A Review on the Causes for the Loss of Major Fishes and Prospects for Future Research in Ethiopia

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Abstract
This paper is aimed in reviewing major causes and losses on fish population in Ethiopia and set a future scenario. Rapid declines threaten the persistence of many marine fish population now days. Reductions in fishing pressure, although clearly necessary for population recovery, are often insufficient. Persistence and recovery are also influenced by life history, habitat alteration, changes to species assemblages, genetic responses to exploitation, and reductions in population growth attributable to the Alley effect. Heightened extinction risks were highlighted recently listed as endangered, on the basis of declines as high as 99.9% over 30 years. Failure to prevent population collapses, and to take the conservation biology of marine fishes seriously, will ensure that many severely depleted species remain ecological and numerical shadows in the ecosystems that they once dominated. Currently, however, about 25% of world fish stocks are overexploited or fully depleted and overcapacity in fishing fleets is the norm rather than the exception. Indeed, many experts agree that the exploitation limit of marine resources has been reached, if not exceeded, and that this overcapacity of fleets, excessive fishing quotas, illegal fishing practices and the generally poor management of most fisheries are to blame, Habitat destruction, pollution, climate change and invasive species also have an impact upon fish populations. Also, a changing environment affects stock abundance, and some stocks experience collapse from environmental causes alone. In many instances, it is quite difficult to determine the main causes of the depletion of fish stocks. Although the review concentrate in Ethiopia on overfishing of fisheries depletion and collapse, the depletion of global fish stocks cannot be attributed to fishing alone. Many scientists have done research, recommended and directed to focus on the prevention of fish losses and the sector scientists and government to discuss on the issue and set a sustainable fish management policies and Laws on future concerns.
Keywords: biodiversity loss, Conservation, fish loss, population ecology.

1. INTRODUCTION

In many parts of the world, fish is one of the important components of human diet. Due to this reason, fish catch from natural water bodies increased highly. This fact can tell us the need of studying the fish stocks in the natural water bodies especially the commercial fishes to manage them in an optimum way. Losses in fisheries include natural and fishing material losses of fish due to spoilage, breakage, size, discarding by catch and operational losses. Although the extent of problem varies from place to place, the country as a whole loses huge quantities of fish after capture before it reaches to consumers. The need for assessment is a first step towards overcoming losses and defining solutions to the existing problem.

The main reasons for losses were the fishing method, inadequate handling facilities and delay between catch, collection and distribution, absence of regulations governing quality and standards of fish to be sold for human consumption, lack of regular supervision from the government side and poor extension service and fragmentation of duties and responsibilities in different institutions. Nevertheless, the protection of marine and coastal areas, and habitat restoration should not be seen as solutions replacing conventional management approaches, but need to be components of an integrated program of coastal zone and fisheries management.

Ethiopia is a land-locked country which depends on its inland water bodies for fish supply for its population. The country's water bodies have a surface area estimated at 7334 km2 of major lakes and reservoirs, and 275 km2 of small water bodies, with 7 185 km of rivers within the country. Ethiopia has an estimated fishery resources potential of about 40,000 tons per year. This potential source can grouped under two categories i.e. Lakes fishery and riverside fishery.

According to federal fishery resource development information the average annual production of fish by species was 15,000 metric tons.

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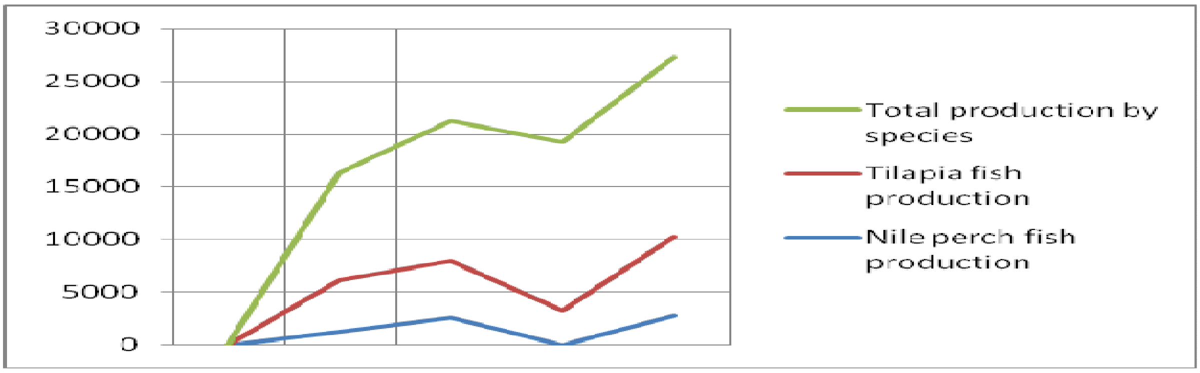

Figure: Total production of fish from inland water bodies, from 2007-2010 Mt

Ethiopia though endowed with abundant fishery and other resources and development potentials the country is with rampant socio-economic problems. Poverty and the resultant food insecurity have been threatening millions of citizen in different parts of the country for decades. As a result, the country has experienced inter linked poverty situation that challenges development efforts of government and its partners. These problems of development are manifested in the form of food insecurity, malnutrition, poor health, low agriculture production and productivity, unemployment, low income, high illiteracy rate, gender inequalities, harmful traditional practices, manmade and natural catastrophes and so on. Habitat alteration and destruction are generally the major causes of most extinction of freshwater fishes (Thomas 1994).

So as to mitigate the multi faceted development problems of the country, the government of Ethiopia together with its development partners has made a concerted effort in formulating development policies and strategies like the current five year Growth and transformation plan. Different actors of development are also contributing their part under the framework of government development endeavor. Role of habitat structure in marine ecosystems Emergent structures, such as rocky outcrops, boulder shoals, epibenthic reef formations (e.g. coral, sabellid, vermetid and oyster reefs), vegetation (e.g. seagrasses, salt marsh, mangroves, kelp and other macroalgae) as well as other topographic features (e.g. shell, burrows, biogenic structures and depressions), provide heterogeneity and structural complexity in marine benthic environments. The structural framework provided by emergent features constitutes an important organizing feature of many ecological systems and is critical to the functioning of the ecosystem as a whole (Ryder & Kerr 1989; Peters & Cross 1992).

Emergent structures represent important habitat for a variety of marine organisms, including a number of commercially and recreationally valuable fisheries species. Fishery in Ethiopia is predominately artisanal currently involving 15000 fishers (of which 5,000 were full timers), fishing from boats, with some 17240 net and 28000 hook gears. Gears in use range from a variety of traps and spear to gillnet, and hooks on hand (FAO-2004).

1.1 THE GLOBAL OVERVIEW

Conservation of biodiversity implies knowledge of the number and distribution of species of any Particular area. As habitat degradation continues on a global scale, maintenance of species richness has become a central issue of conservation biology. This is particularly the case with the fish fauna of inland waters. Fish communities differ per water body, hence site-specific management is important in fishery biology and fish biodiversity conservation. In the past fishery biologists, particularly those working in tropical countries, traditionally have tended to consider fish in isolation, as a natural renewable resource, rather than as integral components of the aquatic ecosystem interacting with other components of the system. This attitude has led to various ecological disasters, therefore, a better understanding of the role of fish diversity in the functioning of ecosystems should be a Precondition before manipulation of inland waters is undertaken (Lévêque 1995).

In Ethiopia the rate of degradation of the environment, mainly by deforestation and overgrazing of grasslands by cattle, is very high (Zinabu Gebre-Mariam 2002) and leads to approximately 1.5 billion tons of soil lost every year from the highlands (Tefera 1994). This has already resulted in a decrease in biodiversity of the fish fauna in the different drainage basins and the Rift Valley Lakes. Getahun and Stiassny (1998) compared the number of fish species reported in five drainage basins and the Rift Valley Lakes during the period 1835 to 1995 on basis of literature with the number of species collected during their own surveys during 1995-97. They reported a reduction in species numbers for each of the drainage basin varying from 40-85% and a reduction of species numbers for the Rift Valley lakes as a whole of ca. 65%. Until the late 19th century, the fish resources of the world's vast oceans were thought to be essentially inexhaustible, even by the most prominent biologists [Smith, 1994].

The objective of review

- ✓ To review and give an overview on the fish species loss and solutions to threats of biodiversity and for possible future management measures.

2. DEGRADATION OR LOSS OF HABITAT STRUCTURE IN ETHIOPIA

Fisheries Management and Ecology, the potentially slow recovery of impacted ecosystems, as well as the frequency of occurrence over time (heavily fished areas may be impacted many times in a year), directly attributable to fishing far exceed the effects of other disturbance agents (e.g. waves, tidal currents, bioturbation processes, and anthropogenic processes such as dredging and extractive activities). Nevertheless, few studies have considered the effects of fishing on the physical modification of habitat structure and the potential implications for associated faunal communities. Likewise, there is little information concerning how, and to what extent, changes in habitat structure affect fisheries resources and contribute to fisheries declines. Habitat degradation or loss as a result of fishing remains the least understood of the environmental impacts of fishing (Committee on Fisheries, Ocean Studies Board, National Research Council 1994, cited in Auster et al. 1996).

Because of the inadequate data which are available to address the specifics of the complex ecological interactions involved, it is rarely possible to predict or quantify the potential loss to fisheries production caused by the degradation or loss of habitat structure. An understanding of the extent of this impact, and its effect on populations of marine organisms (both target and non-target species), is essential if fisheries are to be strategically managed by setting appropriate levels of fishing effort which will maximize fisheries production, and therefore, yield. The extent of fishing activities is potentially extremely large, often leaving few, if any, undisturbed habitats within impacted areas. As well as effects on habitat structure per se, there are important implications on a larger scale with regard to effects on habitat heterogeneity, or the patchiness of habitats, across a landscape. As a landscape becomes fragmented, with reduced physical structure occurring between habitat units, movement of adults, recruits and larvae between habitats becomes impeded. Reductions in heterogeneity over large spatial and temporal scales have implications for the maintenance of diversity and stability at the population, community and ecosystem level (Thrush, Hewitt, Cummings & Dayton 1995).

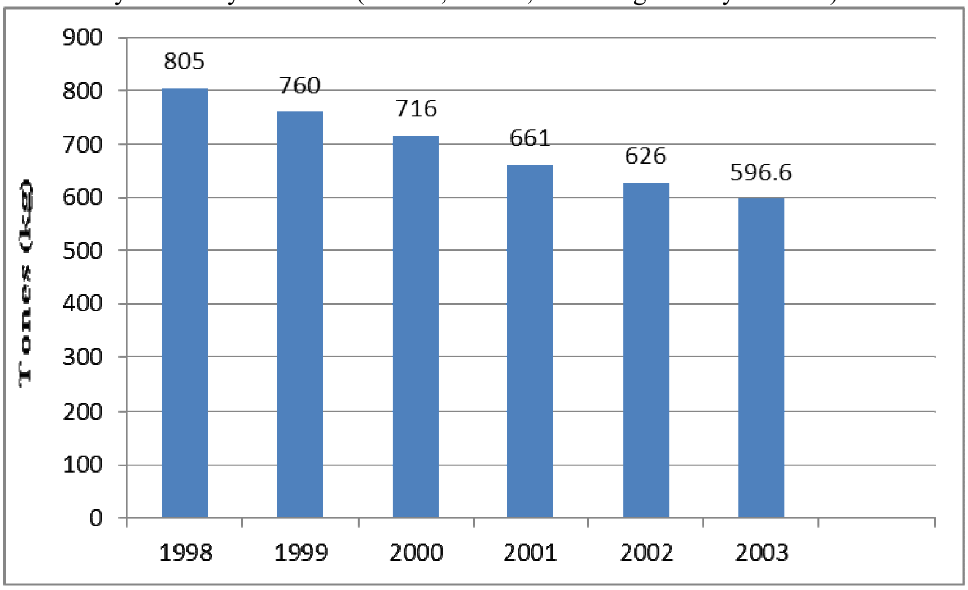

Figure 2: the diminishing trend of tilapia production

Furthermore, as more and more of the habitat structure and the associated communities are destroyed, sources of larvae recruiting into disturbed areas from adjacent habitats will decline, and the recovery-time for biological communities (both habitat-forming species as well as associated species) in these impacted areas will progressively increase. The primary pollutants; sediment, fertilizer, human sewage, animal waste, pesticides, heavy metals (EPA, 2001).

2.1 The relationship of marine ecosystem and humans

Biodiversity is the variation in the genetics and life forms of populations, species, communities and ecosystems. Biodiversity affects the capacity of living systems to respond to changes in the environment, and is essential for providing goods and services from ecosystems (e. g., nutrient cycling, clean water). As well as having intrinsic value, biodiversity has aesthetic value: many of us have admired the wonderful colours and shapes of fishes on coral reefs and in other coastal habitats. Some benefits of biodiversity are not apparent today but may be unlocked in the future (known as the option value): compounds derived from marine animals and plants may serve as medicine to prevent and cure more of our ills in the future. Biodiversity also has cultural value when it is directly linked to the cultural fabric of human societies. Moreover, biodiversity is important for the future sustainability of marine natural resources that include commercial fisheries. Fisheries that exploit a range of species may have more stable catches than fisheries that exploit a single species. A high genetic diversity within a fish population may protect it against environmental stressors (e. g., climate change, pollutants) and the spread of diseases. International agreements give a chance to countries have to manage their natural resources in ways which conserve both the resource and biodiversity (e. g., Biodiversity Action Plans for the Conservation of Natural Resources, Agriculture and Fisheries4-6). Here we summarize risks to the biodiversity in Ethiopian fish resources loss and recommend ways how existing fish diversity can be conserved, restored and managed.

2.2 Significances of fish resources

The scope of human dependence on marine life is significant, both in terms of the nutritional value provided by fish and other seafood to populations (especially in the developing world) and in terms of the level of economic security the fishing industry provides for coastal communities. Marine biodiversity, in itself, also offers tangible benefits to society, via revenues earned from tourism as well as by providing useful ecosystem services, such as the maintenance of water quality [Stokstad, 2006]. Currently, however, about 25% of world fish stocks are overexploited or fully depleted and overcapacity in fishing fleets is the norm rather than the exception [FAO, 2007:29]. Indeed, many experts agree that the exploitation limit of marine resources has been reached, if not exceeded, and that this overcapacity of fleets, excessive fishing quotas, illegal fishing practices and the generally poor management of most fisheries are to blame [Rebufat, 2007:5-6].

Overfishing occurs when fish are being caught faster than they can reproduce and replace themselves. Overfishing can affect biological diversity. Biodiversity is the diversity of living things, and can be thought of as occurring on three levels: genetic, species, and ecosystem. Genetic diversity is the genetic variability that occurs among members of the same species. Species diversity is the variety of species found in a community or ecosystem. And ecological diversity is the variety of types of biological communities. An additional means of categorizing biological diversity is functional diversity; the variety of biological processes characteristic of a particular ecosystem. (Thorne-Miller&Catena, 1991, p10)

Although we concentrate here on overfishing as a cause of fisheries depletion and collapse, the depletion of global fish stocks cannot be attributed to fishing alone. Habitat destruction, pollution, climate change and invasive species also have an impact upon fish populations. Also, a changing environment affects stock abundance, and some stocks experience collapse from environmental causes alone. In many instances, it is quite difficult to determine the main causes of the depletion of fish stocks. For example, On Lake Chamo, the 'gancho' net has caused the rapid depletion of Nile perch stocks (Amha & Wood, 1982).

3. MAJOR LOSSES OF FISH POPULATION

As the fishing industry expanded and technology made larger catches possible and more areas of the ocean exploitable, the received wisdom that fisheries were inexhaustible soon became discredited. The inland water body of Ethiopia is estimated to encompass about 7,400 km2 of lake area and a total river length of about 7,000 km. As many other countries challenged in the world, population rise urbanization, agricultural development, industrialization and other water resource development activities have resulted in a decrease in the species diversity of freshwater fish species (Dereje, 2014).

Fish are a common pool resource, meaning that it is difficult to exclude users and that exploitation by one user reduces the resource availability for others [Ostrom et al. 1999]. Common pool resources are found when a system of individual property rights is insufficient for sustainability or too costly to implement [Bromely, 1991].

Furthermore, in many cases, especially in long-distance fisheries and in developing countries, they are effectively an open access resource, meaning that a system of property rights is completely absent and thus the fish can be caught by anyone. Consumption of food fish is increasing, having risen from 40 million tonnes in 1970 to 86 million tonnes in 1998 (FAO, 2000),).

There are of six fish species whose production is decreasing and diminishing potential which are Nile Tilapia (Oreochromis niloticus (L.)), African Catfish (Clarias gariepinus (B.)), African big barb (Barbus intermedius (R.)), Small barb (Barbus paludinosus (P.)), the Cyprinid (Gara quadrimaculata ((R.)) and the Cyprinodont (Aplocheilichthyes antinori (V.)) (Elias Dadebo, 2000).

Fish kills may result from a variety of causes. The main causes for fish loss are:

- Natural and
- Fishing losses.

3.1. Natural losses

3.1.1. Natural ecosystem destruction

Fish assemblages in rivers are influenced by a biotic factors and ecological processes that operate at multiple spatial scales.

In the face of environmental change, the loss of genetic diversity weakens a population's ability to adapt; the loss of species diversity weakens a community’s ability to adapt; the loss of functional diversity weakens an ecosystem's ability to adapt; and the loss of ecological diversity weakens the whole biosphere’s ability to adapt. Because biological and physical processes are interactive, losses of biological diversity may also precipitate further environmental change. This progressively destructive routine result in impoverished biological systems, which are susceptible to collapse when faced with further environmental changes. (Thorne-Miller and Catena, 1991, p. 10).

3.1.2 Invasive species

It can be accepted, without any stimulation that introducing non-native (alien) forms and species of fishes present grave risks to the native species, including their genetic characteristics, as well as to other aquatic biota (Allendorf 1991,Crivelli 1995, Elvira 2001).

The successful invasion of a marine ecosystem by vertebrate predators is exceedingly rare. Nevertheless, one such invasion is currently unfolding. The ambush predators consume a wide variety of native fish and invertebrate species at high rates, and are well defended from predation by venomous fin spines.

Figure: Invasive species diminishing the lake area/lake Hawassa/

Species invasions have altered ecological communities worldwide, but impact can vary greatly among species and habitats (Williamson and Fitter 1996; Melbourne et al.2007).

Introductions often alter food webs through new interactions with indigenous species, making it difficult to predict invasion effects (Vander Zanden et al. 1999; Bruno et al. 2005). Species introductions are commonly associated with negative effects on native species through predation, or competition for food or habitat (Mack et al. 2000; Mills et al. 2004; Hermoso et al. 2011). They can also benefit native species by becoming an important prey source (King et al. 2006) or through habitat modification or competitive or predatory release (Rodriguez 2006).

Freshwater ecosystems and fish taxa are particularly affected by introductions (Marchetti et al., 2004a; Clavero & Garcı´a-Berthou, 2006).

Introductions of alien fish species are an important part of human activities concerning aquatic ecosystems. At present, such species are considered one of the major causes of erosion or devastation of the native fish biodiversity in freshwater ecosystems (Riberio et al. 2008).

The first and most significant consequences of introduction of an alien fish species become the native species. The function of introduced fish species as hosts of various parasites and diseases, followed by losses among native fish species, is well Documented (e.g. Stewart1991, Keith & Allardi 1997).

The nonnative species are also often blamed for predation on eggs and fry of native ones and due to that decrease of their reproduction success.

The term ‘invasive alien species refers to non-native species, subspecies, race or variety (including gamets, propagules or part of an organism that might survive and subsequently reproduce) that does not occur naturally in a geographic area, i.e. that did not previously occur there and then spread, with or without the aid of humans, in natural or semi-natural habitats, producing a significant change in composition, structure, or ecosystem processes, or caused severe economic losses to human activities (Copp et al. 2005).

3.1.3 climate change

Climate change poses significant threats to fisheries on top of many other concurrent pressures such as overfishing, habitat degradation, pollution ,introduction of new species and so on (Brander, 2010).If we are facing global warning, with impacts on the ocean environment, overfishing may further fortify effects of changes in the ecosystem structure and of invasive species. The above evidence suggests that, instead of managing the risks related to fisheries depletion predominantly on a species by species, or a population by population basis, there needs to be a greater emphasis on ecosystem level measures that guard the overall productivity of the ecosystem. The North Pacific Fishery Management Council has responded to some of the problems with single stock management by adding specific regulations. One is that a cap is set for total catches in each of two defined ecosystems in federal waters off Alaska. The cap for the Eastern Bering Sea has restricted the single stock quotas several times; each time when the added single stock quota limits has exceeded the cap. Another response to ecosystem concerns is that it is generally forbidden to catch fish that are prey for other fish in these waters [Witherell et al, 2000].

Several authors have stated that marine fish are likely to be less affected by an increase in oceanic CO_2 and a corresponding decrease in pH compared with invertebrate groups, such as molluscs and corals (Feely *et al*., 2004; Orr *et al*., 2005; Fabry *et al*., 2008). However, laboratory studies have revealed that manipulation of pH and CO_2 can have dramatic consequences on the physiology, metabolism, and reproductive biology of fish, with egg fertilization and survival of early developmental phases being primarily affected (Ishimatsu *et al*., 2005).

Climate change will affect a range of abiotic factors that are tightly linked to the production and distribution of fish populations, and these climate-driven biotic changes will likely differ between the Open Ocean, shelf seas, and coastal waters (Walther *et al*., 2002; Lehodey *et al*., 2006)

Resolving the effect of climate change on fish populations is complicated, because climate change affects a multitude of environmental factors that may affect various processes at different levels of biological organization (Harley *et al*., 2006; Lehodey *et al*., 2006; Tasker, 2008). For example, even if the effect of changes in an environmental factor on the physiology of an organism is known, it will be difficult to evaluate the outcome of this organism-level physiological response at the population or ecosystem level (MacKenzie and Köster, 2004). Statistical analysis of available time-series revealed changes in distribution and abundance of fish species that correlate with environmental variables (Perry *et al*., 2005; Weijerman *et al*., 2005; Heath, 2007). However, statistical correlations do not necessarily indicate underlying processes (Köster *et al*., 2005).

Natural climatic fluctuations, particularly those at medium (decadal) scale, have always affected fisheries as well as their management performance (Garcia and Rosenberg, 2010).

The atmosphere and the ocean will continue to warm over the next 50–100 years, sea level will rise due to thermal expansion of water and melting of glaciers, ocean pH will decline (become acidic) as more carbon dioxide is absorbed, and circulation patterns could change at local, regional and global scales (Bindoff et al., 2007 in Munday et al., 2008)

Though climatic change consequences are often difficult to distinguish from damage caused by overfishing and pollution, these climatic changes are having impacts on aquatic ecosystems (IPCC, 2007a).

3.1.4 Water Pollution losses

Of known natural causes, fish kills are most frequently caused by pollution from agricultural runoff or biotoxins. Ecological hypoxia (oxygen depletion) is one of the most common natural causes of fish kills. The hypoxic event may be brought on by factors such as algae blooms, droughts, high temperatures and thermal pollution. Many studies have found that deterioration in water quality (e.g. salinity, dissolved oxygen, turbidity, and pH) is a major factor in species losses from drying streams and isolated floodplain habitats (Rodriguez and Lewis 1997; Magoulick and Kobza).

3.1.5 Disease and parasite loss

Fish kills may also occur due to the presence of disease, agricultural and sewage runoff, oil or hazardous waste spills, hydraulic fracturing wastewater, sea-quakes, inappropriate re-stocking of fish, poaching with chemicals, underwater explosions, and other catastrophic events that upset a normally stable aquatic population. Because of the difficulty and lack of standard protocol to investigate fish kills, many fish kill cases are designated as having an 'unknown' cause. An algae bloom is the appearance of a large amount of algae or scum floating on the surface of a body of water. Algae blooms are a natural occurrence in nutrient-rich lakes and rivers, though sometimes increased nutrient levels leading to algae blooms are due to fertilizer or animal waste runoff. A few species of algae produce toxins, but most fish kills due to algae bloom are a result of decreased oxygen levels. When the algae die, decomposition uses oxygen in the water that would be available to fish.

Growth overfishing occurs when fish are harvested at an average size that is smaller than the size that would produce the maximum yield per recruit. A recruit is an individual that makes it to maturity, or into the limits specified by a fishery, which are usually size or age.

This makes the total yield less than it would be if the fish were allowed to grow to an appropriate size. It can be countered by reducing fishing mortality to lower levels and increasing the average size of harvested fish to a size that will allow maximum yield per recruit.

3.1.6 Temperature change

In later (juvenile and adult) life stages, individual fish can clearly respond to a change in temperature (Woodhead, 1964; Berghahn, 2000) and often exhibit active temperature preference (Tsuchida, 1995). Some elasmobranchs are extremely sensitive to temperature variation (e.g. they can respond to changes of <0.001°C; Brown, 2003) and some sharks move to deeper water before the onset of severe storms (Heupel *et al*., 2003).

Naturally, even for individuals in these later life stages that have strong swimming capacity, knowledge of the location of optimal habitats will not be perfect. Field studies on thermal habitats revealed that fish may inhabit and occupy areas with suboptimal temperatures even if areas with more optimal temperatures are within reach (Neat and Righton, 2007), but optimal habitats will also be determined by other factors such as food. Behavioural changes can have unexpected consequences. For example, because of an increase in temperature, fish swimming speed increases (Peck *et al*., 2006).

In addition, fish can behave differently in response to oncoming fishing gear making them more (or less) vulnerable to capture (Winger, 2005).

Finally, at longer temporal scales, climate-driven changes in temperature can modify the phenology of annual migrations to feeding and/or spawning grounds, as already observed (Carscadden *et al*., 1997; Sims *et al*., 2004), and predicted (Huse and Ellingsen, 2008), for temperate marine species.

It can be inferred that the behavioural response to changes in environmental conditions will depend on the rate of change and/or the spatial scale over which conditions change relative to fish body size or developmental stage because the capacity for avoidance responses increases with increasing body size. Small-scale fisheries and aquaculture have contributed little to the causes of climate change but will be amongst the first sectors to feel its impacts. Some anticipated consequences include falling productivity, species migration and localized extinctions, as well as conflict over use of scarce resources and increased risks associated with more extreme climatic events such as hurricanes. These result from direct impacts on fish themselves as well as from impacts on the ecosystems on which they depend, such as coral reefs. In general the consequences of climate change will be negative for fishers at low latitudes. In contrast, fish-farmers may benefit from expansion of the areas where aquaculture is viable due to increased temperatures and rising sea levels. However, these benefits may be tempered by reduced water quality and availability, increased disease incidence and damage to freshwater aquaculture by salinization of groundwater. The precise and localized impacts of climate change on fisheries are, however, still poorly understood (FAO, 2008a; WorldFish Center, 2007a; Stern, 2007).

All marine and aquatic invertebrates (molluscs, crustaceans, worms etc.) and fish are poikilotherms; their internal temperature varies directly with that of their environment. This makes them very sensitive to changes in the temperature of their surrounding environment. When changes do occur they move to areas where the external temperature allows them to regain their preferred internal temperature. This "behavioural thermoregulation" (Roessig *et al.*, 2004) is resulting in rapid migrations pole ward or into cooler bodies of water (FAO, 2008a).

3.2 Fishing losses

3.2.1. Fishing nets loss

Fish fishing nets left or lost in the ocean by fishermen – ghost nets – can, crocodiles, seabirds, crabs and other creatures. These nets restrict Fishing nets left or lost in entangle fish, dolphins, sea turtles, sharks, dugongs the ocean by fishermen – ghost nets – can entangle fish, dolphins, sea turtles, sharks, dugongs, crocodiles, seabirds, crabs and other creatures. These nets restrict movement, causing starvation, laceration and infection, and, in animals that breathe air suffocation..

Figure: over fishing with fish nets/lake hawassa/

3.2.2 Overfishing

Overfishing poses serious risks as the loss of marine biological diversity can have serious consequences for the stability of marine and coastal ecosystems. Biological extinction from a directed fishing effort is extremely rare because economic extinction (i.e., the fish becoming too rare to fish profitably) usually happens well before biological extinction. However, overexploitation of the target fish population can lead it to become depleted to the point where it cannot recover because the depletion of the fish stock often involves other ecological changes. Fishing can also change trophic relationships through changing the relative abundance of predators, prey, and competitors as well as the genetic make-up of populations [ICES 2006].

Today, fish is the only important food source that is still primarily gathered from the wild rather than farmed—with marine capture historically accounting for >80% of the world's fish supply. Total landings from marine fisheries increased ~5-fold in the 40-year period from 1950 to 1990 Mace, 1997).

Figure: fishes damped at landing site as a waste/lake Abaya/

More recently, however, capture fisheries have not been able to keep pace with growing demand, and many marine fisheries have already been over-fished. In the period 1990–1997, fish consumption increased by 31% while the supply from marine capture fisheries increased by only 9% (FAO, 1999).

This has intensified the pressure on the harvesters, which has translated into increased pressures on, and over-fishing of, many commercial fisheries. Nearly half of the known ocean fisheries are completely exploited (FAO, 1999), and 70% are in need of urgent management (MacLennan, 1995).

3.2.3. Harvesting and management losses

A chain of harvesting and management fish losses are:

- losses during fishing losses
- from fishing ground to the landing site
- losses at the landing site/sales of fresh fish
- losses during transportation of fish
- losses during packaging and storage
- losses during marketing

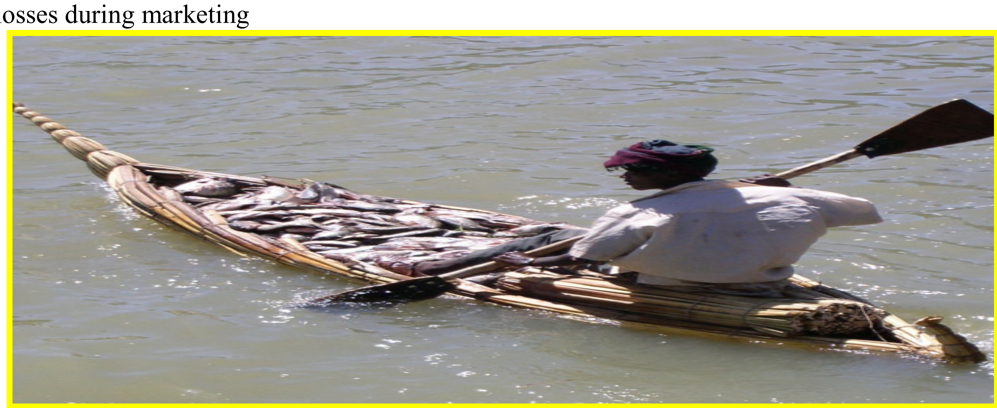

Figure: everyone harvesting in the lakes/lake chamo/

General solutions to overcome and reduce fishing losses

- Use authorized fishing methods.
- Go fishing with enough ice and insulated containers for the trip.
- Do not set nets or gear in the water for long periods of time.
- Pack fish in an insulated container with enough ice as soon as it is caught.
- Use good quality ice and use good icing practice.
- Don't delay getting back to landing site after fishing.
- Don't leave fish exposed to the sun.
- Handle the fish with care and don't throw or drop the fish.

• Prevent the fish from being contaminated with dirt, fuel and any other harmful substances.

4. Formulation of the national aquaculture development strategy

The constraints could also be regarded as the principal issues, the critical success factors or the essential elements to be addressed in a sustained manner for a smooth take-off of the aquaculture industry in Ethiopia. The major amount of aquaculture production in the country at the moment is from the stocking and harvesting of reservoirs. Therefore, culture based fisheries was included in the analysis although not in its entirety.

The constraints identified relate to the following issues; availability and access to inputs, training, education, capacity building, extension/outreach services and research. Other critical constraints listed for redress concern fish health management, gender, access to land or aquaculture zones by enterprises, industries and fish farmers, legal and regulatory frame work, improved marketing of fish, public-private partnerships in aquaculture development, public awareness creation about the potentialities of aquaculture, policy issues, monitoring, control and evaluation of industry.

The critical success factors or constraints were the first issues to be identified followed by the interventions required to address each of them to develop aquaculture in Ethiopia. At several follow-up meetings, the list of constraints and interventions were reviewed until a final list was agreed upon for the preparation of the draft strategy.

A stakeholder consultative workshop will held seasonally to present and adopt the draft strategy. The stakeholders were selected to reflect the different interests involved in aquaculture management and development. Their views and recommendations were incorporated in updating the draft strategy. Government, represented through its ministries, departments and agencies, was identified as a major public stakeholder whose policies, activities and decisions are very crucial.

5. Conclusions and recommendations

In spite of the large aquatic resources of social, ecological, genetic, environmental and economic values in the region, the research and development effort for conservation, development and management so far done is inadequate and uncoordinated. This situation may be due to inadequate attention by different stakeholders. Policy-makers, development actors, researchers, funding agencies, higher learning institutions and the public lack awareness of the nature of the aquatic systems and the resources they contain. As a result, there is virtually inadequate scientific information on the aquatic ecosystem and wetland resource base used by different stakeholders for different purposes. The unpracticed and fragmented aquatic ecosystem and wetland use policy in terms of conservation, management and development in an effective way on the available resource base is also a serious problem that requires adequate attention by the different stakeholders. If captured fishery and aquaculture are developed and sustained, the important contribution to food security and poverty reduction is enhanced. The aquatic ecosystems that support these resources need to be managed and maintained. In the face of growing pressure from diverse human interference on the aquatic resources as stated earlier, better information on the role of these ecosystems in sustaining capture fishery and developing aquaculture is required. Efficient use of this information in policy processes, development, management, researches and conservation at different levels may mitigate the existing situation.

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