The Role of Fishery Methods in Conservation and Management of Aquatic Systems

Idowu Eunice Opeyemi
Oyeniran Babatunde Hezekiah
Odeyemi Dolapo Funmi
Jack Josphine

Ekiti State University, Ado Ekiti, Nigeria

Abstract. The aquatic environment houses a wide range of living creatures; many of which are yet to be understood or even discovered. One of the most common of these living creatures is fish. This work describes the role of fishery methods and governance in conservation and management of aquatic systems. The management and the conservation of the aquatic environment are hinged on the employment of sustainable practices such as technical measures, size selectivity of target species,, spatial and temporal controls on fishing, control of fishing gear on habitat, energy efficiency and poison control, fishing mortality control and catch control by the stakeholders in fishery. These also include the Government and everyone who is a beneficiary of the aquatic system directly or indirectly.

Key words: fishery methods, conservation, management, governance, sustainability.

Introduction

Fishes are abundant in most bodies of water. They can be found in nearly all aquatic environments, from high mountain streams (e.g. Char and gudgeon) to the abyssal and even hadal depth of the deepest oceans (e.g. gulpers and angler fish). With about 33,100 described species, fish exhibit greater species diversity than any other group of vertebrates (Froese and Pauly, 2020). The human societies had long been depending upon aquatic biodiversity for food, medicine and other uses including commercial and industrial nature. In recent times, the factors like over-exploitation, pollution, habitat alteration, destruction and introduction of alien species etc., are overwhelmingly causing impacts and threats to aquatic biodiversity which very much includes fishes. There is necessity to put in place appropriate conservation strategies and actions to safeguard the aquatic biodiversity for the benefit of the present, as well as, future generations. The term “fisheries” is often used broadly to include “fisheries and aquaculture” (Safran, 2014: 24).

Harvesting of aquatic resources and production is done either in the wild or in controlled environments (aquaculture), both use a large variety of technologies - from artisanal to highly-industrial - encompassing vessels and equipment as well as fishing gears and methods. For both capture fisheries and aquaculture, the technological development and widespread use of synthetic fibers, hydraulic equipment for gear and fish handling, electronics for fish finding, satellite-based technology for navigation and communications, onboard conservation and increased use of outboard engines have all contributed to the major expansion of fisheries and aquaculture in recent decades particularly in small-scale fisheries. Technical advances have generally led to more efficient and economical fishing operations, reduction of the physical labour required per unit of output and improved access to resources. Where management has been ineffective, the greater efficiency of fishing methods and aquaculture production has sometimes led to overfishing and environmental degradation (Olden, 2016: 107-148).

Fishing operations need to emphasize policy reform, explicit environmental, community considerations, strengthening of institutions, research and training. However, developing countries like Nigeria with pressing concerns, such as food security and poverty reduction, should also be thinking about the sustainability of their natural resources. Human population is increasing at the rate of about 7.5 million per year and the major population increase occurs in the under-developed world, an area that holds about 75% of the world population (Federal Department of Fisheries, 2003). With the present rate of increase in the world population is likely to double by the year 2020.

In Nigeria, the current demand for fish food is estimated at a little over 1,000,000 tons per annum as against a supply of about 800,000 tons per annum. The most bio-diverse ecosystems in the world are found in many coastal waters, and these require adequate and effective conservation, protection to enable both local and global benefits. The wealthy countries should give more attention and aid to these basic fisheries and aquaculture management issues in developing countries. However, too often, developed countries have their own agenda dictated by domestic politics and home-grown green or blue fashions, whereas governments of developing countries like Nigeria have to face up to tackling most of these problems themselves. If they fail, they will be risking not the just the health of their citizens but certainly the health of our “blue planet” as well from ancient times fishing (as a sport or business of catching fish and other aquatic living resources) has been a major source of high-protein food for humanity, particularly for lower income groups, and has had a significant impact on economic growth as a provider of employment and economic benefits by means of foreign exchange earnings to those engaged in this activity. The wealth of aquatic living resources was assumed to be an unlimited gift of nature (Safran, 2014: 24). For years the world lived with the thought that the ocean could replenish itself with around 100 million tons of fish annually. Overfishing, however, has led to a decline in fish catch. Now overfishing as well as the destruction of marine ecosystem is endangering the world’s food supply.

However, this review paper focused on reviewing possible solutions to the problems of extinction facing various fish species and the management of fishing practices either in the wild or in controlled so as to ensure the sustainability of the aquatic environment in Nigeria. The combined synergy effects of changes in the physical and chemical environment amounts to a deterioration in the quality of habitat for native taxa. Species tolerant of environmental change dominate biological communities, while native species decline. As habitat continues to be degraded under the socioeconomic pressures of development, the threats to the well-being of native organisms and ecosystems mount. Aquatic environments are home to countless species of fish and invertebrates, most of which are consumed as food. (Others are harvested for economic reasons, such as oysters that produce pearls used in jewelry). Seafood is respected all over the world, in many diverse cultures, as an important source of protein and healthy fats. For thousands of years, people have fished to feed families and local communities.

Demand for seafood and advances in technology have led to fishing practices that are depleting fish and shellfish populations around the world. Fishers remove more than 77 billion kilograms (170 billion pounds) of wildlife from the sea each year. Scientists fear that continuing to fish at this rate may soon result in a collapse of the world’s fisheries. In order to continue relying on the ocean as an important food source, economists and conservationists say we will need to employ sustainable fishing practices i.e. engaging in different fishery methods as shown in the figure below, that do not deprive forthcoming generations the opportunity of making use of aquatic resources. The challenge of achieving sustainability in fisheries requires consideration of ecological, social and

economic components whilst the biological sustainability of an individual fish stock underpins the flow of benefits from it, the wider ecological sustainability of the marine ecosystem is also necessary to ensure continuing productivity. Alternatively, a fish stock may be exploited sustainably, but the fishing fleet that targets it may be unprofitable and therefore economically unsustainable. Sustainability can be addressed at various levels, from local to international. Many fisheries issues need to be addressed at the global scale and a number of important international frameworks for managing fisheries have been developed over the last few decades (Olden, 2016: 107-148).

Effects of Crude Fishing Techniques

Aquatic biodiversity plays a vital role in rural livelihoods. However, it is being threatened by factors within the fisheries sector, such as overfishing, destructive fishing practices and introduction of alien species, as well as by external factors such as habitat loss and degradation mainly caused by land-based activities. Thus, the FAO Aquaculture Management and Conservation Service embarked on a programme aimed at constructing an inventory and valuation of inland aquatic biodiversity that is used by rural communities in natural and modified ecosystems with special emphasis on traditional knowledge, sustainable use, enhancement and gender issues (FAO, 2017:). Crude method was the main fishing technique used by traditional or local fishermen in catching their fishes from the water. However, both the technique and the fishing gears employed pose some hazards to the fishes, the aquatic environment and the society at large. The use of poisons or chemicals like Gamalin 20 and the poisonous leaves, roots and fruits of some toxic plants like Indian Kinotree (Pterocarpus marsupial) cause water pollution thereby making the water unsafe for human use. Consumption of fishes killed by poison also has lethal effects on the consumers i.e. it is harmful to consumers. By eating poisoned fish, the poison or toxic is directly or indirectly transferred to the consumer and if adequate medical care is not given, vital organs may be damaged and may eventually result in death. A pregnant woman that takes poisoned fish faces the likelihood of the unborn suffering from some congenital abnormalities e.g. cleft lip.

Effects of Modern Techniques

This method involves the use of sophisticated modern equipment as fishing gears. It includes the use of fishing nets with regulated mesh sizes, motor propelled machines, trawlers and ships for commercial fishing. With the use of these modern fishing equipment:

More catch is registered at faster rate leading to quicker depletion of fish population.

1. The fishes caught are safe for human consumption.

2. The purity or quality of water is not affected since the water is not polluted. Thus the water is safe for drinking and for other domestic uses.

3. Fishes can be stored for longer period and well preserved in mobile refrigerator fishing vessels.

Also poisoned water is very unsafe for drinking or for other domestic uses. The use of poisoned river for irrigation to agricultural farmlands also poses a potent environmental danger to the agricultural crops and the farmland. The use of hooks, spears, cutlasses inflicts physical damage on the fishes and this accelerates the rate of decay of the fishes as a result of bacterial invasion on the damage parts. The volume of catch is also reduced by the use of hook and line method. It is also time-consuming as fishermen have to spend a long time on boat only to catch few fishes.

The Role of Fishery Methods in Conservation and Management of Aquatic Systems

Technical measures

Most fishing gear affects marine life in one way or another. One major impact of gear is to remove the larger fish from a population and thus to change the size composition of the targeted species. In many fisheries, the gear also has an impact on non-target organisms (Cooke et al., 2016: 753-764). The consequences for the ecosystem can be severe. For example, discarding by-catch can often change the trophic structure of entire ecosystems with the encouragement of scavengers, as is seen in many shrimp fisheries around the world (Vörösmarty et al., 2010: 555-561). Size selective harvesting can, under some circumstances, lead to genetic changes in affected populations, such as changes in growth and in size and age at first maturity. Under EAF, these effects need to be considered more seriously (Winfield et al., 2016a).

Size selectivity of target species

Mesh size restrictions can be a useful measure to avoid capturing individuals of target species in the immature stages, but they have limitations in multi-species fisheries. When organisms of different shapes and sizes occur on the same fishing ground, immature individuals of a co-occurring larger species might still be captured (Olden, 2016: 107-148). When considering introduction of mesh size regulation in a trawl fishery, it is also important to consider the survival rate of the organisms that escape through codend meshes. If mortality is high, the anticipated benefit of larger meshes may not be achieved. Selectivity can be improved through a variety of methods other than mesh size, including the use of square mesh, sorting grids and other devices, which enable the unwanted portion of the catch to escape (Winfield et al., 2016b).

Fig. 1 and Fig. 2 are showing some examples of fishing crude techniques.

Fig. 1. Wheelk Pot (Source: Mike, 2015)

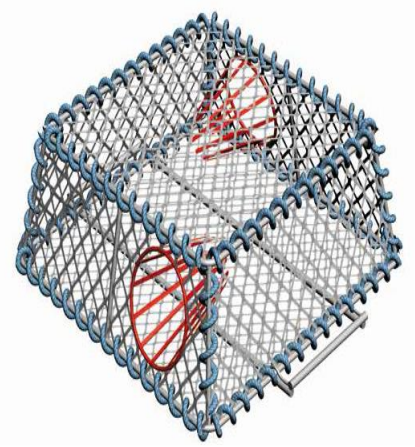

Fig. 2. Cuttlefish Trap (Source: Mike, 2015)

Figs. 3, 4 and 5 are showing some examples of modern fish techniques.

Fig. 3. Seine net (Source: Mike, 2015)

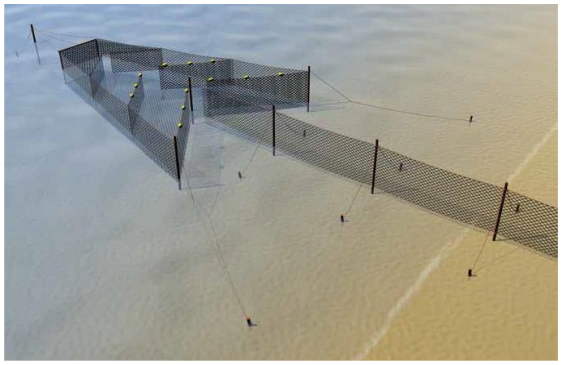

Fig 4. A Trap net (Source: Mike, 2015)

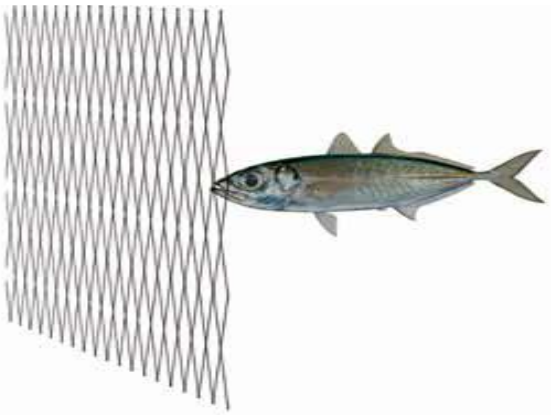

Fig. 5. Mechanism of action of Gill net (Source: Mike, 2015)

Spatial and temporal controls on fishing

Fishing mortality can be modified by restricting fishing activity to certain times or seasons, or by restricting fishing in particular areas. Such measures can be used to reduce the mortality rate of individuals of either target or non-target species in vulnerable life stages. Where stocks are shared by more than one country, the closures like other management measures must be coordinated. The selective reduction of fishing mortality rate on both target and non-target species generally reduces both the direct and indirect effects of fishing on the ecosystem (Fenichel et al., 2013: 223-233; Winemiller et al., 2016: 128-129). Closures may be used to protect critical habitats where fishing activity would otherwise cause damage to the physical structures supporting the ecosystem. These may also help to reduce mechanical disturbance to the benthos and facilitate the

establishment of more stable and structured communities (Frederico et al., 2016: 91-102; Winemiller et al., 2015: 361-398).

Impact control of fishing gear on habitat

Fishing gear that touches or scrapes the bottom during fishing operations is likely to produce negative impact on the biotic and abiotic habitats. Because only limited knowledge exists about the long-term effect of such impact, a precautionary approach is recommended in the use of high-impact fishing methods in critical habitats. Use of towed gear with reduced bottom contact is a technical option in such areas. Prohibition of certain gear in some habitats is another, e.g. trawling in coral reef and sea-grass areas. A third option is to replace a high-impact fishing method with one with less impact on the bottom, e.g. trapping, long lining or gillnetting (Sheath et al., 2015: 2235-2246; Vörösmarty, 2010: 555-561).

Energy efficiency and pollution control

Many modern fishing vessels use fossil fuel for propulsion, for operating the fishing gear and for the preservation and processing of the catch. The impact of exhaust gas emission of dangerous substances, including CO2, has been fully recognized, and technological innovations that reduce such emissions are encouraged. Energy optimization can be achieved through improved efficiency (Heino et al., 2016: 76-106).

Fishing mortality control

The direct effects of fisheries on ecosystems are to increase fishing mortality rate among target and non-target species and to affect habitat (Froese and Pauly, 2020). The fishery management methods that are used to control fishing mortality are often referred to as input and output controls. Input controls apply to capacity (which is closely related to the fishing mortality a fishing fleet could generate if the entire fleet were to fish full time) and effort (which is the actual amount of fishing activity) (Heino et al., 2016: 76-106). Output controls apply to the catches that result from the fishing effort. (Heino et al., 2016: 76-106).

Catch controls

Catch controls in the form of catch limitations are aimed to reduce fishing mortality on target species. If complemented with by-catch controls (such as quotas) they have the potential to protect associated species (Castello et al., 2015: 587-598). They have proven successful in some cases, including multi-species fisheries, but have sometimes also led to undesirable outcomes (high-grading, increased discarding, etc.). In terms of an EAF, however, in a mixed-species fishery, consideration needs to be given to the different vulnerabilities and productivity of the various species (Edeline et al., 2016: 519-532). It will be necessary to implement a set of consistent catch limits across the range of target and by-catch species to reflect these differences and addresses desired ecosystem related objectives (such as maintaining food webs). Catch limits for target species may need to be modified to control catches of more vulnerable species (Castello et al., 2015: 587-598; Cheung et al., 2007: 1-12).

The Role of the Government in Fisheries Management

Governance is the process of decision-making and the legal frameworks, structures and processes by which decision are implemented (or not implemented) (United Nations Economic and Social commission for Asia and the Pacific (UNESCAP, 2016). Governance is therefore largely about the politics of natural resource and how policy and management decisions are made and implemented (Béné and Neiland, 2006: 1834-1841). It relates to how people are involved in decision-making and how this affects their abilities to empower themselves and others and derive benefits from the process. Power,

and the way that power is distributed between different stakeholders, are key aspects of governance. Stakeholders include those directly involved in fisheries (the fishers, processers and fisheries departments) as well as those with a broader stake or interest in the outcomes of fisheries management including NGOs, policy makers and wider civil society (Acreman et al., 2014: 466-473). Poor governance is variously characterized by corruption and a lack of transparency, lack of participation by key stakeholders, a lack of accountability and lack of the rule of law (MRAG, 2010).

Governance is the most complex of the challenges because it is a human and a political challenge. Within any given fishery there are a range of interests at play and these interests may be variously supported and challenged by efforts to transform fisheries. Many of the key challenges also raise aspects of rights of access and entitlement, which are governance issues. Efforts to restrict or redistribute rights can be resisted by actors within the fishery and sustainability initiatives and the rhetoric of sustainability can even be deployed in support of these interests (MRAG, 2010). There is growing recognition that many of the policies, institutional and regulatory arrangements governing use of natural ecosystems and their resources have led to inefficient and inequitable allocation of these resources and loss of their benefits to people. As a result, there is growing investment in the development of more efficient policies and governance regimes for these natural resources, most noticeably of fisheries, forests and wildlife. This is particularly so in light of the processes of decentralization currently being pursued in many countries (UNDP, 2000). However, in many developing countries, policy-making and implementation systems for aquatic ecosystems and their resources are not clearly understood. Therefore, an urgent need to better understand these policy making processes as a basis for improved governance of these resources (Dugan, 2016: 1-12). Efforts to improve policies and systems of governance, and to strengthen institutions, will need to be grounded in a better understanding of how these policy-making processes function, how responsibilities for managing aquatic resources can be shared between government and community organizations, how different stakeholder groups in society affect policy-making and implementation, and how improved information can result in decisions that benefit the poor. A major constraint to effective policy making in Nigeria is that; majority of society are usually excluded from any involvement in the policy-making process (Fenichel et al., 2013: 223-233). As a result of this, policy decisions frequently favor certain powerful sectors of society, rather than wider society and especially the poor. This occurred when the poor are located far from urban centers. To address these concerns new approaches and frequently new institutions are needed to manage aquatic resources. In most cases these need to be developed through effective interaction between communities, government and non-governmental organizations (Dugan, 2016: 1-12).

Conservation and Management Measures

There are ways to fish sustainably, allowing us to enjoy seafood while ensuring that populations remain for the future. In many indigenous cultures, people have fished sustainably for thousands of years. Today's sustainable fishing practices reflect some lessons learned from these cultures. Certain people have traditionally employed fishing practices that simultaneously harvest and maintain fish populations. They continue to follow these practices today. They set aside certain areas, such as coral reefs, as protected spots in which fishing is prohibited. When they do fish, these traditional fishers primarily use hook-and-line methods, catching only what they need to feed themselves and their communities (Frederico et al., 2016: 91-102).

Modern spear fishing is practiced all over the world, including in South America, Africa, Australia, and Asia. In many cases, spear guns are now used to propel the spear underwater. Spear fishing is a popular recreational activity in some areas of the United States including Florida and Hawaii. This fishing method is considered sustainable because it targets one fish at a time and results in very little by-catch. Rods and reels come in different shapes and sizes, allowing recreational and commercial fishers to target a wide variety of fish species in both freshwater and saltwater. The different types of rods and reels, coupled with different locations and bait, mean fishers can catch pelagic fish like sailfish, bottom-dwellers like flounder, and freshwater species such as catfish and trout. Rod-and-reel fishing results in less by-catch because non-targeted species can be released immediately. Additionally, only one fish is caught at a time, preventing overfishing (Olden and Naiman, 2013: 86-107).

Management schemes that attempt to address the interests of each of the various fishing sectors are sometimes result in catches that exceed the target levels and lead to depletion of the stocks. Actively engaging recreational and commercial fishers, with their firsthand experiential knowledge of the industry, in management processes can improve management decisions. Such engagement also improves communication and fosters constructive working relationships among fishermen, fisheries managers, and scientists, thus creating an environment that should promote greater acceptance of fishing regulations (National Academy of Sciences, 2008 and NOAA, 2017). According to Code of Conduct for Responsible Fisheries (2012), any fishery plan prepared for the management and development of fisheries should be based on the best scientific information available, ensures optimum utilization of the resources while avoiding overexploitation and must also be consistent with good management principles. Each fishery plan, irrespective of the target water area or fish species for which it is meant should:

1) identify the fishery resource and its characteristics, economic and social values and interrelationship with other species in the ecosystem;

2) assess the present state of exploitation of each resource and taking into account relevant biological and economic factors, determine the potential average annual yields from the resource;

3) specify the measures to be taken to promote the development of the local fishing enterprises, both industrial and artisanal;

4) determine the amount of the fishery resource to be made available to licensed foreign vessels;

5) specify the conservation measures to be enforced to protect the resources from overexploitation;

6) indicate the research necessary to enhance management and development of fisheries;

7) take into account relevant artisanal fishery methods or principles.

Conclusion

The aquatic system is notably dwindling in terms of resources due to some of the unsustainable practices and methods of fishery. Governments of developing countries like Nigeria are not performing their duties in terms of policy making and law enforcement. Every stakeholder should see to it that the sustainability of the aquatic system is not threatened. In conclusion the aquatic system is of great importance; not only as a source of food but also as a major part of our ecosystem. It is therefore imperative that measures

are put in place to ensure the sustainability of the aquatic system to ensure balance in our ecosystem and continual benefit from its resources.

Acknowledgement

We sincerely acknowledge the efforts of each co - author in the course of this review study.

References

Acreman, M., Arthington, A.H., Colloff, M.J., Couch, C., Crossman, N., Dyer, F., Overton, I., Pollino, C.A., Stewardson, M., Young, W. (2014). Environmental flows for natural, hybrid and novel riverine ecosystems in a changing world. Frontiers in Ecology and the Environment, 12, 466-473. https://doi.org/10.1890/130134

Béné, C., Neiland, A.E. (2006). From participation to governance: A critical review of the concepts of governance, co-management and participation, and their implementation in small-scale inland fisheries in developing countries. A review Prepared for the Challenge Programme on Water and Food. World Fish Center, Penang, Malaysia and CGIAR CPWF, Colombo, Sri Lanka, pp. 1834-1841. Available at: https://www.researchgate.net/publication/23550955_From_participation_to_governance_a_critical_review_of_the_concepts_of_governance_co-management_and_participation_and_their_implementation_in_small-scale_inland_fisheries_in_developing_countries

Castello, L., Arantes, C., McGrath, D., Stewart, D., de Souza, F. (2015). Understanding fishing-induced extinctions in the Amazon. Aquatic Conservation: Marine and Freshwater Ecosystems, 25, 587-598. https://doi.org/10.1002/aqc.2491

Cheung, W.W.L., Watson R., Morato T., Pitcher T.J., Pauly D. (2007). Intrinsic vulnerability in the global fish catch. Marine Ecology Progress Series, 333, 1-12. https://doi.org/10.3354/meps333001

Code of Conduct for Responsible Fisheries. (2012).Governance for a Sustainable Future. Commission on Fisheries Resources as Part II of the WHAT (World Humanity Action Trust) Report. London. Available at: http://www.what.org.uk

Cooke, S.J., Allison, E.H., Beard, T.D., Arlinghaus, R., Arthington, A.H., Bartley, D.M., Cowx, I.G., Fuentevilla, C., Leonard, N.J., Lorenzen, K. (2016). On the sustainability of inland fisheries: finding a future for the forgotten. Ambio, 45, 753-764. https://doi.org/10.1007/s13280-016-0787-4

Dugan, P.J. (2016). The Contribution of Aquatic Ecosystems and Fisheries to Food Security and Livelihoods: A Research Agenda. Journal of Environmental Management, 1-12. https://doi.org/10.13140/2.1.2436.5124

Edeline, E., Groth, A., Cazelles, B., Claessen, D., Winfield, I.J., Ohlberger, J., Vøllestad, L.A., Stenseth, N.Chr., Ghil, M. (2016). Pathogens trigger top-down climate forcing on ecosystem dynamics. Oecologia, 181, 519-532.

FAO. (2017). For a world without hunger. Fisheries and Aquaculture Department. Food and Agriculture Organization of the United Nations in Africa. Research Report 51, pp. 73-91.

Fenichel, E., Gentner, B., Arlinghaus, R. (2013). Normative considerations for recreational fishery management: a bioeconomic framework for linking positive science and normative fisheries policy decisions. Fisheries Management and Ecology, 20, 223-233. https://doi.org/10.1111/j.1365-2400.2012.00869.x

Frederico, R.G., Olden, J.D., Zuanon, J. (2016). Climate change sensitivity of threatened, and largely unprotected, Amazonian fishes. Aquatic Conservation: Marine

and Freshwater Ecosystems, 26(1), 91-102. https://doi.org/10.1111/j.1365-2400.2012.00869.x

Froese, R., Pauly, D. (2020). FishBase (version Feb 2018). In: Species 2000 & ITIS Catalogue of Life, 2020-04-16 Beta (Roskov, Y., Ower, G., Orrell, T., Nicolson, D., Bailly, N., Kirk, P.M., Bourgoin, T., DeWalt, R.E., Decock, W., Nieukerken E. van, Penev, L.). Available at www.catalogueoflife.org/col

Heino, J., Erkinaro, J., Huusko, A., Luoto, M. (2016). Climate change effects on freshwater fishes, conservation and management. In: G.P. Closs, M. Krkosek, J.D. Olden (Eds). Conservation of Freshwater Fishes (pp. 76-106). Cambridge: Cambridge University. https://doi.org/10.1017/CBO9781139627085

Marine Resources Assessment Group 'Towards Sustainable Fishery Management'. (2010). Available at: http://mrag.org

Mike M. (2015). Sea fish. Available at: https://www.seafish.org/

National academy of Science. (2020). Available at: http://www.nationalacademia/sciences.org

National Oceanic and Atmospheric Administration (NOAA). (2017). Available at: http://www.noaa.org

Olden, J.D. (2016). Challenges and opportunities for fish conservation in dam-impacted waters. In: G.P. Closs, M. Krkosek, J.D. Olden (Eds). Conservation of Freshwater Fishes (pp. 107-148). Cambridge: Cambridge Cambridge University Press. https://doi.org/10.1017/CBO9781139627085.005

Olden, J.D., Naiman, R.J. (2013). Incorporating thermal regimes into environmental flows assessments: modifying dam operations to restore freshwater ecosystem integrity. Freshwater Biology, 55, 86-107. https://doi.org/10.1111/j.1365-2427.2009.02179.x

Safran, P. (2014). Fisheries and Aquaculture: Towards Sustainable Aquatic Living Resources Management. Fisheries and Aquaculture, 1, 24. Available at: https://www.eolss.net/Sample-Chapters/C10/E5-05-00-00.pdf

Sheath, D.J., Williams, C.F., Reading, A.J., Britton, R.J. (2015). Parasites of non-native freshwater fishes introduced into England and Wales suggest enemy release and parasite acquisition. Biological Invasions, 17, 2235-2246. https://doi.org/10.1007/s10530-015-0857-8

UNESCAP. (2016). What is good governance? Bangkok, Thailand: United Nations Economic and Social Commission for Asia and the Pacific. Available at: http://www.unescap.org/pdd/prs/ProjectActivities/Ongoing/gg/governance.pdf

United Nations Development Programme (UNDP). (2000). Growing investments and efficient policies. Overcoming human poverty. Poverty report 10, pp. 345.

Vörösmarty, C.J., McIntyre, P.B., Gessner, M.O., Dudgeon, D., Prusevich, A., Green, P., Glidden, P.S., Bunn, S.E., Sullivan, C.A., Reidy Liermann, C., Davies, P.M. (2010). Global threats to human water security and river biodiversity. Nature, 467, 555-561.

Winemiller, K., Humphries, P., Pusey, B. (2015). Protecting apex predators. In: G. Closs, M. Krkosek, J. Olden (Eds.). Conservation of Freshwater Fishes (Conservation Biology, pp. 361-398). Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781139627085.013

Winemiller, K.O., McIntyre, P.B., Castello, L., Fluet-Chouinard, E., Giarrizzo, T., Nam, S., Baird, I.G., Darwall, W., Lujan, N.K., Harrison, I. (2016). Balancing hydropower and biodiversity in the Amazon, Congo and Mekong. Science, 351, 128-129. https://doi.org/10.1126/science.aac7082