure that impacts serve as a benchmark for the development of the framework and, in so doing, their development may explore the existence of national or regional benchmarks, precedence, etc., and identify concerns about sustainability of fish resources. Through the same process, agreement should be reached on monitoring frameworks.
COMPENSATION (CASH OR IN-KIND)	Provide food	Food supplements to compensate for reduced access and catch during period of temporary disturbance, e.g., dredging
	Provide equipment and training	Cool boxes, nets, lines, etc. to compensate for damage to equipment
		Boats and motors to address reduction in access and use, relocation to more distant fishing grounds, and/or adaptation to new fishing practices (The distribution of fishing equipment or training to improve fishing techniques should focus on increasing the capacity of affected people to exploit fish resources. Experience shows that, without adequate resource assessment and management systems, such interventions may either directly or indirectly lead to higher intensity of resource use, through greater catches per unit of effort and/or higher participation rates. Hence, in the absence of an assessment of the sustainability of resource use, it is uncertain whether these activities may inadvertently lead to unsustainable resource use in the medium-to-long term. As such, caution should be exercised in recommending or acceding to individual fishermen's requests to increase their capacity.)
	Provide cash compensation (if markets exist, are functional and offer necessary goods and services)	Cash compensation in lieu of providing food (see above)
		Cash compensation for damage to equipment (see above)
	Provide construction-phase employment or for on-going monitoring of resource and project impacts	
RESTORATION AND DEVELOPMENT OF FISHERIES ACTIVITIES AND LIVELIHOODS (continued on next page)	Provide fishing equipment, including: • boats • motors • other equipment Install artificial reefs	Provision of equipment to address project impacts (The distribution of fishing equipment or training to improve fishing techniques should focus on increasing the capacity of affected people to exploit fish resources. Experience shows that, without adequate resource assessment and management systems, such interventions may either directly or indirectly lead to higher intensity of resource use, through greater catches per unit of effort and/or higher participation rates. Hence, in the absence of an assessment of the sustainability of resource use, it is uncertain whether these activities may inadvertently lead to unsustainable resource use in the medium-to-long term. As such, caution should be exercised in recommending or acceding to individual fishermen's requests to increase their capacity.) Work to ensure availability of key inputs by working with traders, etc.
	Provide capacity building on: • fisheries resource management • boat construction • equipment maintenance and repair • fishing technique • postharvest processing • alternative products • aquaculture • safety	• Teach courses in fisheries science/management or provide funds for local governments to hire additional qualified staff • Supply boat construction training, materials and power equipment • Provide training, tools, and parts for equipment maintenance and repair • Provide training and gear for improving fishing techniques. Improved fishing should, where possible, focus on other fishing grounds and under-utilized species, e.g., pelagic rather than demersal), to minimize risk of overexploitation and also consider alternative products, e.g., seaweed. (continued on next page)

CATEGORY OF INTERVENTION	SPECIFIC MEASURES	DESCRIPTION
RESTORATION AND DEVELOPMENT OF FISHERIES ACTIVITIES AND LIVELIHOODS (continued from previous page)	(Replacement of capture fisheries with aquaculture requires access to land, capital, capacity and resources and is also a fundamentally different livelihood activity with a different contribution to livelihoods.)	(continued from previous page) • Provide training in best management practices (BMPs) and needed infrastructure (power, water, and equipment) geared to identified markets to improve post-harvest processing • For postharvest processing, explore development of alternative products that would add value to existing products • Provide training and equipment for improved safety
	Formalize customary or other fishing rights where the opportunity exists. Assist communities to develop and implement fisheries management plans for sustainable use/possible improved productivity.	Work with government and development partners (universities, NGOs) to analyze and implement co-management projects and organizational development and strengthening of groups
	Provide inputs and utilities, including: • water • electricity • ice-making equipment • fuel supply and storage	• Provide inputs and utilities to address project impacts and development needs • Promote delivery of utilities by public sector or community development interventions • Promote appropriate allocation and delivery of fuel supplies by relevant authorities and traders, as appropriate
	Support infrastructure development, including: • equipment storage • jetty, mooring, access • postharvest processing • storage • market infrastructure	Promote development of infrastructure to address project impacts and development needs of fisheries livelihood activities, e.g. establishment of camps, boat storage, repair and processing facilities at alternative locations.
	Support the creation of fishermen's organizations/ associations	Provide proven models for organizing, funding, and operating fishermen's organizations/associations; build capacity through organizational development training
	Provide access to credit	Facilitate fishermen's access to credit to promote entry into and expansion of fishing
	Support market development	Include provision for project catering

COMPENSATION AND LIVELIHOOD RESTORATION FRAMEWORKS	• Support alternative livelihoods, including:
	  • agriculture (cropping, community gardens, etc.)
	  • livestock enterprises
	  • small-scale forestry, woodlots
	• Support micro and small enterprises
	• Offer vocational training
	• Encourage part-time fishermen to focus on non-fishing livelihood activities, including project-related employment
	• Facilitate early retirement or retirement (for older fishermen)
		Promote the development of alternative livelihoods to address project impacts on fisheries. Scope existing areas where affected communities and households already operate diversified livelihood activities and where combinations of access to resources (land), seasonal production levels, adequate markets and sufficient demand allow for adequately addressing stability and resilience contributions typical of fisheries.

(Table 6.2 continued on next page)

(Table 6.2 continued from previous page)

CATEGORY OF INTERVENTION	SPECIFIC MEASURES	DESCRIPTION
PHYSICAL RELOCATION		• Ensure that relocation plans align with the requirements of IFC Performance Standard 5, Land Acquisition and Involuntary Resettlement • Follow the specific assessment, mitigation, and compensation guidance as outlined in this document • Follow the specific recommendations on physical displacement in Section 6.2.5
PROMOTION OF SUSTAINABLE MANAGEMENT OF SMALL-SCALE AND ARTISANAL FISHERIES	Develop interventions that promote the sustainability of small-scale and artisanal fisheries	Systems analysis of fisheries resources may demonstrate threats and opportunities for development interventions in activities other than fishing: • Protection and rehabilitation of fisheries systems and resources, e.g., investigation of breeding areas (mangroves) may suggest interventions promoting mangrove protection and development • Coastal zone planning, including recognition and assessment of cumulative impacts • Local and regional management of small-scale and artisanal fisheries, e.g., community-based management systems
STAKEHOLDER ENGAGEMENT	Develop a stakeholder engagement plan for affected households and communities	Develop and implement stakeholder engagement plan: • Ensure all stakeholders are included, including directly affected fishing households and communities, participants in the fish value chain and institutional representation (where it exists) • Provide affected households and communities with details of project development plans as early as possible and seek feedback on potential impacts • Provide affected households and communities with opportunities to understand activities through various media and actual observation of equipment, technology, etc. • Ensure that stakeholder engagement includes participant observation and regular focus group meetings, to demonstrate active interest in and monitoring of affected people's opinions and perceptions about project impacts on fisheries • Ensure frequency of stakeholder meetings is correlated with periods of greatest disturbance

Compensation for Ownership and Communal Access to Common Property Resources

Both the ownership of fish resources (i.e., fishing grounds) and disruption of community-level access to common property resources (discussed in Chapter 3) may be subject to compensation. While loss of access to common property resources typically refers to situations where community access to fish resources has been disrupted, it also involves cases where the project affects terrestrial resources and communal infrastructure that is required to access and use the fishing resource. Examples of situations where communities were compensated regarding ownership and access issues include:

- PNG LNG—The Resettlement Action Plan (RAP) for Omati Waterways recognizes customary ownership by local clans and provides compensation for dredging/pipeline installation on the river bottom on the same basis as if it were land.
- PNG LNG—A Kikori Waterways Memorandum of Understanding defines development assistance to be provided over time to delta communities for the right to use waterways and offset inconveniences due to project barging operations.
- BP BTC—The exclusion zone associated with the operation of a marine terminal was associated with the loss of an additional 450 hectares where net and line fishing would be prohibited. An assessment determined that only the fishermen of Golovasi village would be impacted, since other fishing communities were far from the project-impacted area. Impacts were determined to comprise a loss

PLATE 22 | Livelihoods associated with fishing: Canoe building, Ghana. **Credit: Ted Pollett**

PLATE 23 | Livelihoods associated with fishing: Boat building, Senegal. **Credit: Ted Pollett**

PLATE 24 | Livelihoods associated with fishing: Fishing net manufacture, Lake Albert, Uganda. **Credit: Ted Pollett**

PLATE 25 | Livelihoods associated with fishing: Boat repair, Lake Albert, Uganda. **Credit: Ted Pollett**

of (i) 20 percent of the total village fishing area and (ii) 16 percent of income potential. To maintain resource use intensity, the project helped 20 percent of active fishermen to find alternative employment, establish shore-based businesses, or retire (elderly).

- BP Tangguh Land Acquisition and Resettlement Action Plan—As defined in the entitlement matrix, clans with customary rights (hak ulayat) over marine resources affected by the establishment and enforcement of a marine safety exclusion zone for the LNG site and associated facilities were to be compensated by the establishment of a development foundation with an initial project endowment of US$2 million to generate revenue streams for three land- and marine-resource-selling clans.

Short-term/Interim Compensation for Diminished Household Access and Use – Cash or In-kind

Permanent economic displacement stemming from project impacts on fish resources and fishing activities should preferably be addressed through fisheries restoration and development activities (Section 6.2.3) and alternative livelihood development activities (Section 6.2.4). However, when this is not possible, for whatever reason, in-kind or cash compensation may be required. The provision of fisheries restoration and development and/or alternative livelihood activities or compensation requires the determination of both eligibility and adequacy of mitigation and/or appropriate compensation levels. Eligibility and participation are discussed in Section 5.2. Determination of mitigation and/or compensation is discussed above.

In-kind and/or cash compensation should address short-term loss, including temporary depletion of stock and impacts on household food security and nutrition, stemming from a temporary impact, e.g., during construction, damage to and loss of equipment, and transitional support for temporary impacts associated with physical relocation of communities and/or equipment. In-kind compensation is preferable, because cash compensation relies on the existence of adequate markets and household commitment to utilize compensation for the intended purpose. A commitment to provide employment for affected households during periods of maximum disturbance (i.e., construction phase) may be appropriate, since it serves as a direct replacement for loss of employment and income. Irrespective of whether in-kind or cash compensation is provided, the project should establish guiding principles that are agreed upon with the potentially impacted communities and recipients well in advance of any project construction.

For ongoing risks and impacts (e.g., construction and operations phase damage to equipment, risk to life and limb), the project should aim to avoid and otherwise minimize risk and impact through project design and operational procedures (e.g., due consideration of project and community traffic, demarcation of channels, etc.). Notwithstanding these efforts, the project should establish guidelines and procedures for compensation that are agreed to and shared with affected communities. Projects need to ensure that contractors are aware of and abide by these guidelines and procedures, preferably by ensuring their inclusion in relevant contracts. Appropriate safeguards against opportunistic claims should be included.

6.2.3 Restoration and Development of Fisheries-Based Livelihoods and Activities

A wide array of activities fall under the rubric of restoration and development. Depending on the context, these activities may be implemented at the household, group, or community level. Furthermore, the same activity may be applied in different ways to different groups within the community.

At the outset, a note of caution is warranted: Interventions that increase the capacity of fishermen (i.e., provision of boats, motors, fishing equipment; building capacity through improved fishing techniques), and thus lead to higher resource use may inadvertently threaten the sustainability of fish resources (and thus the fishery) in the medium-to-long term. The project is responsible for assessing the sustainability of the fishing resource and evaluating proposed interventions in terms of their potential effects on sustainability. By doing so, the project can position itself as development-focused, identifying threats posed by the project and other actors and promoting stakeholder action to ensure sustainable fisheries management and strategic community investment.

In addition, providing different mitigation and compensation packages to fishermen may inadvertently create inequality among fishing communities, with the groups that benefit from improved capacity, equipment, etc. potentially being able to monopolize fish resources.

Finally, it is noteworthy that, given the nature of fish resources and the common constraints faced by fishing communities around the world, the majority of restoration-development options address sector constraints; thus their benefits may not be able to be restricted to affected fishermen. As a result, it may be strategic to separate what is primarily mitigation (i.e., compensation and restoration) measures to be provided to affected households from more general sector development interventions that can be delivered through community development programs. Such fisheries development programs are distinct from mitigation, compensation, and development measures in that they aim to address fundamental constraints to the development of fisheries and, through project support of these initiatives, create a broader social license to operate. This issue is further addressed in Section 7.2.

6.2.4 Development and Restoration of Non-Fishing Livelihood Activities

In situations where the restoration and development of fishing activities may not be viable, the project should seek to develop alternative livelihood activities, such as agriculture, enterprise, or employment. In most cases, such development involves strengthening existing livelihood activities rather than developing wholly new activities, thereby ensuring that affected people are able to leverage and build upon existing expertise.

Nonetheless, even where projects seek to alter the relative contribution of different livelihood activities, due consideration should be given to (i) the baseline contribution of fisheries to subsistence and especially household nutrition (i.e., fish as a source of protein), and (ii) the contribution of fisheries to promoting household stability and resilience. As described in Section 5.2.2, this requires analysis that moves beyond the relative contribution of fisheries (e.g., to household income) to understanding the role of fisheries in local livelihood systems.

As with development projects, such interventions should be developed using a results-based or logical framework.

6.2.5 Physical Relocation

When fishing communities are physically displaced as a result of a project, it is important to keep the following in mind:

- Ensure baseline assessment of fishing is correct, accounting for changes associated with alternative economic opportunities. Factor in a percentage return to the activity.
- Promote continued access to and use of existing fisheries where possible.
- Minimize increased risk to life associated with potentially more hazardous access to aquatic and marine environments and use of alternative fishing grounds (see Box 6.2).
- Ensure that the design of new settlements considers:
  - adequacy of mooring and access to fisheries (see Box 6.2);
  - adequacy of household-level input and equipment storage requirements, taking into account distance from houses, need for security, etc.; and
  - adequacy of processing, drying, and curing facilities, reflecting cultural norms and freshwater supply.
- Account for current and future requirements for fuel storage and delivery, ice production, cold storage, and marketing.
- Minimize major shifts in equipment, technology and practice.
- Ensure identification and recruitment of technical people who understand fisheries; the riverine, lake, estuarine, and coastal or marine environment; and fishing equipment, technology, and techniques.

6.2.6 Promoting Sustainable Management of Small-Scale Fisheries

There are various reasons for including a sustainability awareness-building program for fishermen in project

BOX 6.2 | TANGGUH RESETTLEMENT AND THE ADEQUACY OF MOORING AND ACCESS TO FISH RESOURCES

At the Tangguh LNG Project, in West Papua, Indonesia, the community of Tanah Merah was resettled to two other locations, Tanah Merah Baru and Onar Baru. The shoreline of the original village at Tanah Merah comprised a sandy beach leading to extensive mud flats that, when combined with the significant tidal variation in sea levels, formed an effective barrier that restricted access to the sea and its fish resources, a situation most clearly observed at low tide (see photos below).

PLATES 26 & 27 | Beachhead at Tanah Merah Village: The shallow mudflats and significant tidal variation in sea levels restrict access to the sea. **Credit: Robert Gerrits**

The Tanah Merah Baru resettlement village, by contrast, was well-elevated above sea level, at the top of a small rise immediately adjacent to the bay. The village (and the host village, Saengga) was primarily accessed though a river mouth leading into the bay. Given the significance of fishing activities, the project included two jetties in the design of the resettlement village. The jetties extended +/-50 meters from the shoreline into the Bay, effectively lying on mudflats. Furthermore, the eastern-most jetty practically abutted the marine exclusion zone associated with the project combo-dock and LNG loading facility, thereby restricting movement to the east.

Although the intention of the jetties was to provide enhanced access to the bay, in fact, as designed, the jetties actually pr ovided even more limited access to the bay than the adjacent river and, as a result, were never used by the resettled population. In the original Tanah Merah village, there was a beach, and people had the ability to access the sea at low tide, even though they had to push/walk through mudflats for a long distance, which was difficult. However, at the new Tanah Merah Baru village site, the location of the jetties left boats dry, and there was no hope of people being able to push them through the mud, because it was too deep, and there was no beachhead to mitigate the depth of the mud.

fisheries programs. First, awareness and understanding of fish resource sustainability is typically limited. Second, the "open access/common property" nature of artisanal fisheries increases vulnerability to and risk of overfishing and resource depletion. In cases where ownership of fishing grounds is defined, such ownership is more commonly used to ensure benefit sharing rather than management of resource use, and projects impacting fish resources and fisheries would have various responsibilities to promote sustainable fisheries. Third, as noted above, interventions that increase the capacity of fishermen and lead to higher resource utilization may inadvertently threaten the sustainability of the fisheries resources in the medium-to-long term.

Projects that have considerable impacts on fishing communities should, at a minimum, implement the following activities:

- assess the sustainability of the fishing resource and evaluate proposed interventions in terms of their potential effects on sustainability;
- develop and implement a basic fisheries sustainability program aiming to promote resource users' awareness and understanding of fisheries resource sustainability; and
- develop and implement a fish resource and fisheries monitoring program to continually assess the status of and monitor the trajectory of fisheries.

Systems analysis of fisheries resources may demonstrate threats and opportunities for development interventions in activities other than fishing. These may include:

- protection and rehabilitation of fish resources, e.g., investigation of breeding areas (mangroves), which may suggest interventions promoting mangrove protection and development;
- coastal zone planning, including recognition and assessment of cumulative impacts;
- local and regional management of small-scale and artisanal fisheries, e.g., community-based management systems; and
- organizational development of fishermen's interest groups.

In certain circumstances, there may be a case for investing in the development of fisheries management systems. By doing so, the project can position itself as development-focused, identifying threats posed by the project and other actors and promoting stakeholder action to ensure sustainable fisheries management.

6.3 ADDITIONAL CONSIDERATIONS THAT REQUIRE MANAGEMENT ACTIVITIES

In addition to mitigating the direct impacts to fisheries habitats and resources, as well as those on the fishing activities of affected populations, there are several other impacts and increased risk scenarios that will require attention when designing an impact management and mitigation strategy. These include risks to safety and security, and the effects of project-induced in-migration and behavior changes among local populations.

6.3.1 Safety

The safety concerns associated with project development and operations should be addressed proactively prior to the occurrence of any incidents. Key interventions include:

- Development and enforcement of guidelines for shipping activity and operation of motorboats. Guidelines should include:
  - a description of key fishing activities that may be encountered, including maps of the main fishing areas and commuter routes and a list of the potential issues (i.e., damage to equipment, risks of collision and capsize, crushing against ships or pier pilings, injury and loss of life);
  - the required mode of operation and behavior when close to and within the project area of influence;
  - specific guidelines pertaining to the interaction of shipping personnel with affected communities, including issues such as sale of food, alcohol, and drugs; gambling; and prostitution; and
  - management of engagement with affected parties, including grievances, compensation, etc.

- Engagement with appropriate authorities as early as possible to ensure the legal definition of exclusion zones, channels, or transit lanes and their demarcation on maritime maps.
- Development and implementation of an outreach program with affected communities. This should aim to promote an awareness and understanding of (i) project shipping and motorboat usage, (ii) the risks that their use poses to equipment and life, (iii) project guidelines to operators, and (iv) the project grievance mechanism (including the need to specify names of vessels and times so the project can verify that vessels were working for the project). Where appropriate, maps of key shipping areas, exclusion areas, etc. in relation to fishing grounds and commuter routes should be produced and distributed. Furthermore, if periods of high shipping intensity can be identified, establishing communication channels to inform communities of these activities may be useful.
- Development and delivery of an education and training program to promote safety among fishermen within the project-affected area. Such a program could include (i) navigation protocols for shipping, (ii) interpretation of markers and buoys used to guide shipping, and (iii) distribution of maps of key shipping areas, exclusion areas, etc. in relation to fishing grounds and commuter routes. The program may also consider delivering extension classes on basic seamanship and navigation and ensuring access to safety equipment (life jackets, lights, signals), although this should reflect the fact that local fishermen have considerable experience at sea using relatively basic equipment and technology and that provision of such equipment may be unsustainable if the equipment is not available in local markets. (Box 5.7 provides an example of a project providing assistance to a local women's interest group to manufacture and market life jackets at Lake Albert, Uganda.)
- Support for the development of a rescue and emergency response service. While this may be appropriate in some cases, given the poor levels of public services in many areas, the project would probably have to provide on-going support for a broader service to local communities in the vicinity of its project operations.

6.3.2 Security

Security forces may be engaged to ensure the enforcement of exclusion zones, the security of onshore and near-shore infrastructure, and the continuity of project operations. To manage the potential impacts associated with operations of a security force, the project should:

- subject all contracted security forces to appropriate due diligence;
- work with contracted and national security forces to establish appropriate guidelines for the operation of security, including implementation of voluntary principles on security and human rights as appropriate;
- engage affected communities to ensure an awareness and understanding of the need for project security;
- engage affected communities in participatory processes to ensure that their recommendations and concerns regarding the operation of project security forces inform the development of operational guidelines, e.g., the development of codes of conduct pertaining to use and operation of boats, ensuring compliance, use of force, emergency responses such as to accidents, and adverse marine and weather conditions and ongoing monitoring and evaluation of these measures; and
- conduct outreach to promote awareness of project security forces, their area of operation and guidelines for their operation, and utilization of project grievance systems to report incidents and/or express concerns.

While project exclusion zones may be marked with buoys and enforced by security, widespread awareness and respect of project exclusion zones is likely to develop only over an extended period of time. To this end, project security activities may need to be linked to an ongoing extension program, with selected community members and fishermen participating in site visits and playing a role in ensuring that fishermen's interest group members comply with agreed security

measures. Enforcement activities may need to be implemented progressively, building on a cautious approach and lessons learned.

6.3.3 Managing Indirect Project-Induced Impacts

Although project-induced impacts are generally not a direct result of the project activities (and are not covered under the requirements of PS5), the presence of the project is a causative factor. These impacts, which can result from interactions between shipping personnel and local communities, behavior change among local populations, in-migration, displacement to other fishing grounds, increased disposable income, and project-induced development, should be included in any consideration of impact management activities (see Section 4.2.6 for more details).

While the need to address these risks should be based on an assessment of the risk of project-induced impacts, some impacts, including interaction of local people with shipping personnel, behavior change among local populations, and competition with migrants to the area, occur without the fault of any project. As a matter of good practice, these impacts should be predicted and managed.

Interaction of shipping personnel with affected communities: The project should ensure that potential risks are addressed through contracts with shipping service providers that require development of a common, strictly enforced code of conduct, a requirement for project investigation of reported events, and penalties for non-compliance that may involve both the affected communities and the project. Communities close to the activity should be engaged and informed of risks and potential management strategies.

Behavior change: Inevitably, large near-shore operations result in some sort of behavior change within local populations. Often, these changes take the form of negative high-risk behaviors, such as fishing trips with limited fuel supplies, intrusion into exclusion zones, or excessive concentration of fishermen, based on the assumption and/or knowledge that the project will provide assistance (e.g., fuel, tow back to shore, or compensation). The issue of behavior change needs to be addressed through early stakeholder engagement and development of community agreements where behavior is tied to benefit streams. The intention of this proactive engagement is to hold the group and/or community responsible for managing individual behavior. This can be managed by linking disincentives to repetitive flagrant or willful negligence or criminal behavior.

Competition: Project development almost always leads to some level of in-migration into an area, leading to increased resource use intensity and competition. Communities close to the activity should be engaged and informed of risks and potential management strategies.

7. DEVELOPMENT AND IMPLEMENTATION OF FISHERIES LIVELIHOOD RESTORATION PLANS AND DEVELOPMENT PROGRAMS

This document has explored the multiple dimensions of subsistence and artisanal fisheries systems, identified potential project impacts on the resource and fisheries, and considered the assessment of these impacts and the wide array of mitigation and compensation options available. With this background, the question of what a project fisheries livelihood restoration plan should look like can now be addressed.

While previous chapters have demonstrated the potential diversity and complexity of issues that may need to be considered when a project impacts upon artisanal fisheries, one key challenge pertaining to the development of a project response remains: namely the relationship between mitigation and compensation and development. As noted, it is recommended that a project clearly distinguish between a fisheries livelihood restoration plan that provides compensation and mitigation measures to impacted fishermen and more general fisheries development programs, implemented through strategic community investment and social responsibility initiatives and directed at fishing communities located within the project area of influence. Put simply, it is important for all stakeholders to understand and differentiate between what a project is responsible for because of impacts associated with its development and operations, and what it voluntarily chooses to sponsor.

This chapter addresses both fisheries livelihood restoration plans and strategic community investment/ corporate social responsibility initiatives.

7.1 PROJECT FISHERIES LIVELIHOOD RESTORATION PLAN

A project's first responsibility is to address the impacts to fish resources, fisheries, and fishing-based livelihoods that result directly from project activities. This can be done through the development of a fisheries impact management program that includes impact mitigation and compensation for affected fishermen and communities (see Box 7.1 for a recommended outline for a fisheries livelihood restoration plan).

7.1.1 Determinants of a Fisheries Livelihood Restoration Plan

Determination of the design and implementation of a project fisheries livelihood restoration plan should consider several issues, including the importance of fisheries to people's livelihoods, the nature of impacts, data quality and cost, and the choice between management and development.

The importance of fisheries to people's livelihoods: The significance of a project's potential impacts on fisheries is determined by the importance of fisheries activities in affected people's livelihood systems. While there is a tendency to consider such impacts in economic terms, i.e., economic displacement, a broader analysis assessing various other aspects of fishing-based livelihoods, such as stability, resilience, and nutrition, should also be undertaken. In general terms, the greater the significance of fisheries in supporting livelihoods, the greater the levels of livelihood restoration and compensation that will need to be provided by the project, unless equivalent alternative fish resources are available.

The nature of impacts, including their diversity, scale, duration, and their effect on productivity: Diversity addresses impacts across habitats, fisheries, and fishermen, while scale refers to the area affected and the number of fishermen/fishing households affected. The duration of impacts may be temporary (e.g., dredging associated with construction), permanent, or ongoing (e.g., damage to fishing equipment). Impacts on productivity of fisheries and fishing activities range from insignificant to significant. Singular impacts of limited scale (either impacting a small geographic area and/or a limited number of fishermen) that are temporary in nature and have limited impact on productivity of the underlying resource and/or the fishing activity are rela-

tively easy to manage, compared with impacts that are diverse, large-scale, permanent, and that significantly affect productivity.

Data quality and the cost of baseline assessment and monitoring: The establishment of baseline conditions, impact assessment, and ongoing monitoring can be resource intensive (i.e., cost, time), particularly where primary and secondary data on fish resources and fisheries are scarce. A project needs to strike an appropriate balance between impacts and their management, cost of assessment, and data quality. This balance should be based on the objective of effective management of impacts in consultation with local and national governments and lending institutions.

The choice between impact management and development: The design of a fisheries impact management program is likely to include a combination of mitigation, compensation, and community investment-development interventions. The design of such a program must, to the greatest extent possible, seek to ensure a correlation between impact and response, and ensure that impact management interventions can be deemed to be solely directed toward affected fishermen. As noted, more general development interventions that target entire communities of fishing-based communities located within the project area of influence should be considered as part of a project's strategic community investment or social responsibility programs.

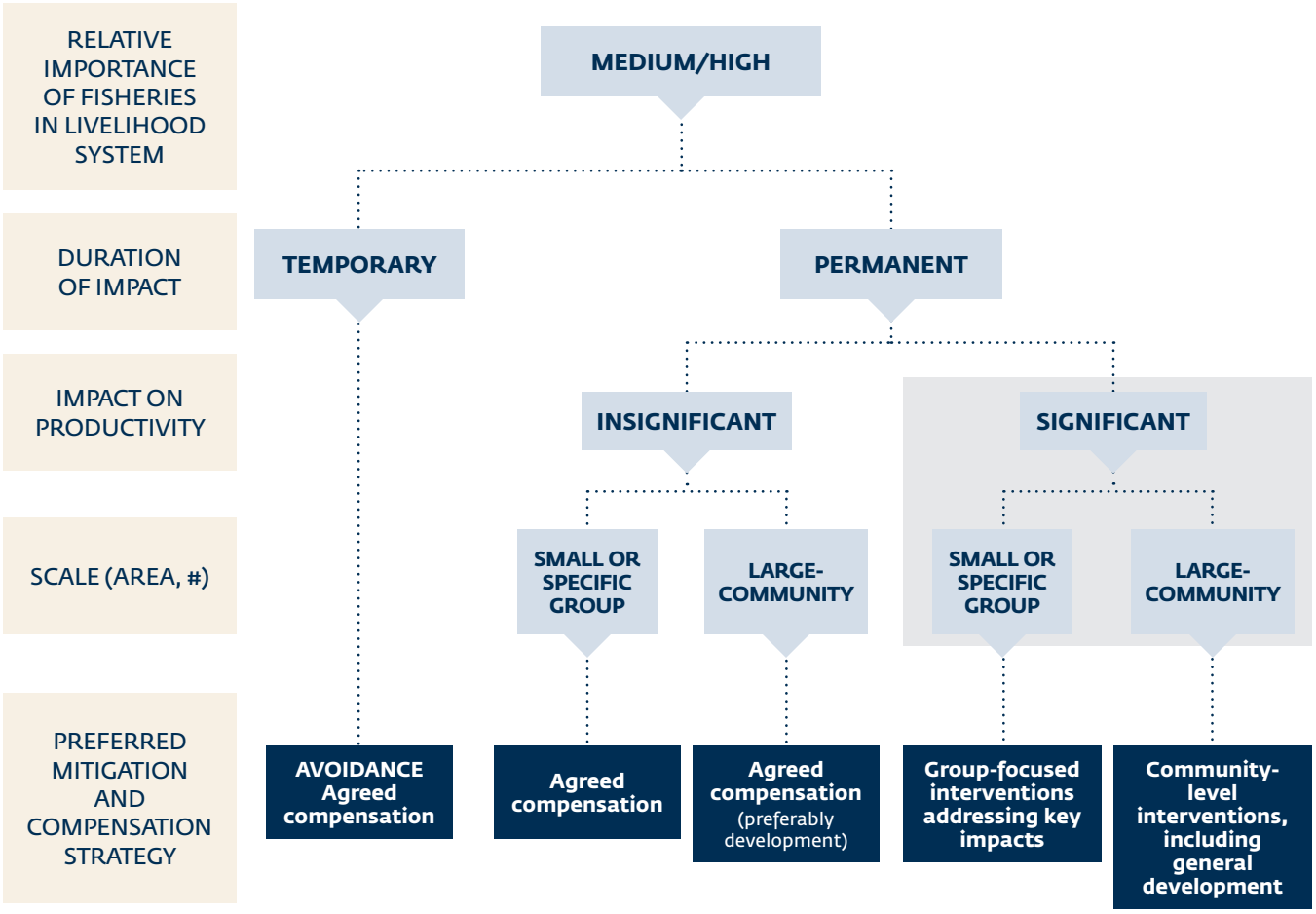
Figure 7.1 uses the determinants listed above to develop a decision tree to guide assessment and management of potential impacts resulting in loss of habitat, resources, and livelihoods. Key strategies for assessment and management include:

- Temporary impacts are best addressed through avoidance and, where avoidance is not possible, direct compensation. Assessment should focus on defining eligibility, and categorization and determination of the appropriate level of compensation.
- Longer-term but insignificant impacts are best addressed through compensation. Strategies for small groups can involve direct compensation, while for large groups/communities, compensation strategies should focus on development interventions. For small groups, assessment should focus on defining eligibility, categorization, and determination of the appropriate level of compensation. For affected communities, assessment should focus on identification of fish resource management, human resource capacity, and development needs.
- The most significant impacts are associated with either a defined group of fishermen or an entire community, where permanent impacts significantly affect habitats, productivity, and livelihoods. These circumstances have the greatest assessment, management, and monitoring requirements.
- Given that projects may traverse multiple ecoregions (and involve several different ecosystem services), including estuaries, near-shore, continental shelf, continental slope (e.g., linear projects involving pipelines, projects involving construction, operational, and shipping activity across various ecoregions) or, on a smaller scale, may affect the riparian–intertidal–near-shore–offshore continuum, the complexity of assessment, mitigation, and compensation may be high.
- Irrespective of the typology of impacts, there is an ongoing need for stakeholder engagement that ensures (i) awareness and understanding of project activities; (ii) awareness and understanding of project impact management programs, including impacts, eligibility, categorization, and proposed management programs; and (iii) availability of a grievance mechanism that allows affected fishermen to register grievances. Finally, for ongoing impacts there is a need to have an established typology and management procedure.

7.1.2 Impact Management Programs and Activities

Chapter 4 described the potential range of issues to be addressed by projects impacting fish resources and small-scale fisheries. In addressing these impacts, projects should develop a fisheries impact management plan that includes component programs appropriate to context, the project, and potential risks and impacts. A list and description of standard component programs is provided below.

FIGURE 5.4 | Decision Tree Addressing the Nature of Socioeconomic Impacts on Fish Resources, Fishing and Fishing-Based Livelihoods



Stakeholder engagement and grievance mechanism: Stakeholder engagement throughout the project cycle builds relationships with affected communities and promotes awareness and understanding of project development and risks and impacts. Stakeholder engagement should target both individuals and groups whose fishing activities have been affected, as well as broader communities whose livelihoods are tied to these fishing activities. An agreed stakeholder engagement framework should be developed with affected fishermen and communities to ensure that livelihoods adversely impacted by the project are identified in a timely manner and on an ongoing basis.

Human and equipment safety: Project development and operations will include activities posing risks to human and equipment safety. Projects need to ensure adequate consideration of such risks and their management. Where relevant, the project should also ensure that it coordinates with relevant national authorities to develop updated navigation charts showing new project infrastructure and associated exclusion areas.

Security: Security services are typically provided to safeguard project personnel, assets, and activities. The development of appropriate security measures and building awareness and understanding within affected communities about these measures is critical to promoting compliance and minimizing project-community conflicts. Furthermore, where appropriate, the imposition of restrictions enforced through security measures must be available to manage the threats. When these disincentives are explained to the local communities, the measures will be correlated with

positive mitigation, compensation, and development initiatives. This will demonstrate a fair and just enforcement policy for mitigation measures and community agreements regarding fishermen's behavior.

Contractors: Typically, a wide range of contractors are involved in project development and operations, e.g., shipping, construction, transportation, security, etc. It is critical to ensure that contractors abide by the project's commitments to environmental and social management and affected communities. It is good practice to ensure that relevant conditions are inserted into contractor/supplier contracts (including requirements, right to investigation of reported incidents, and penalties for noncompliance) and to require that vetted and agreed codes of conduct are developed and shared with all contractor employees.

Mitigation, compensation, and development: The project should select appropriate mitigation, compensation, and development interventions to address physical and economic displacement caused by the project. Projects should select and evaluate potential interventions through a process that involves the following steps:

1. **Identification of alternatives:** Chapter 6 listed the many options through which economic displacement might be addressed. The first step requires identification of alternatives. The project context and the key principles for managing impacts on fisheries and fishing-based livelihoods outlined in Section 6.2 should guide development of a list of alternatives.
2. **Evaluation of alternatives:** Each option should be evaluated in terms of the following:
    - Whether the intervention meets the following criteria:
        - culturally appropriate;
        - socially acceptable;
        - appropriate to current expertise and capacity (for operation, maintenance, and repair);
        - technically feasible;
        - economically viable (including cost for operation, e.g., fuel, oil, maintenance, and repair); and
        - sustainable (i.e., ability for the intervention to be sustained by affected population and markets independent of further project support).
    - The anticipated outcomes on fishing activities and livelihoods, including (i) assumptions regarding anticipated increases in catch per unit of effort (or per unit of cost), requisite fishermen, and/or community behavior change, etc.; (ii) any linked requirements, including availability and cost of inputs (fuel, oil, nets, etc.), provision of support services (electricity, water, cold storage), market development for supply of inputs, and/or the sale of additional catch, etc.
    - The identification of component activities, the resources and time required to deliver these activities, and thus the schedule for delivery of anticipated outcomes.
3. **Selection and prioritization of the most viable interventions:** Selection should be based on overall assessment stemming from consideration of the criteria itemized in Step 2 above. Preferred interventions are those that minimize shifts in capacity, equipment, and technology; deliver outcomes within a reasonable time frame; and are not excessively reliant on assumptions and/or dependent on services and support to be provided/developed by other stakeholders.
4. **Implementation:** Where relevant and practicable, interventions should be subject to a participatory pilot implementation phase, allowing the intervention to be tested and the anticipated outcomes to be confirmed before it is implemented across the population of affected fishermen.

Monitoring: Irrespective of the magnitude of project risk and impacts, it is essential that the project establish a participatory monitoring and evaluation framework. Such a framework will have multiple objectives, including (i) building awareness and understanding of the fish resources and fisheries, their trajectory, and the impact of external forces on them; (ii) ensuring awareness, understanding, and joint management of

BOX 7.1 | RECOMMENDED OUTLINE FOR A FISHERIES LIVELIHOOD RESTORATION PLAN

1. **Introduction**
   Include brief project description, purpose of the document, and scope of the fisheries impact management plan.

2. **Project Description**
   Provide a comprehensive description of the project based on the "end-game." The description should provide an overview of the project and subsequently describe the exploration, construction, and operational phases of the project, i.e., the whole project life cycle. Key aspects relevant to fish resources, fisheries, and fishing-based livelihoods of project-affected communities should be described in detail.

3. **Statutory and Regulatory Framework**

4. **Livelihood Systems of Project-Affected Fishing Communities**
   Describe the livelihood systems of project-affected fishing communities.

5. **Fish Habitat and Resources**
   Describe fish habitat and resources that are both impacted by and at risk from project activities.

6. **Fisheries Systems**
   Describe the range of fishing activities used by individuals, households, and communities impacted by the project. Include postharvest processing and sale, including the value chain of produce.

7. **Identification of Stakeholders**
   Identify the various stakeholders who may be impacted or may be involved in the process of development, implementation, and monitoring of the programs.

8. **Impact Assessment**
   Provide impact assessment

9. **Definition of Eligibility Criteria and Entitlement Matrix for Directly Affected Fishermen**

10. **Fisheries Livelihood Restoration Strategy**
    Define the overall impact management strategy.

11. **Program and Activity Description**
    Provide a description of program and component activities. Include key information pertaining to target group, implementation, human resources, timeline, budget, etc.

12. **Project Implementation (human resources, partners, and organizational responsibilities)**
    - Describe human resources for implementation of the plan and component programs/interventions.
    - Clearly define roles and responsibilities and organizational structure.
    - Describe potential partners (affected groups and communities, NGOs, government, etc.) and their respective roles and responsibilities.

13. **Schedule**
    Present a multiyear schedule of implementation (Gantt chart) for the component programs/interventions and the overall plan.

14. **Budget**
    Present budgets for the component programs/interventions and the total cost of the plan.

15. **Monitoring and Evaluation**
    Develop an overall monitoring and evaluation framework (M&E) that integrates the M&E requirements for the component programs/interventions. Based on this framework, define an M&E plan.

project risks and impacts; and (iii) ensuring that the activities, outcomes, and impacts of the project fisheries livelihood restoration plan are monitored to compare actual impacts against those predicted. The deliberate use of a broader monitoring and evaluation framework is aimed at building collaborative partnerships with the affected communities and ensuring exposure to a sufficiently broad view of the factors affecting fish resources and fisheries. In this way, the focus on the project management plan commitments, deliverables, and outcomes is contextualized.

7.2 PROJECT-SPONSORED FISHERIES DEVELOPMENT AND MANAGEMENT PROGRAMS

Project-sponsored fisheries development programs differ from fisheries impact management programs in that they are not necessarily a specific response to particular impacts, but rather a more general, proactive attempt to increase development in the project-affected area. Such programs aim to promote specific and general development interventions targeting particular groups of fishermen and/or entire fishing-based communities located within the project area of influence. These development programs may be created in parallel to fisheries impact management programs or in the absence of specific project economic displacement risks and impacts (see Box 7.2 for a recommended outline for a fisheries development management plan).

The establishment of project-sponsored fisheries development programs – particularly when they occur in parallel to fisheries impact management programs – should be particularly cognizant of the following:

- It is important to ensure that all affected communities are aware of and understand the difference between what the project is obligated to do to mitigate impacts and what it voluntarily chooses to support.
- At the earliest stage of development of these programs, scoping meetings involving appropriate representatives of federal, provincial, and local governments should take place, so that all levels are in consensus as to the goals and objectives and their respective roles and responsibilities. This will avoid inefficiencies with potentially competing programs by these entities.
- Development programs should be based on a systems analysis of the fish resources and fisheries within the project area of influence, leading to the identification of priority areas (e.g., through strength/weakness/opportunity/threat (SWOT) analysis, needs analysis, etc.). Through this process, the project should define objectives, boundaries, target groups, and component programs.
- Regarding objectives, the program may include initiatives to address (i) fundamental constraints to the development and operation of fishing-based livelihood systems, (ii) identified needs of fishing-based communities, and/or (iii) threats to the sustainability of such systems. Interventions should be subject to screening processes similar to those identified in Section 7.1.2. Written objectives should be quantified with specific temporal end points or products.
- It may be useful to develop a fisheries strategic development framework that commits the project to supporting fisheries development over its lifespan and defines a mechanism through which priorities are identified and component programs designed, implemented, and evaluated. Use of a framework allows for a more strategic, longer-term perspective on fisheries development and is sensitive to evolution of the situation and, specifically, fishing-based livelihoods. Three-to-five-year development plans defining component programs can be developed in support of the framework.
- A fisheries development program may have multiple component programs and activities. Such programs should provide benefits to large groups and/or entire communities operating fishing-based livelihoods, should not be exclusive, and should not be directly correlated to a project's direct impacts on fish resources and fisheries. Finally, it is useful to ensure that programs include multiple initiatives, some of which provide results and outcomes in the short term.

BOX 7.2 | RECOMMENDED OUTLINE FOR A FISHERIES DEVELOPMENT AND MANAGEMENT PLAN

1. **Introduction**
   Include brief project description, purpose of the document, and scope of fisheries development and management plan.

2. **Project Description**
   Provide a comprehensive description of the project based on the "end-game." The description should provide an overview of the project and subsequently describe the exploration, construction, and operational phases of the project, i.e., the whole project life cycle. Key aspects relevant to fish resources, fisheries, and fishing-based livelihoods of project-affected communities should be described in detail.

3. **Rationale for Corporate Social Responsibility (CSR)**
   Define the rationale for the CSR program, specifying project and community objectives to be achieved. Outline the nature of project commitment (time, resources) to be dedicated to the CSR program.

4. **Livelihood Systems of Project-Affected Fishing Communities**
   Describe the livelihood systems of project-affected fishing communities.

5. **Fish Habitat and Resources**
   Describe fish habitat and resources that are both impacted by and at risk from project activities.

6. **Fisheries Systems**
   Describe the range of fishing activities used by individuals, households, and communities impacted by the project. Include postharvest processing and sale, including the value chain of produce.

7. **Identification of Stakeholders**
   Identify the various stakeholders who may be impacted or may be involved in the process of development, implementation, and monitoring of the programs.

8. **Analysis of Development Priorities**
   Provide analysis of development priorities, including process of identification, analysis of their significance, and potential development outcomes/impacts if addressed sustainably.

9. **Fisheries Development Framework**
   Describe the fisheries development framework that the CSR program will support. Describe how the framework was developed, the roles and responsibilities of various stakeholders, etc.

10. **First Three-to-Five-Year Fisheries Development Plan**
    Introduce the first three-to-five-year development plan.

11. **Identified Development Priorities**
    Describe development priorities to be addressed in the first development plan.

12. **Selection of Interventions**
    Describe how selected interventions addressing key development priorities were identified. Include suitability and sustainability analysis of the selected interventions.

13. **Program and Activity Description**
    Provide a description of program and component activities. Include key information pertaining to target group, implementation, human resources, timeline, budget, etc.

14. **Project Implementation (human resources, partners, and organizational responsibilities)**
    - Describe human resources for implementation of the plan and component programs/interventions.
    - Clearly define roles and responsibilities and organizational structure.
    - Describe potential partners (affected groups and communities, NGOs, government, etc.) and their respective roles and responsibilities

15. **Schedule**
    Present a multiyear schedule of implementation (Gantt chart) for the component programs/interventions and the overall plan.

16. **Budget**
    Present budgets for the component programs/interventions and the total cost of the plan.

17. **Monitoring and Evaluation**

    Develop an overall monitoring and evaluation (M&E) framework that integrates the M&E requirements for the component programs/interventions. Based on this framework, define an M&E plan.

APPENDIX 1

Terms of Reference,
Environmental and Social Assessment of Project-Affected Small-Scale Subsistence and Artisanal Fisheries

1. INTRODUCTION

(INSERT PROJECT NAME) in (INSERT REGION AND COUNTRY) is in the early phases of development and is seeking a Consultant/Organization to conduct an environmental and social assessment of project-affected small-scale subsistence and artisanal fisheries. The social assessment is to provide an understanding of the fish resource, fisheries activities, and fishing-based livelihoods, such that the potential project impacts on subsistence and artisanal fisheries can be defined. The situation analysis should also inform mitigation and compensation options and provide a key input into the development of a fisheries livelihood restoration plan.

2. CONTEXT

This section is to be used to provide a high-level description of the project context.

3. SCOPE OF WORK/DELIVERABLES

The key deliverable of the selected CONSULTANT/ORGANIZATION is the implementation of a social assessment of project-affected small-scale and artisanal fisheries for COMPANY, PROJECT NAME. This document should include:

1. A review of national laws pertaining to small-scale and artisanal fisheries
2. A review of comparable projects at various stages of development
3. A description of the project, including:
   - the project, logistical bases, and associated facilities and the extent to which the project is required to develop additional infrastructure, services, and utilities;
   - the alternatives for location and design of project and associated facilities assessed as part of the environmental and social risk and impact assessment (ESIA) process;
   - the project construction and operational activities, focusing on those predicted to impact small-scale and artisanal fisheries; and
   - the project development schedule.
4. A description of the project context, including:
   - local and regional biophysical and socioeconomic context;
   - assessment of local and regional development; and
   - a review of capacity of local and regional government, infrastructure, service, and utilities.
5. A description and analysis of the current status of small-scale and artisanal fisheries in the project area of influence, including identification of key stakeholder groups (fishermen's organizations, boat/canoe builders, equipment suppliers, net and fish trap manufacturers, fish processing, markets and retailers, transportation enterprises), state of development, government support, development assistance, etc.
6. An assessment of the key expected environmental and social impacts on small-scale subsistence and artisanal fisheries within the project area of influence
7. Social assessment of the affected small-scale subsistence and artisanal fisheries, including a description of livelihood systems; fishing, processing, and marketing activities

In addition to presenting the results of the above studies and analyses, the final section of the social assessment should identify the potential approaches and interventions for addressing and managing the predicted impacts.

4. **SCHEDULE**

It is anticipated that the development of the social assessment will take X months to complete. [Indicate timeline for each project deliverable].

5. **REQUIREMENTS**

The Consultant/Organization shall submit the following to the Company to be considered for the assignment:

- proposal;
- scope of social assessment;
- actions;
- deliverables;
- timeline;
- budget; and
- personnel with clarity on support required from Company.

6. **QUALIFICATIONS**

The Consultant/Organization shall possess the following skills:

- experience in planning and implementing social assessment, socio-economic surveys, and multistakeholder engagement processes;
- experience in developing ESIA; environmental, social and health impact assessment (ESHIA); social impact assessment (SIA); resettlement action plan (RAP); community development strategies; etc.;
- experience within sector and within region and country preferred;
- ability to provide a multisectoral team with expertise in the following areas: ecology, fisheries biology and management, anthropology, social sciences, community development, health, economics, governance, and organizational development, etc.; and
- ability to meet Company time frame.

7. **RESOURCES**

Company will make available relevant documentation and also facilitate logistics to the extent it involves access to and around project location. In addition, the Consultant is referred to the following:

IFC 2014, "Addressing Project Impacts on Fishing-Based Livelihoods, Baseline Assessment and Development of Fisheries Livelihood Restoration Plans," Environment and Social Division, CommDev, Washington, DC.

APPENDIX 2

Terms of Reference,
Development of a Project Fisheries Livelihood Restoration Plan

1. INTRODUCTION

(INSERT PROJECT NAME) in (INSERT REGION AND COUNTRY) is in the early phases of development and is seeking a Consultant/Organization to develop a fisheries livelihood restoration plan for project-affected small-scale subsistence and artisanal fisheries. The fisheries livelihood restoration plan will articulate a specific impact management strategy and component programs that together achieve the restoration of fishing-based livelihoods experiencing economic displacement (and other relevant dimensions) associated with project development and operations. The strategy and component programs may comprise a combination of mitigation, compensation, and development options relevant to livelihood restoration, but should aim to ensure that (i) management options are clearly linked to impacts; (ii) where necessary, proposed programs and deliverables are able to be defined and allocated exclusively to affected fishermen; and (iii) eligibility, categorization of participation and proposed compensation are adequately assessed and defined. The fisheries livelihood restoration plan should be based on the results of the social assessment of project-affected small-scale subsistence and artisanal fisheries and, where appropriate, further supported by additional studies.

2. CONTEXT

This section is to be used to provide a high-level description of the project context.

3. SCOPE OF WORK

The key deliverable of the selected CONSULTANT/ORGANIZATION is the development of a fisheries livelihood restoration plan to address project-affected small-scale and artisanal fisheries for COMPANY, PROJECT NAME. This document should include:

- A review of national laws pertaining to small-scale and artisanal fisheries
- A description of the project, including:
  - the project, logistical bases, and associated facilities and the extent to which the project is required to develop additional infrastructure, services, and utilities;
  - the project construction and operational activities, focusing on those predicted to impact small-scale and artisanal fisheries; and
  - the project development schedule.
- A description of the project context, including:
  - local and regional biophysical and socioeconomic context;
  - assessment of local and regional development; and
  - a review of capacity of local and regional government, infrastructure, services, and utilities.
- A description and analysis of the current status of small-scale and artisanal fisheries in the project area of influence, including key stakeholder groups, state of development, government support, development assistance, etc.
- Socioeconomic baseline of project-affected communities
- A summary of the assessment of the key expected environmental and social impacts on small-scale and artisanal fisheries within the project area of influence
- A summary of the social assessment of the affected small-scale and artisanal fisheries, including a description of livelihood systems and fishing, processing, and marketing activities

- Proposed fisheries livelihood restoration strategy and component programs. In addition to fisheries activities (catch, post-harvest processing, and sale), the strategy may include programs addressing health, safety, security, project-induced change, etc.
- Component programs to include objective, rationale, target group, definition of eligibility, participation rates, etc.; description of component activities; monitoring requirements; schedule; budget; resources

4. SCHEDULE

It is anticipated that the development of the fisheries livelihood restoration plan will take X months to complete. [Indicate timeline for each project deliverable].

5. REQUIREMENTS

The Consultant/Organization shall submit the following to the Company to be considered for the assignment:

- proposal;
- scope of social assessment;
- actions;
- deliverables;
- timeline;
- budget; and
- personnel with clarity on support required from Company.

6. QUALIFICATIONS

The Consultant/Organization shall possess the following skills:

- experience in planning and implementing social assessment, socio-economic surveys and multi-stakeholder engagement processes;
- experience in developing environmental and social impact assessment (ESIA); environmental, social and health impact assessment (ESHIA); social impact assessment (SIA); resettlement action plan (RAP); strategic community investment; integrated development planning and implementation; etc.;
- experience within sector and within region and country preferred;
- ability to provide a multisectoral team with expertise in the following areas: anthropology, social sciences, health, economics, governance, and organizational development, etc.; and
- ability to meet Company time frame.

7. RESOURCES

Company will make available relevant documentation and also facilitate logistics to the extent it involves access to and around project location. In addition, the Consultant is referred to the following:

IFC 2014, "Addressing Project Impacts on Fishing-Based Livelihood, Baseline Assessment and Development of Fisheries Livelihood Restoration Plans," Environment and Social Division, CommDev, Washington, DC.

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The decision to develop this handbook followed an informal exercise to collate IFC experience with projects impacting fisheries and fisheries-based livelihoods and the recognition of the challenges associated with assessing these impacts and designing appropriate mitigation strategies. Revision of the IFC Performance Standards, particularly PS5, Land Acquisition and Involuntary Resettlement, and PS6, Biodiversity Management and Sustainable Management of Living Natural Resources, recognizing access to natural resources and their value as ecosystem (provisioning) services supporting livelihoods gave further impetus to the development of the handbook.

Robert Gerrits is the primary author of this handbook. The environmental dimensions of lake, river, and marine systems (Chapter 2), the assessment of a project's environmental impacts (Chapter 5), and potential management strategies of managing such environmental impacts (Chapter 6) were written by Mark Pedersen. Case studies and photographs were contributed by IFC environmental and social specialists and external experts. The views expressed in the document are those of the authors only.

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