Research Frontiers in Wetlands, Fishery & Aquaculture

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By Devashish Kar, Shakuli Saxena

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CHAPTER 1

WETLAND ECOSYSTEM SERVICES: SUSTAINABLE FISHERIES

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ABSTRACT:

Wetlands are one of the most prolific ecosystems in the biosphere, equivalent to tropical evergreen forests, and play an important part in a region's ecological sustainability. Wetlands are a transitional zone between land and water, where water saturation is the dominating element affecting the nature of soil and the sorts of plant and animal communities that live in and on it. A wetland ecosystem has a wide range of microorganisms, plants, insects, amphibians, reptiles, birds, fish, and mammals.Wetlands offer a plenty of food, attracting a wide range of animal species. These animals spend part or all of their lives in wetlands. Dead plant leaves and stems decompose in water, forming microscopic particles of organic material known as "detritus." Many tiny water insects, crustaceans, and small fish feed on this enhanced material, which provides food for bigger predatory fish, reptiles, amphibians, birds, and mammals. These areas are now referred to as ecotones.

KEYWORDS:

Aquatic, Fish, Food, Vegetation, Water.

INTRODUCTION

Wetlands may range in size from a home pond to the Everglades, and they can be found across the United States and on every continent except Antarctica. Wetlands are distinguished from other landscape characteristics by the fact that they are wet. Wetlands are described in this article as vegetated areas that are submerged in water or have extremely moist soils for portion of the year. However, there are other legal and scientific definitions of wetlands that incorporate additional features. Other definitions of wetlands include wet places devoid of vegetation; however, this article concentrates on vegetated areas since wetland plants offer a distinct habitat and other advantages to fish that unvegetated areas do not. What sorts of wetlands do you have in your neighbourhood? There are usually wetlands along the river and on the floodplain if you live near a river. Wetlands may exist in shallow places at the margin of a lake if you live near one. Wetlands may be found behind beach dunes or in small bays if you live near the coast. Even though there is no open water nearby, a damp shrubby dip or grassy valley may include wetlands that fill with water during the rainy season but remain dry the rest of the year. Wetlands are almost certainly close to where you live. It is critical to remember that wetlands do not exist in isolation, but rather as part of a vast, linked system of land and water known as a watershed[1], [2].

A watershed is a section of land that drains to a body of water, such as a river, lake, or marsh. The hydrologic cycle connects wetlands to the atmosphere. Rain penetrates wetlands either directly or indirectly through lakes, streams, and groundwater. Wetlands aid in the regulation of the hydrologic cycle by collecting precipitation and gently releasing it back into streams and lakes, ensuring that fish have a consistent and continuous water supply. Wetlands are important to fish populations because specific wetland processes are required for fish. Wetlands provide food, refuge, spawning and nursery habitats, and water filtering. They contain vast amounts of food that attract a wide range of animal species. Small aquatic insects, fish, and shellfish eat plants and other organic stuff. Smaller insects and fish, in turn, provide food for bigger predatory fish, reptiles, amphibians, birds, and mammals. Wetlands

not only supply food for aquatic and non-aquatic animal and fish species, but they also provide vegetated regions for fish to breed, hide from predators, and seek sanctuary from inclement weather or other physical changes. Wetlands also filter off sediments and contaminants, giving fish with clean water. As a result, a network of numerous and healthy wetlands is critical to the survival of the majority of fish species[3], [4].

Despite the significant advantages provided by wetlands, more than half of the wetlands in the lower 48 states have been impacted by pollution or development since colonial times. Wetlands, thankfully, are increasingly acknowledged as a crucial and important component of natural ecosystems. Over the past 20 years, federal, state, and municipal policies have reduced the loss of this vital ecosystem. Despite a greater awareness of their value and rules regulating wetlands destruction, the United States continues to endure a net loss from construction, agricultural, and transportation projects. Wetlands are being damaged or destroyed as a consequence of increased development and continuing conversion of wetlands to other uses. As a consequence, finding suitable habitat for fish becomes increasingly challenging. According to research, one issue affecting young coho salmon survival is a shortage of habitat such as wooded wetlands, beaver ponds, and stream pools that they need to survive the rainy winters. Blue crab populations on the East Coast may be falling as a result of the loss of eelgrass beds, which juveniles and moulting adults rely on for protection from predators. Fish habitat loss may result in their designation under the Endangered Species Act. Wetland degradation and diminishing fish populations have an impact not just on natural ecosystem functioning, but also on commercial and recreational fishing. Each year, the marine and freshwater commercial and recreational fishing sectors provide hundreds of billions of dollars to the US economy and employ millions of Americans.

According to the US Department of Commerce, Americans spent $52.3 billion on fish goods in 1999, including money spent in restaurants and grocery shops. According to the United States. According to the Fish and Wildlife Service, America's 35 million adult anglers spent almost $37 billion on fishing activities in 1996. With 1.2 million employments supported countrywide, the American Sportfishing Association says that if sportfishing were a company, it would rank 13th on the Fortune 500 list of America's top enterprises. Wetland loss and its impact on fish populations are only two of the numerous concerns driving us to reconsider our land-based activities. The connection between land, water, and atmosphere ensures that no lake, stream, ocean, or wetland has been unaffected by human activities. Pollution, habitat destruction, and the introduction and subsequent population explosions of non-native species have resulted in at least one state listing more than one-third of the freshwater fish species found in North America as endangered, threatened, or of special concern. Wetlands conservation and restoration are important areas to start to reverse this trend[5], [6].

Fish need the same things that people do: food, housing, clean water, and a safe location to rear their young. Because of their roles, such as providing habitat, generating food, and cycling nutrients, wetlands may meet many of the requirements of fish. Food production, spawning and nursery habitat, shelter, and the reduction of hazardous pollutants in water are the most significant wetland functions for fish survival. Wetlands offer a large food source due to their fast plant production. Some fish consume plant portions, while others consume microscopic insects and crustaceans that consume or live on plants. Some fish prefer wetland plant material that has been digested by bacteria, worms, and aquatic insects into detritus, which is an energy-rich organic substance. Detritus circulates throughout the aquatic system, enriching it with nutrients necessary for fish development. The alternate flooding and drying of wooded floodplains, for example, promotes plant growth, detritus formation, and nutrient

availability. These products are then swept downstream, benefitting fish that live thousands of kilometers distant, such as menhaden, whose diet contains one-third detritus. Furthermore, fish do not have to consume detritus to profit from this abundant source of wetland food supply. Striped bass, for example, feed on smaller fish and crabs that devour debris.

DISCUSSION

Wetlands provide sustenance for humans as well. Although most of us would not love a platter of steamed cattails, many would enjoy some succulent grilled largemouth fish. Largemouth bass do not consume marsh vegetation or debris, but they do eat red swamp crawfish. Detritus is also eaten by red swamp crawfish. A food chain is the interaction between wetland plants that create detritus, red swamp crawfish that consume detritus, largemouth bass that eat red swamp crawfish, and humans that eat largemouth bass. Wetland plants nourish fish and all of the birds, reptiles, bears, otters, sea lions, and humans that consume fish via a system of interwoven feeding chains known as food webs. Food webs are delicately balanced. Wetland degradation, for example, impacts not just golden shiners, which dwell and feed in swamps, but also herons, egrets, kingfishers, and water snakes, which devour golden shiners. Furthermore, the nesting success of the California brown pelican is directly linked to the amount of anchovies found in salt marshes and other wetlands. Indeed, many marine mammal and seabird population decreases have been connected to declining fish numbers. Because food webs are interrelated, any wetland disturbance that disturbs the food web may have a domino impact on fish, animal, and human populations. Because fish eggs and young fish have different demands than adult fish, many adult fish dwell in various environments before laying eggs in wetlands.

Predators may hide defenseless and immobile eggs in marsh borders and submerged grasses. Wetland plants, dead plant debris, and detritus serve as a surface for fish eggs to adhere to. When the eggs hatch, the vegetation serves as both a protective cover and a source of nourishment. Young fish hide in wetland vegetation, while juvenile bay scallops, hard clams, and other shellfish cling to salt marsh vegetation and seagrasses for many weeks before settling on the bottom. The majority of shrimp taken in the Gulf of Mexico are raised on salt marshes. The vegetation shields newborn shellfish until they are big enough to survive on the estuary bottom. Because many adult fish cannot thrive in shallow water, shallow waters in wetland habitats offer protection for juvenile fish from adult predators. Wetlands provide as good breeding grounds for fish. Northern pike swim from Lake Erie's deep waters to breed in freshwater marshes near the coast. Adults depart the marshes shortly after spawning, while larvae and juveniles stay until mid-summer, when the shallow waters become too heated.

Anadromous fish, such as salmon and river herring move hundreds or thousands of kilometers to spawn in freshwater streams and marshes. When floods open up access to the copious food supply of streamside hardwood woods, blueback herring spawn. Although many salmon species lay their eggs in the slow-moving water of streambeds, during floods, the larvae and juveniles feed on the plentiful food supply of streamside wetlands. Some chum salmon populations spawn immediately on coastal marshes. Striped bass travel to freshwater locations to breed, allowing juveniles to exploit tidal freshwater wetlands for nursery and feeding.Wetlands are used by both adult and young fish to hide from predators. Thick plant growth may mislead predators and conceal little fish. Juvenile muskellunge, northern pike, and other tiny fish with green and speckled colouring may mix in with marsh grasses, making them nearly invisible to predators. Many predators are kept out of coastal marshes and other wetlands due to dense vegetation and shallow water. To avoid bigger predators, gobies, anchovies, young snook, and juvenile spotted seatrout dive into the interweaving root networks of mangrove wetlands. The root systems of trees and shrubs in floodplain wetlands

enable stream banks to dangle over the water, protecting chinook salmon, cutthroat trout, and other species. Wetlands are used by fish to avoid predators as well as to escape changes in environmental circumstances such as changes in water level, velocity, or severe weather. During winter floods, coho salmon depend on the calmer waters of wooded wetlands close to streams to escape the rapid currents of Pacific Northwest streams. Clean Water Clean water is just as crucial to fish as clean air is to us. Wetlands aid in water purification by filtering away potentially dangerous contaminants.

Some contaminants may be captured by wetland vegetation and subsequently preserved in sediment layers. Wetland plants and microscopic creatures known as microbes convert other pollutants into less dangerous forms. Wetlands offer natural filtering at a far lower cost and with significantly more efficiency than technology. In 1991, scientists predicted that if it was feasible to replicate the filtering capacity of the bottomland hardwood wetlands present across South Carolina, such a water treatment facility would cost millions of dollars to build. A treatment facility would not only be difficult and expensive to build, but it would also be costly to maintain. Wetlands help mitigate the impact of natural variations in water quality on fish populations. Wetland plants' roots, stems, and leaves restrict water flow, minimizing streambank and coastline erosion. Erosion control minimizes the quantity of debris in the water, which may block fish gills or suffocate fish eggs. Lake Erie marshes, for example, trap silt, which benefits species that need clean water and sand or gravel bottoms to breed. The flow of freshwater into brackish and estuarine nursery regions downstream is regulated by forested wetlands in the North Carolina coastal plain. Without this vital function, salinity levels would fluctuate dramatically with each rainstorm, putting fish and other aquatic species under stress since they depend on a delicate balance of freshwater and saltwater.

The first step in learning about the fish that reside in local wetlands is to identify the kind of wetland that exists in your garden or neighbourhood. Check out the descriptions of typical wetland kinds on the following pages. Then, go to the page for that wetland type to discover what fish species you could find there. Please keep in mind that many more fish species utilize wetlands than are included in this article. Furthermore, many species utilize more than one form of wetland, yet this paper only used one type of wetland as an example. These tables include many of the fish species known to utilize each common wetland type, how each species uses the wetland, and the areas of the nation where each fish may be found.

Finally, go directly to the source your wetland to determine which fish are utilizing it. Wetlands exist in a variety of shapes, sizes, and configurations. The fact that these habitats are moist is what unites them. Different fish species live in various kinds of wetlands. The quantity of water in a wetland and how long it remains wet impact the fish species that may benefit from it. The kind of wetland, its geographic location, salt level, and plant type are all key factors in determining which fish species live in a given wetland. What makes a wetland suitable for fish habitat? Fish need standing water that is deep enough so that it does not freeze solid in the winter. Marshes near rivers, lakes, and estuaries are often flooded and are home to a variety of fish. Wetlands, on the other hand, do not have to be wet all of the time to be valuable fish habitat. For example, wooded floodplains that may contain standing water for just a few weeks at a time are critical to the reproductive cycles of many species that dwell in streams and rivers, such as American eels and Pacific salmon. Not every marsh is suitable for fishing. Some wetlands are small depressions in the terrain that collect rain and runoff for a few months out of the year. Wetlands that dry up in the summer must be near enough to another water source to enable fish to migrate back to safer, more permanent waters when required.

Wetlands may be classified in a variety of ways depending on similar and dissimilar traits. Sorting wetlands might be important in determining what fish could be there. Several approaches for describing distinct kinds of wetlands have been devised. This article categorizes wetlands depending on whether they are tidal, whether the water is salty or fresh, and the kind of plant that grows most regularly in the wetland. Saltwater Wetlands The salinity of all saltwater wetlands varies with season, time, precipitation, location, and water depth. Except for Georgia and South Carolina, all coastal states include submerged saltwater wetlands known as seagrass beds. Vegetation includes rooted submerged plants known as seagrass. Although the plants resemble grasses, they are not members of the grass family. Tidal Salt Marshes Tidal saltwater wetlands are often populated with salt-tolerant grasses, rushes, sedges, and other soft-stemmed plants. Throughout the United States, it may be found around protected beaches. Mangrove Wetlands Tidal wetlands characterized by short salt-tolerant mangrove trees in the Southeast, Gulf Coast area, and Hawaii. Mangrove wetlands, like salt marshes, need shelter from the open ocean. Mangrove trees are notable for their distinctive system of twisted roots that grow above the water's surface and offer home for fish and animals.

Freshwater Wetlands Freshwater wetlands get its water from one or more sources, including precipitation, surface water, and ground water. Tidal Freshwater Marshes Tidal freshwater wetlands characterized by grasses, sedges, rushes, and broad-leaved aquatic plants. Coastal locations are home to this species. Non-tidal Freshwater Marshes Non-tidal freshwater wetlands where water depth varies with the seasons. It might rain all year or dry out periodically. Softstemmed aquatic plants such as cattails, arrowheads, pickerelweed, reeds, grasses, and sedges cover the water. It may be isolated from other bodies of water or it may border a river, lake, or pond. This variety is found all throughout the nation and includes prairie potholes, playas, certain vernal pools, and fens. Freshwater wetlands that may be tidal or non-tidal, although water depth varies with the seasons. Trees such as red maple, cypress, tupelo, and/or evergreen plants cover the ground. Forested wetlands are found all throughout the nation and include river floodplains, backwater swamps, pocosins, and bogs. These wetlands may look dry at times of the year.According to the Ramser Convention, a wetland system is defined as any area of marsh, fen, peatland, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish, or salt, including areas of marine water whose depth at low tide does not exceed 6 meters. Also includes peat bogs such as Ombrotrophic bogs and Soligenous bogs, as well as marshes, fens, swamps, and floodplains[7].

Fisheries Need Wetlands

Wetlands are ecosystems that produce a large amount of food, attracting numerous animal species such as shellfish, tiny fish, and predatory fish. Capture and culture fisheries operations may be carried out efficiently in these types of waterlogged environments if the system is correctly controlled.

Fisheries Captured

Wetlands have their own biota, which may be designed for capture fisheries if they are deep enough. Capturing fisheries is nothing more than collecting natural habitats from water using a variety of gears like as cast nets, gill nets, classic and modern traps, trawl gears, seiens, and so on. Furthermore, area suited for pleasure, including angling, sport fishing, and tourist spots, serves as a fishing ground. We can create decorative catch fisheries for colourful fish and beautiful plants.Vegetation is a key issue while operating nets in wetlands areas. Most of the time, operations fail or different operational issues arise, such as net degradation or net

arresting in vegetation. The majority of aquatic vegetation issues are caused by high amounts of nutrients, particularly nitrogen and phosphorus, in the pond/lake's water and sediments. These nutrients are constantly available in some form and accumulate spontaneously over time.The gill net may be employed at the wetland's edge in the floodplains region. Pit or pond-like formation near floodplains where fish get ensnared following severe rains. Bamboo traps and advanced mechanical traps may also be utilized to effectively capture fish in this location. Traps serve a vital function in marshes, fens, and swamps, and they are quickly removed by fish when put in thick vegetative regions.Prawns and crabs that slither along the bottom of the coast, particularly at night, are primarily captured by traps installed in such locations. Gill nets are typically used in the deeper sections of the wetlands. Cast nets are generally used in shallow water with little vegetation[8], [9].

Culture Fisheries

Aquaculture is feasible in the wetland region, however clearance of aquatic weeds is required first. There are three techniques for eradicating aquatic weeds: mechanical methods, chemical approaches, and biological methods.

1. **Mechanical approach:** The mechanical approach is highly significant for eradicating aquatic weeds;however, it is only used on a small scale. Water weed cutters and weed harvesters are two different kinds of cutters or mechanical equipment used to eliminate aquatic weeds and fens. Mechanical controls are typically only practical for smaller sized wetland regions or for spot treatments of smaller sections in larger wetland bodies since they are not only slow and costly, but also need manual labour to finish the follow-up operations. Cutting or pulling away the vegetation, raking and/or seining floating vegetation driven into corners by wind or wave action are some of the procedures used.
2. **Chemical Control Techniques:** Herbicides, as they are often called, may efficiently manage harmful aquatic weeds. A wide variety of compounds have been employed as herbicides for control, and they are classified into six groups.

Aquatic Weed Biological Control

A appropriate organism is introduced in biological control. The creature either feeds on aquatic weeds or severely destroys them, keeping them in control and spreading to appropriate levels.The organism employed to control the spread of weeds is known as a biocontrol agent or a bioagent, and it might be specific or nonspecific.The biological control approach of aquatic macrophytes offers several benefits over the chemical control method. It is easy, inexpensive, devoid of environmental dangers, and has no effect on the pond's fertility.Grass carp (Ctenopharyngodonidella), Puntius javanicus, Common carp (Cyprinuscarpio), Tilapia spp., silver carp (Hypophthlmichthys molitrix), and Gourami (Osphronemus gourami) are some examples of herbivorous fish bio agents.Manatees (sea cows), ducks and geese, aquatic rats, insects such as water hyacinth weevil, water hyacinth moth, and water hyacinth mite, and fresh water snails are other bio agents. Pilliaglobosa is used in India to eradicate Salviniamolesta[10], [11].

Cultivated Fisheries

We may grow aquaculture in the wetland region, and by changing and eradicating aquatic weeds from the ideal depth of the wetland area, we can aggressively undertake aquaculture operations.A pen is described as a fixed enclosure in which the bottom is the bed of a water body. The term 'pen' is frequently used synonymously with 'enclosure' in enclosure culture.Because a wetland is a nutrient-rich environment, pen culture is an essential culture

method. High primary production, mainly found in wetland environments, and hence famed for the food, which attracts a variety of fishes. A specific area might be confined with a net and all vegetation eradicated using mechanical, chemical, or biological means, and this water platform becomes a closed area for aquaculture, serving as a pen culture.Rearing juvenile stages of fin and shellfish in wetland pens is a novel and reasonably easy technology that has the potential to become a significant seed rearing system for lucrative resource usage in the near future.Indian and Chinese carp, eels, catfishes, milkfishes, mullets, tilapia, and both fresh and brackish water prawns have the ability to be reared in pens.

Cage Culture

Cage culture may be viable in wetland environments if the depth is adequate to place cages. However, before developing a cage culture approach, the first job is to remove aquatic vegetation. Cages have a hard bottom, and the frame of the bottom drives plants from the wetland region into the cage, making water accessible for aquaculture.The goal of cage culture is to raise spawn and fry to fingerling size in two or three months. This phase restores high density rearing with intense high protein feeding. The availability of natural food, along with the addition of supplementary feed, leads in quicker development rates for the fish. Fresh water wetland cage culture systems may be used to grow Rohu, Catla, Mrigal, silver carp, grass carp, and common carp fry or spawn.Carp seed production in wetland cages with proper technology decreases land burden for fish nurseries.Ponds in the floodplain or lagoon side region are naturally supplied by water when the water level rises and falls. Pumping to meet the pond's water demand is an additional alternative.In the wetland region, there is also room for raft and stake culture. This sort of aquaculture may produce clams, oysters, and other seafood.Wetland areas, which are often unused, may be exploited for integrated fish farming with Makhana culture. This form of mixed culture will increase resource efficiency, minimize risk by diversifying crops, and give more food and revenue. This approach will be especially important since it will enhance the socioeconomic situation of the poorer rural fishing community. This is generally done along the shore, particularly in estuary areas where the water level is lower[12], [13].

CONCLUSION

Fish and humans both need certain things in order to stay alive. Both need food, a place to live, and a clean surrounding. Wetlands provide necessary things for fish all over the United States. For instance, shrimp eat and get bigger in the muddy areas near the Mississippi river. Striped bass chase after killifish that live in the salt marshes near the Chesapeake Bay. Baby fish called salmon stay in the salty marshes on the West Coast until they get used to the salty water in the ocean. Alewife and blueback herring lay their eggs in the forests that are wet and near rivers in the eastern part of the United States. There are different kinds of wetlands that give fish things they need like food, a safe place to hide, and a safe spot to lay their eggs. This article talks about how wetlands are important for fish to survive. By reading this publication, you will learn how wetlands are important for fish and get ideas on how to protect wetlands in your community. If you like fishing, eating fish, or think fish are beautiful and important in nature, this book will help you get involved in protecting wetlands. If you already know how important wetlands are, you can share this information with fishing communities and encourage them to help protect wetlands with you.

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CHAPTER 2

MODERN WETLAND RESTORATION: AQUACULTURE CONNECTIVITY STRATEGIES

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ABSTRACT:

Creating strategies that can withstand the effects of climate change at the local level is necessary. This paper focuses on restoring wetlands and implementing fish farming at the village level as an important strategy to adapt to climate change. Geospatial techniques have been used to help map and manage degraded wetland resources in specific regions. This work aims to gather information about wetlands through both qualitative and quantitative methods. Scientific organizations provide advice and oversight during all stages of the project. We want to include local groups in the project and make sure they have control over the wetlands in their area. This text talks about how better fishing techniques can help ensure there is enough food for everyone, and how scientific organizations can help choose and use the right methods for fish farming. Instead of removing aquatic weeds by hand, we suggest using equipment like 'aquatic weed harvesters'. We expect to turn the plants we collect from water into eco-friendly products like biochar, biofuels, and improved goods that can withstand climate changes. The proposed idea includes mapping and restoring wetland resources at a regional level. It also involves setting up fish farms based on scientific guidelines and consulting with scientific organizations.

KEYWORDS:

Ecosystem, Fisheries, Restoration, Wetlands, Water.

INTRODUCTION

Wetlands have a unique place in restoration ecology because they have been impacted by so many disturbances and are subject to rules that mandate mitigation of potential harm. Wetlands, unlike lakes and streams, have not always been regarded as valuable. In recent years, popular opinions around wetlands have shifted from a general indifference to a broad desire to conserve and restore them. A major policy forum has advised net gain and no net overall lossin the quality and quantity of the nation's wetland resources. As a result, there have been several initiatives to restore damaged wetlands, and there are many different perspectives on the state of wetland restoration.The Bush administration has advocated for no net loss of wetland area and functionality. However, efforts to put such a program in place have been challenging since wetlands often obstruct development. In the agreement to ameliorate wetlands damages, Alaska wetlands were accorded special status. At the moment, the extent of protected wetlands might be lowered by changing the delineation manual used to define wetlands that fall within the authority of the Clean Water Act, Section. Seasonal wetlands, for example, would need to remain wetter for a longer period of time; and vegetation in peripheral regions would need to be categorized as wetland vegetation[1], [2].

Although wetland delineation is outside the scope of this chapter, one issue is crucial to the committee's charge: Can damaged wetlands be restored? If this is the case, repairing one wetland may compensate for destroying another. The answer is often determined by the quality of wetland science. Determining whether a damaged wetland has been recovered requires extensive knowledge of animals, plant, soil, and hydrology.This chapter examines

past losses and damages as well as the functional benefits of wetlands. Current wetland restoration technology is summarized, as well as constraints to achieving restoration goals, problems encountered during restoration, opportunities for major restoration projects, wetland restoration programs, and reasons for differing opinions on wetland restoration success. The chapter concludes with conclusions, suggestions, and research requirements; however, recommendations on wetlands policy and institutional improvements relevant to wetlands[3], [4].

Wetlands, according to science, are transitional zones between terrestrial and open-water systems. Wetlands, according to the law, are separate entities subject to regulatory control. Because of the variety of wetland kinds, it is difficult to establish a singular definition for a wetland.Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water, according to the United States Fish and Wildlife Service (FWS). The presence of hydrophytes, hydric soils, and saturated or flooded substrate are three characteristics that assist identify wetlands, according to the FWS. Some wetlands are recognized for their temporal naturehydrophytes and hydrologic indicators need only be present on a regular basis. This definition is broader than that utilized for regulatory reasons by the United States Environmental Protection Agency (EPA) and the United States Army Corps of Engineers (COE). The main federal agencies engaged in wetland management have established a standardized guideline for determining wetland borders[5], [6].

The variety of wetland habitat types and the species they sustain is astounding. Cowardin's categorization scheme5 system types, 8 subsystems, 11 classes, 28 subclasses, and a significant number of dominance types for wetlands in the United States. Wetlands include vegetation types ranging from early colonizing pioneer communities dominated by species like cattails to ancient, self-sustaining in the South and black spruce. The perturbations encountered by these systems vary, as does the degree of restoration success.Wetlands are environmentally complicated due to their dynamic nature. Newly deposited sediments along river banks will be easily overrun by opportunistic plants and animals. The first immigrants are unlikely to be the same species as the ultimate floodplain forest. Mud flats are generated around the margins of continents by alluvial outwash and are progressively colonized by salt marsh, grasses, and succulents, which trap sediments that elevate the topography and attract other plant and animal species. Sphagnum moss and herbaceous plants form a carpet along the margin of an acidic lake, ultimately supporting bog shrubs and bog forest trees.

The nutrient content of the soil and the biomass of plants and animals rise with time in all of these environments, as does species diversity and ecosystem complexity. The transformation of open substrates into enduring ecosystems is known as primary succession, and it might take decades or millennia. However, the process is not unidirectional, and Niering proposes replacing the word succession with vegetation development or biotic change to highlight the diverse changes that ecosystems experience in response to slow and catastrophic occurrences.

Wetlands were thought to be wastelands until the past two decades, with little constructive use in society and little direct economic benefit to individual landowners. To improve their public benefit, they required to be reclaimed by draining, ditching, diking, or filling. Some federal, state, and municipal regulations actually offered incentives for wetland degradation. The purpose of the first official federal acts dealing with wetlandsthe Swamp Lands Acts of 1849, 1850, and 1860was to convey all swamp and overflow lands unfit for cultivation to 15 states along the Mississippi River and to Oregon so that the states could reclaim the land for agriculture. Wetlands are being drained and destroyed.

Until the mid-1970s, Save Cancel was the accepted and even encouraged practice in the United States.Negative effects, such as decreased waterfowl numbers, were becoming evident by the early to mid-1900s. The Fish and Wildlife Coordination Act of 1934, in conjunction with the U.S. Fish and Wildlife Wetlands Inventories of 1954 and 1973, caused the conclusion that wetland habitat degradation was causing a reduction in fish and waterfowl populations. The general public has come to recognize that wetlands are vital systems that provide several advantages to civilization. The contradiction between private ownership of wetlands and limited private advantages and the need to protect social and economic values, on the other hand, continues to contribute to wetlands loss and degradation.Wetlands feature both aquatic and terrestrial ecological traits. Their most commonly appreciated purpose is to provide habitat for fish, birds, and other species, which helps to maintain biodiversity. Wetlands perform hydrologic functions and water quality improvements in addition to this food chain support" function, all of which are recognized as valuable to society as a whole. Wetlands provide recreational, educational, scientific, and aesthetic purposes for persons[7], [8].

Although wetlands cover only about 5% of the land surface in the conterminous United States, many wetlands are among the most productive natural ecosystems, outperforming even the best agricultural lands and rivalling the production of tropical rain forests. They support a diverse range of natural species. Riverine wetlands also serve as migration corridors for big, wide-ranging animals like the Florida panther and black bear, as well as wetland-dependent species like frogs. More than one-third of the federally endangered and threatened plants and animals need wetlands at some point in their lives. Riverine wetlands and surrounding floodplain lands can produce natural floodways that transport floods from upstream to downstream places.Storm wave and erosion protectionCoastal and inland wetlands next to bigger lakes and rivers decrease the effect of storm tides and waves before they reach upland regions.Flood storageDuring floods, inland wetlands may store water and slowly release it to downstream regions, decreasing flood peaks.Wetlands lower flood flows and floodwater velocity, minimizing erosion and causing floods to discharge sediment.Wetlands are significant spawning and nursery habitats for fish and shellfish, and they offer nutrients to the commercial and recreational fin and shellfish industries, especially in coastal locations.

Waterfowl and other wildlife habitatBoth coastal and inland wetland environments are critical for breeding, nesting, feeding, and shelter for many species of waterfowl, other birds, animals, and reptiles.Wetland habitat for rare and endangered species. Wetland habitat supports almost 35 percent of all rare and endangered animal species, but accounting for just around 5 percent of the nation's land area.Wetlands provide opportunities for fishing, hunting, and animal observation.With the expansion of urban centres and declining ground and surface water resources, wetlands are becoming more significant as sources of ground and surface water.Both tidal and inland wetlands offer unmet food production potential for collecting marsh vegetation and aquaculture due to their high natural productivity.Despite the physical difficulties of wood removal, forested wetlands remain a significant supply of timber when managed properly.Preservation of historic and archaeological values. Some wetlands are historically significant. Indian towns were built on coastal and interior wetlands that provided fish and shellfish.Tidal, coastal, and inland wetlands provide educational possibilities for nature observation and scientific inquiry.Contribution to aesthetic values and source of open space. Both tidal and inland wetlands are diverse and beautiful ecosystems that offer open space for recreational and aesthetic pleasure.Water quality improvement. By eliminating surplus nutrients and various chemical pollutants, wetlands help to enhance water quality. They are sometimes employed in the tertiary treatment of wastewater.

DISCUSSION

The business case for inland fisheries ecosystem restoration is mostly based on expenditures spent and benefits provided. Official statistics for inland fisheries sometimes understate their real importance; total catches and the amount of involvement in, or reliance on, them are frequently drastically understated. This develops a broad unfavourable opinion of their worth, stifling enthusiasm in their repair. Local data and knowledge on specific fisheries, on the other hand, frequently demonstrate their importance, which is often best expressed not only through gross weights of catches, but also through food security and nutrition, as well as livelihood dependency of local communities, both of which can be very high and present a strong case for restoration. An ecosystem services framework is the best way to examine the costs and benefits at stake, how they relate to an area's existing ecological health, and how they could react to ecosystem restoration initiatives. Many ecological services may be translated to monetary values to facilitate comparisons, but evaluations should also include non-monetary benefits. In the framework of pro-poor sustainable development, the socioeconomic positions of the different stakeholders, winners and losers, must also be addressed[9], [10].

When these factors are taken into account, ecological restoration for inland fisheries may make a compelling financial case. Average values for ecosystem categories, namely rivers, lakes, and wetlands, on which inland fisheries rely, are orders of magnitude greater than for terrestrial ecosystems. The average contribution of inland fisheries to these values is low, ranging between 0.5 and 2.5 percent of their total economic value, but studies that calculate the full range of services in play are biased toward developed countries where significant inland food fisheries have long since vanished. In underdeveloped nations, examples indicate that inland fisheries may provide the majority of ecosystem value, but they often do not compute values for the complete spectrum of services. Inland fisheries and other key high-value services such as water quantity and quality control, disaster risk reduction, nutrient cycling, biodiversity protection, and so on have synergy. Although climate change may be a negative cause of change in inland fisheries habitats, climate change adaptation objectives are strongly associated with inland fisheries interests due to the reciprocal need to maintain and restore inland water ecosystems. As a result, there are several chances to promote inland fisheries in collaboration with other interest groups. Reviews of net benefit-cost ratios for ecosystem restoration in general show a good rate of return on investment, with internal rates of return ranging from about 4 percent to 19 percent for rivers and lakes and from -5 percent to 12 percent for inland wetlands, with benefit-cost ratios ranging from 1:1 to 13:1.

These findings are only estimates of benefits at one point in time, and they reflect the lower limit of the welfare benefits of ecosystem restoration because both scarcity and demand for ecosystem services are increasing, and new benefits of natural ecosystems and biological diversity are being discovered. In most published research, there is a dearth of data on the financial, economic, and/or social costs and/or benefits of ecosystem restoration, especially for inland fisheries. This is true even for numerous comprehensive instances from industrialized countries. In the case of underdeveloped nations, published research often concentrate on benefits, while costs are frequently not sufficiently reported. Nonetheless, there are several instances demonstrating that ecosystem restoration for inland fisheries may be a highly cost-effective investment, with expenses being negligible in many situations, especially for community-based restoration programs. Unlike other evaluations in industrialized nations and for ecosystem restoration in general, the advantages of ecosystem restoration for inland fisheries may be realized immediately, with cases of local harvests doubling or tripling within one to two years.

Experiences with ecosystem restoration and inland fisheries decisively disprove the widely held belief that fisheries and biodiversity conservation goals clash, owing mostly to sea fisheries. Fish habitat restoration always improves circumstances for other forms of biodiversity. Local communities will manage resources collaboratively because they appreciate the interdependence between fisheries-related and other biodiversity. In many situations, stand-alone biodiversity conservation initiatives are typically unsustainable in the absence of the advantages provided by sustainable fisheries usage. In many situations, inland fisheries are essential to meet larger biodiversity conservation goals. Many individuals are concerned that unsustainable fishing will persist in regions with high fishing pressure, casting doubt on ecological restoration. However, the potential effects of unsustainable fishing on resources after restoration may be handled through community-based initiatives. Evidence suggests that ecosystem restoration may relieve constraints on fisheries and other natural resources by boosting catches. Evidence suggests that when communities manage the resources, catches and biodiversity may be maintained.

Experiences with ecosystem restoration for inland fisheries in industrialized nations have been inconsistent, owing to factors such as inadequate planning, a lack of knowledge of ecosystem dynamics, and stand-alone interventions without local management and maintenance systems. In these circumstances, insufficient cost-benefit analyses are widespread, as is an emphasis on recovering species, which is not the same as restoring fisheries. In affluent nations, there are fewer published research on inland food fisheries, but these show a greater degree of success. The presence of local communities that are resource reliant, have a high level of local knowledge, and live close or inside the environment being managed is a crucial factor to this success. Successful and long-term ecosystem restoration for inland fisheries is primarily concerned with identifying and regulating the primary and indirect, positive and negative drivers of ecosystem change that affect the fisheries. Inland fisheries rely on inland aquatic ecosystems located inside the larger terrain. Ecosystem restoration for inland fisheries may include both terrestrial and aquatic habitat restoration, and it often includes stakeholders outside of the fisheries industry. Land-use patterns, habitat conversion and fragmentation, and changes in hydrological regimes are the primary direct causes of ecosystem degradation affecting inland fisheries. In order to restore inland fisheries, an ecological approach is required.

Unless the biological dynamics of aquatic habitats and fisheries across landscapes are well understood, as well as how they link to social and cultural systems and the fishery, effective restoration initiatives are unlikely to be found or successful. Decisions impacting the environment and live aquatic components are seldom made by a fishing authority, but rather by other bodies. In most nations, inland fishing concerns are frequently on the periphery of environmental policymaking and funding. Engaging with decision-makers may so need extra effort. Technical tools and approaches with broad application for inland fisheries ecosystem restoration include applying nature-based solutions to water resource and land management challenges based on restoring overall ecosystem health, sustainable land management, integrated water resource management and environmental flows; and restoring longitudinal and lateral connectivity in rivers, particularly reconnecting floodplains to river c Building community-based restoration projects that employ these and other instruments but do not use such technical jargon is the most common and successful strategy.

In terms of costs and returns, efforts to restore fisheries by integrating or retrofitting fish passages on bigger dams are considered as experimental high-risk solutions. In underdeveloped nations, they have a weak or untested track record. There are few instances of proved advantages for the various fish species assemblages that define tropical rivers, and

no examples of verified enhancements for food fisheries. Dam removal for fishery benefits is becoming more common in affluent nations, although there is no recorded case of this in poor countries. However, there is significant potential for controlling water regimes from bigger dams to restore biological conditions for fisheries and other downstream advantages. Assessments of the full range of ecosystem services in play, as well as their sensitivity to hydrological change, can identify dam operation parameters that lead to optimal overall water-use efficiency, often benefiting inland fisheries, without jeopardizing the dam's intended outputs such as energy or irrigation. There are also good opportunities for managing connectivity by removing barriers to fish passage at a smaller scale, such as at the field scale in irrigation networks, especially by leveraging community-based integrated water and land management techniques.

Ecosystem restoration for inland fisheries may be implemented at many sizes, ranging from local interventions to basin-wide initiatives. Local community-based initiatives at a small scale, without wider basin-scale techniques, have a track record of generating considerable local advantages, contrary to certain evaluations of experiences in affluent nations. These may include restoring very tiny areas even less than 1 hectare in the case of, say, fish refuges or sanctuaries that provide advantages to a considerably greater region. When such treatments are scaled out to a greater region, they may provide significant overall advantages. Restoration of transboundary river basin fisheries may be complicated by divergent views among riparian governments on the goals of restoration and how to achieve them. Nonetheless, governments have shown that they may still make great headway in recovering fisheries under their own jurisdiction.

Opportunities and prospects Given the damaged status of the habitats and ecosystems that sustain such fisheries, there are tremendous prospects for ecosystem restoration to assist inland fisheries. In the short term, societal solutions to current global concerns, such as biodiversity loss, climate change, and meeting the Sustainable Development Goals (SDGs), should enhance investment in ecosystem restoration. This should be followed by a greater awareness of the prospects for ecological restoration in inland food fisheries. Trade-offs in ecosystem restoration for inland fisheries may be reduced, if not avoided, with proper evaluation, analysis, and debate. Priorities must change to maximize overall system benefits while avoiding single-objective solutions or sector-based domination in natural resource management. There is a compelling argument to be made that inland fisheries habitat restoration and inland fisheries should get much more attention and investment than they now do. However, reaping the benefits of ecosystem restoration for inland fisheries needs coordinated work to overcome present barriers. Among them is the inland fisheries' lack of visibility in many policy settings as well as technical and scientific forums. This is due, in part, to a lack of statistics on their relevance, but also to a failure to prioritize pro-poor policies above more apparent economic gains, a lack of knowledge of the realities of food security and nutrition, and power inequalities. Better involvement with local communities, as well as their full and effective participation in decision-making, has a demonstrated track record of bridging data and information gaps, as well as developing agreement on priority restoration alternatives and preserving their results. The prospects for inland fisheries profiting from or contributing to the UN Decade on Ecosystem Restoration are promising, but scaling up current accomplishments will need expanded and sustained efforts to mainstream inland fisheries values.

CONCLUSION

Wetland restoration combined with scientific fish farming is suggested as a possible technique for improving regional Climate Resilient Agriculture. Because of the country's

immense variety, India has the potential to achieve considerable sustainable aquaculture development in restored fresh water, estuarine, and coastal wetlands. Aside from regional ecological development, the concept model envisions enhanced fish output, which would improve food and nutrition security. Scientific entities might give the required criteria for regional wetland restoration and aquaculture technology selection. Climate resilient aquatic weed products will bring many advantages for wetland restoration, renewable energy production, and carbon sequestration. The methodology might be tailored to be used at the village or panchayat level, opening up new avenues for climate resilience. The multi-stage concept model will be an important step in creating climate resilient cities or communities.

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CHAPTER 3

CLIMATE CHANGE EFFECTS ON WETLAND FISHERIES: RESILIENCE METHODS

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ABSTRACT:

Climate change presents additional challenges to the sustainability of fisheries and aquaculture systems, with major consequences for the 520 million people who rely on them for a living and the almost 3 billion people who rely on fish for animal protein. Two-thirds of all reefs are found in poor nations, and 500 million people in the tropics rely significantly on reefs for food, livelihood, catastrophe protection, and other fundamental necessities. Fishing is the only source of income for many coastal communities in reef zones. Climate change may have an immediate impact on fisheries and aquaculture by affecting fish populations and the worldwide availability of fish for consumption, or it may have an indirect impact by influencing fish prices or the cost of products and services needed by fishers and fish farmers. Climate change has substantial consequences for capture fisheries, including the potential loss of species or a shift in composition, as well as effects on seed availability for aquaculture, variations in precipitation, and water availability. Climate change reduces water quality, increasing disease and increasing competition with other water users, resulting in changed and decreased freshwater supplies and a higher risk of drought. fishing communities that rely on inland fishing resources are especially susceptible to climate change. Increased inland water temperatures may diminish the availability of wild fish populations by degrading water quality, exacerbating dry season mortality, introducing new predators and diseases, and altering the quantity of food available to fisheries species.

KEYWORDS:

Aquaculture, Climate, Fish, Populations, Water.

INTRODUCTION

Fish can help people cope with climate change by combining farming and raising fish. This can aid farmers who deal with lack of water while also making money and improving the food in their homes. Fisheries management needs to focus on increasing the ability to adapt, rather than just trying to catch as much fish as possible. Fish can help people who are very poor and have few ways to make a living. Fish are important for these people because their environment can change a lot and they need something reliable to rely on. People who rely on fish from rivers and lakes for their livelihood are more likely to be negatively affected by climate change. Aquaculture has been growing really fast since 1970 and is now the fastest-growing way of producing food globally. Aquaculture now gives us half of the fish that we eat, and it needs to keep growing because the number of fish being caught from the wild is getting smaller and smaller. Combining fish farming with crop farming, such as raising fish in rice fields or using agricultural waste to fertilize ponds, can help improve nutrition and generate income using existing land and resources[1], [2].

The agreement to reduce the damage to ecosystems is still being discussed. It is clear that this goal mainly focuses on fixing ecosystems, not making them worse. This is a sad result because many places are getting really damaged because people are taking too much wood, letting animals eat too much grass, or draining the water in the ground. Many areas, like

wetlands or forests, have lost most of their natural features. In most situations, restoring something is possible and worth the effort. People are not motivated to decrease these pressures because they only care about the total amount of loss.The conversation about how much land, water or ocean areas should be protected is still happening. We have agreed that we will not only consider protected areas, but also other ways to conserve land. The problem with this statement is that any place that is somewhat preserved could be included in this goal but it may still get worse over time.We have agreed on a goal to restore 15% of degraded areas, which will make them better at dealing with climate change and storing carbon. Depending on how we define the word 'degraded', this goal could help restore damaged mangrove forests or areas of Southeast Asia where the trees have been cut down[3], [4].

Negotiations are still happening about how biodiversity and ecosystems help with providing and controlling water, and how water affects biodiversity. Wetlands International works on issues related to water and biodiversity. Many countries consider water as a matter of national importance.A draft text about ecosystem services talks about how ecosystems help with water. This means that getting water recognized and talked about at the Convention is a small but important first step. We won't know the final and approved targets until the convention meeting is over. After that, there will be important meetings to figure out how to measure the abstract goals. Each country will make clear promises during these meetings.

Wetlands International believes that it is very important for countries to set clear and achievable goals for protecting biodiversity. These goals help to ensure that actions are taken to save biodiversity. Currently, the loss of biodiversity is causing problems for society by reducing important services like ensuring there is enough food and water for everyone. According to the IPCC, scientists can now measure how much greenhouse gases are released from wetlands. This important discovery was shared by the IPCC at the UN climate conference (UNFCCC) in Cancun (Mexico)[5], [6].

This conclusion is very important because it helps countries reduce their pollution by refilling drained wetlands. During a meeting called UNFCCC COP 15 in Copenhagen, a group called the Global Partnership on Climate, Fisheries and Aquaculture (PaCFA) held a special event at the European Environment Agency. The event was about how climate change affects fish, fish farming, and water systems. The European Bureau for Conservation and Development, a member of PaCFAA, organized an event to examine how climate change affects the future of fishing and farming seafood. This has a big impact on the availability of food and people's ability to support themselves.We need to quickly find ways to make fisheries and aquaculture less vulnerable. This means using different strategies to adapt and reduce the impacts of climate change, at the right size and level. Their effectiveness relies on creating strong communities and countries that can react to changes and on incorporating strategies to deal with climate change in policies about managing nature and development. Many different things need to be done, such as monitoring the weather and predicting it, using the weather forecasts to help prevent disasters, and improving policies and technology for adapting in fish farming.

Aquaculture, which is the direct management of fish production, can help communities that are susceptible to climate change. It has the potential to make them better able to adapt and be resilient. This can make up for the changes in wild fish populations caused by climate change. However, aquaculture relies a lot on fishmeal feeds made from small, wild-caught fish and on wild-caught baby fish for planting. Both stocks are affected by climate change. We need to find alternatives to fishmeal and ways to raise certain species in hatcheries instead of relying on naturally occurring seeds. Improving the ability of national innovation

systems in aquaculture will help the industry adapt to climate change and stay competitive in changing markets[7], [8].

DISCUSSION

Climate change is expected to have a wide-ranging influence on ecosystems, society, and economies, putting further strain on all livelihoods and food sources, including those in the fisheries and aquaculture sectors. It is critical to better identify where climate change is most likely to restrict fishing livelihood alternatives and where there is the greatest need to invest in alternative rural and urban businesses.The International Food Policy Research Institute investigates scenarios, outcomes, and policy choices to improve climate-smart food production. According to the paper, better agricultural production, broad economic expansion, and vigorous international commerce might alleviate the negative effects of climate change on food security. Fish is the primary source of animal protein for 3 billion people throughout the globe. Fish is a vital source of necessary vitamins and fatty acids, as well as a great protein supplement to the starchy diet typical among the world's poor. Fishing and aquaculture provide a living for around 520 million people and their dependents worldwide, the majority of whom reside in poor nations. Fish is a frequently traded food product that offers an essential source of financial income for many disadvantaged people. Fish may be a key source of foreign currency in addition to encouraging local market economies. Fishing is usually a component in mixed livelihood strategies, in which people take advantage of seasonal stock availability or turn to fishing when other sources of food production and revenue creation fail[9], [10].

Two-thirds of all reefs are found in poor nations, and 500 million people in the tropics rely significantly on reefs for food, livelihood, catastrophe protection, and other fundamental necessities. People living in the coastal zone are often impoverished and landless, with limited access to amenities, and so subject to natural resource effects. Fishing is the only source of income for many coastal communities in reef zones. Higher water temperatures are a primary cause of coral bleaching and reef ecosystem destruction all around the world. El Nio, a worldwide linked ocean-atmosphere phenomena that affects the direction and timing of regional ocean currents and generates significant inter-annual fluctuation in sea surface temperature, caused a bleaching event in 1998 that destroyed an estimated 6% of the world's coral. According to studies, 60% of coral reefs may be gone by 2030, and both rising ocean temperatures and increased acidity from greater amounts of atmospheric carbon dioxide may play a role.

Changes in water temperature and current flow will cause changes in the distribution of marine fish populations, with some places gaining and others losing. Fishers must learn to utilize a wider variety of species and diversify their sources of income in order to lessen their dependence on a limited resource base.The average sea level is expected to increase between 0 and 90 centimetres this century, with most projections falling between 30 and 50 centimetres. Many coastal habitats, such as mangroves and salt marshes, will be harmed or destroyed, which are critical to sustaining wild fish supplies and giving seed to aquaculture. Storm surges, which may destroy fish ponds and other coastal infrastructure and may become more frequent and stronger as a result of climate change, are buffered by mangroves and other coastal vegetation. According to the United Nations Environment Programme (UNEP), the yearly ecological value of mangroves is between $200,000 and $900,000 per square kilometre. Several research have revealed potential adaption techniques for mangrove systems and the people who rely on them[11], [12].

Changes in inland water temperatures may diminish the amount and distribution of wild fish populations by lowering water quality, increasing dry season fish mortality, introducing new predators and diseases, and altering the availability of food for fisheries species. Because of increased temperatures, mixing of surface and deep-water layers has decreased in Lake Tanganyika, which contributes up to 25% of animal protein to the nations that surround it. This has lowered the amount of nutrients accessible to plankton, reducing output in planktivorous fish by an estimated 30%.

Floods and droughts caused by rising seasonal and yearly variability in precipitation will be the most prominent drivers of change in inland aquaculture and fisheries. Bangladesh, one of the world's least developed countries, gets almost 80% of its animal protein from fisheries. Precipitation in Bangladesh is expected to decrease during the dry season and rise during the rainy season under a 2-6oC global warming scenario, extending flood-prone regions by 23-39%. While there is a relationship between greater flooding extent and higher production in many floodplain fisheries, potential benefits may be offset by a variety of factors such as reduced spawning success of river fishes due to higher wet season river flows, reduced fish survival in lower dry season flows, and habitat loss due to new hydraulic engineering projects and other human responses. Water level is the most critical element regulating stock size and capture rates in shallow African lakes such as Mweru WaNtipa, Chilwa/Chiuta, and Liambezi. When lake levels are low, catch rates may drop.

Reduced yearly and dry season rainfall, as well as changes in the length of the growing season, are expected to have an impact on aquaculture and increase the likelihood of conflict with other agricultural, industrial, and home users in water-scarce locations. These effects are most likely to be felt most strongly by the poorest aqua-culturists, whose often smaller ponds hold less water, dry up quicker, and are more likely to suffer from shorter growth seasons, decreased harvests, and a restricted selection of species for cultivation. Aquaculture, on the other hand, may provide chances for increasing water production in locations where water shortage is worsening.Climate change may have an immediate impact on fisheries and aquaculture by changing the number and distribution of fish populations, as well as the worldwide supply of fish for consumption, or it may have an indirect impact by influencing fish prices or the cost of products and services needed by fishers and fish farmers. Changes in sea surface temperature may result in more hazardous algal blooms, less dissolved oxygen, an increase in disease and parasite incidence, changed local ecosystems with changes in competitors, predators, and invasive species, and changes in plankton composition. Changes in infrastructure and operational expenses caused by increasing infestations of fouling organisms, pests, nuisance species, and/or predators in aquaculture. Impacts on the quantity and species mix of fish populations in catch fisheries. As a consequence of rising temperatures, mixing of surface and deep-water layers has decreased in most African lakes, which provide more animal protein to the nations that surround them. This lowers the amount of nutrients accessible to plankton and hence the output of planktivorous fish.

Changes in species composition, impacting the timing and success of migrations, diminishing spawning success, and changing sex ratios may counterbalance potential advantages for aquaculture and fisheries. Coral reefs that serve as breeding grounds and safeguard the coastline from wave action will be harmed. Its exposure to which may increase as sea levels rise, resulting in diminished recruitment of fisheries species. Storm surge flooding or increased wave damage to infrastructure. El Nio-Southern Oscillation Alters the position and timing of ocean currents and upwelling, affecting nutrient delivery in surface waters and, as a result, primary production.The distribution and productivity of open sea fisheries are changing as a result of climate change. Reef fisheries production has been lowered due to

changes in ocean temperature and bleached coral. Flooding and drought are caused by altered rainfall patterns. Land loss due to rising sea levels restricted the area accessible for aquaculture. Changes in estuary systems and the loss of freshwater fisheries influenced changes in species abundance, distribution, and composition of fish stocks, as well as aquaculture seed. Infusion of salt water into groundwater, harm to freshwater catch fisheries, and decreased freshwater availability for aquaculture might result in a shift to brackish water species.

The loss of coastal habitats, such as mangrove forests, limited recruitment and stocks for capture fisheries and aquaculture seed. Increased vulnerability to waves and storm surges, as well as the possibility of inland aquaculture and fisheries flooding. Higher inland water temperatures exacerbated stratification and decreased lake mixing, limiting primary production and, as a result, food sources for fish species. Increased metabolic rates boost feeding rates and growth provided water quality, dissolved oxygen levels, and food supply are sufficient; otherwise, feeding and development may be reduced.A shift in the location and size of a particular species' potential range will result in species loss and a change in species composition for capture fisheries. Reduced water quality, particularly in terms of dissolved oxygen; changes in the distribution and quantity of diseases, predators, and competitors; introduction of invasive species, changed stocks, and species composition in catch fisheries. Changes in precipitation and water availability, changes in fish migratory and recruitment patterns, and changes in water and seed availability for aquaculture may all have an influence on the number and composition of wild stock. Lower water quality causes more illness and more competition with other water users, resulting in changed and decreased freshwater supplies with increased danger of drought, higher expenses of managing pond water levels, and animal mortality, resulting in lower production capacity.

Conflict with other water users arose, as did a shift in cultural species. Changes in lake and river levels, as well as the general size and movement patterns of surface water, impacted the distribution, composition, and availability of fish populations, forcing fishermen to go further and exert more effort.Many fishermen and aquaculturists are unprepared to adapt to change, leaving them exposed to the effects of climate change on fish supplies. Temperature and precipitation variations in freshwater environments harm fisheries and aquaculture. Storms may become more frequent and severe, putting ecosystems, stocks, infrastructure, and livelihoods at jeopardy.

Many artisanal fishermen are impoverished. Even when they earn more than other rural residents, fishermen are often socially and politically excluded, with restricted access to healthcare, education, and other public services. Because of social and political marginalization, many small-scale and migratory fishermen have little ability to adapt and are very susceptible to climatic effects damaging the natural capital on which they rely heavily for a living. Increased migration to deal with and exploit climate-driven output changes may exacerbate a variety of cultural, social, and health issues. HIV/AIDS is common in many fishing villages, and the situation is expected to deteriorate as climate change causes increasing migration and social instability. As falling catches exacerbate poverty and food scarcity, desperate individuals become less risk averse. Transactional sex, in which women fish vendors, for example, exchange sex for fish, will become an increasingly major vector for HIV/AIDS transmission.

According to a recent stern review on the Economics of Climate Change, for fisheries, information on the likely impacts of climate change is very limited. Efforts to increase understanding of how and why climate change may affect aquaculture and fisheries should prioritize developing strategies by which fisheries, and perhaps more importantly

aquaculture, can play a role in our overall adaptation to the challenges of climate change. However, the inherent unpredictability of climate change, as well as the interdependence of fisheries and aquaculture livelihoods with other livelihood choices and economic sectors, make determining the precise mechanisms of climate effects very difficult. This advocates for a major emphasis on developing broad adaptive capacity that may assist the world's impoverished fishing and aquaculture communities in dealing with new problems, both anticipated and unexpected.Cyclones and their related storm surges and inland floods may have major consequences for fisheries, especially aquaculture, by causing damage or loss of stock, facilities, and infrastructure. Institutional solutions such as building manmade flood defences and maintaining natural ones might offer considerable but insufficient protection. Because poor populations in vulnerable places are unlikely to be able to construct major defences, the most practical and cost-effective option will be to develop resilience. Short culture periods and little capital investment in aquaculture assist decrease stock loss and related costs in Bangladesh and other flood-prone nations. Building higher adaptive ability would need techniques such as diverse livelihood options and loan access, which will allow aqua-culturists to manage financially with unexpected losses of investment and revenue. Other factors to consider for high-risk coping mechanisms include risk monitoring and assessment, as well as encouraging aquaculture species, fish strains, and procedures that optimize productivity and profit during successful cycles.

The vulnerability of fishery and aquaculture-dependent communities and regions to climate change is complex, reflecting a combination of three key factors: a system's exposure to climate change, its sensitivity to climate impacts, and the adaptive capacity of the group or society experiencing those impacts. Vulnerability varies widely amongst manufacturing systems, homes, communities, countries, and geographies. It is impacted by shifting demographics, market globalization, and evolving agricultural development policies. Poor and disadvantaged populations, including women, are expected to be the most susceptible, since climate change will worsen existing inequalities in access to natural resources, productive assets, knowledge, and technology. Developing policies and strategies to address the effects of climate change on fisheries and aquaculture requires identifying susceptible regions and individuals as well as understanding what causes their susceptibility. This necessitates vulnerability assessment at several dimensions and consideration of many interacting causes. The following are key questions that must be answered.

The results of the study to address these questions will be vulnerability maps that indicate 'hotspots' and the person’s most impacted. These maps may be used to direct adaption investments. Understanding climate sensitivity in the context of other factors helps in the prioritization of climate-related measures and informs programs aimed at mainstreaming climate change responses into other development policy and planning efforts. Two-thirds of the most susceptible nations to climate change are in Africa, where fish accounts for more than half of animal protein consumption in certain countries. Inland and coastal waterways are very vulnerable to climate change, and their adaptation potential is limited.The discovery and promotion of aquaculture species and methods that are adaptable to changing environments and resources may provide new uses for land that has become unsuitable for current livelihood strategies, allowing aqua culturists to adapt to change. As ambient temperatures rise, aquaculture in colder zones may benefit from greater growth rates and longer growing seasons. Pond aquaculture schemes in Malawi have effectively decreased farmers' susceptibility to drought, given a supply of high-quality protein to complement crops, and increased total productivity and profit. Aquaculture water reuse technologies outperform terrestrial agricultural and animal production in terms of water usage efficiency.Understanding the various ways in which fisheries and aquaculture have reacted to

previous climatic variability as well as other'shocks' may help guide policies that enable adaptation to climate change. Examining fishing communities' reactions to natural catastrophes, particularly the responses of women and the poor, might help us determine which policies may minimize vulnerability and promote resilience in the face of future climate effects. The following are key research topics that must be addressed.

Agriculture accounts for 10-12% of global greenhouse gas emissions, with aquaculture accounting for a minor but unknown portion of that figure. Fishing consumes 1.2% of the world's fossil fuels per year. While the potential benefit of investing in fishing energy efficiency and emission reduction is limited, the industry does give chances to enhance livelihoods, environmental and resource management, and climate change mitigation. Market-based mitigation measures, such as the Clean Development Mechanism and voluntary carbon markets, might be used to support work that contributes to the development of sustainable fisheries and aquaculture.Mitigation strategies for fisheries include encouraging the use of fuel-efficient fishing vessels and methods, eliminating disincentives to energy efficiency such as fuel subsidies, and reducing global fishing fleet overcapacity, which occurs when there are too many boats burning too much fuel to chase too few fish. Mitigation options exist with aquaculture systems that decrease energy usage and maximize the potential for carbon sequestration. Mangrove conservation and restoration, on the other hand, sequesters carbon, protects coasts, and improves fisheries and livelihoods.

Opportunities for financing adaptation should be pushed via creative programs that also contribute to mitigation, such as the Reduced Emissions from Deforestation and Degradation initiative for mangroves. The research findings will give solutions for establishing adaptive capability that governments, communities, and businesses may utilize to influence their responses to climate change and other forces. By identifying important policy processes, stakeholders in the fisheries and aquaculture sectors will have a better understanding of how to get both technical and financial adaptation help. By learning from past mainstreaming experiences, sectoral policies will be more successfully 'climate-proofed,' and governments will be better equipped to cooperate with their aquatic resource-dependent communities to safeguard the future development benefits of fisheries and aquaculture. Finally, institutions need assistance in strengthening their ability to promote the integration of climate change adaptation into larger fisheries and rural development strategy. Understanding and managing climate change's disproportionate impact on disadvantaged people will be extremely critical.

To achieve these objectives, fisheries and aquaculture management, as well as research institutes, must participate in global, regional, and national policy to drive thinking and investment in climate change adaptation. When evaluating these challenges, the following essential research topics must be addressed: Building adaptive capacity to react to climate change also entails enhancing the ability of fishers and fish growers to respond to existing climatic risks. Indeed, some of the most productive aquaculture and fisheries regions, contributing the most to poverty reduction and food security, are also the places most vulnerable to natural catastrophes induced by severe weather events and sea level rise. Because these events are expected to become more frequent and severe in many parts of the world, and sea level rise is expected to accelerate, it is critical to collaborate with disaster relief agencies and affected communities to develop processes for disaster preparedness and post-disaster fisheries and aquaculture rehabilitation.

CONCLUSION

In the future, there will likely be less fish that can be caught in the oceans, with a decrease of around 2. 8% to 53% under one scenario and 7. 0% to 121% under another scenario by 2050.

This is because of the amount of greenhouse gases being released into the environment. Although the global average is not very big, the effects are much stronger on a smaller scale. This is because the expected changes in catching fish can differ a lot between different regions. The estimates can change a lot, but we can expect the largest decreases to happen in the tropics, particularly in the South Pacific areas. In areas near the North and South poles, it is expected that the amount of fish that can be caught will either increase or decrease less than in the tropical regions. It is important to remember that these predictions only show how much fish the oceans can produce, and do not think about the decisions people might make to manage this. The way ecosystems change and how we respond to those changes is really important in order to reduce the dangers and make the most of the benefits that come from climate change.

Changes in production are happening because some types of animals and plants are moving to different places.

This is causing problems between people who use these resources, both in the same country and between different countries. This text looks at how climate change affects marine fisheries and what can be done to adapt to these changes. The study focuses on 13 different marine regions that have different environments, societies, and economies. The conclusion is that when dealing with climate change, changes in fishing practices should be made. These changes should work together with other efforts to address climate change and also focus on sustainable use of resources. It is understood that some of these actions will need the organizations to make changes.

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CHAPTER 4

WETLAND FISHERIES BIODIVERSITY CONSERVATION: A COMPREHENSIVE OVERVIEW

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ABSTRACT:
Wetlands are really important for humans and the environment. They help support lots of life and they have a big impact on our society and economy. They are very important for keeping different kinds of plants and animals alive, and they play a big part in the overall environment. Interestingly, people have seen wetlands as useless and linked to sickness, problems, and risk. Focusing only on the bad effects and not recognizing their value, these homes for living things were seen as barriers to moving forward and so they were emptied, covered, ruined, and made worse for money reasons. The disappearance of wetlands has almost caused many animal and plant species to completely die out. Not fully understanding the important role and usefulness of wetlands is a big problem. The Convention on Wetlands, also known as Ramsar, has been important in getting governments around the world to protect and wisely use wetlands. The Ramsar Convention has been around for 25 years. It has done a good job of making people aware of wetlands and helping governments protect and manage these places in a way that is good for the environment. By putting into action, the Strategic Plan that was recently accepted by the 6th Conference of Contracting Parties, the Ramsar Convention will become more closely linked to the wider issues of the Convention on Biological Diversity and the UN Commission on Sustainable Development.

KEYWORDS:

Animals, Biological Diversity, Conventional Biology, Fish Species, Ramsar Convention.

INTRODUCTION

Most of us understand that water is essential to life on Earth, particularly the survival of human populations. What is less widely recognized is that freshwater accounts for less than 3% of the world's total water resources, with less than 1% of that occurring in the earth's liquid surface freshwater the remainder being locked in ice caps or as groundwater beneath the planet's surface. This fraction of the world's water supply supports an exceptionally high level of biodiversity, which is directly supported by a variety of freshwater ecosystem types, including running waters in rivers, standing waters in lakes and marshes, and areas of transient water availability in seasonal or ephemeral wetlands. These inland water habitats supply a variety of commodities and services critical to human well-being. Scientists are still documenting the complexity and variety of these ecosystems in space and time, but their significance is undeniable. Consider the fact that all great civilizations grew in conjunction with river systems, as seen by the placement of most major cities today[1], [2].

Freshwater is required not just for drinking, but also for agriculture, manufacturing, transportation, and a variety of other critical purposes. However, as human populations have expanded and water consumption has climbed, our activities have taken a massive toll on the world's freshwater supply. We are not only overconsuming a highly important and scarce resource and the life it supports; we are also abusing it by permitting pollution from land operations to flow into rivers, be carried for ultimate dilution in the sea, or collect in lakes and other wetlands. It is unsurprising that the strains humans have imposed on inland waterways have resulted in their being listed as one of the most vulnerable global

ecosystems. We are beginning to recognize these issues and are making steps to fix them. The Ramsar Convention on Wetlands of International Importance, Particularly as Waterfowl Habitat, colloquially known as the Ramsar Convention, was the first official worldwide inter-governmental endeavour to promote the sustainability of inland water-dependent species. While the Convention on Biological Diversity encompasses all ecosystem types and geographical locations, inland waters have been designated as an urgently critical thematic area of study. Many local, national, regional, and global initiatives are now focusing directly or indirectly on inland water conservation and sustainable use, with many sponsored by non-governmental organizations such as Wetlands International, IUCN[3], [4].

The World Conservation Union, The WWF for Nature, and BirdLife International. A critical prerequisite is our capacity to determine the present state of, and then monitor, the biodiversity of inland waterways and the ecosystem services they offer for the world. If we are unable to do so, we will be unable to evaluate our progress toward fulfilling crucial conservation and sustainable use objectives in this critical region. Recognizing this reality, the Parties to the Convention on Biological Diversity have asked that the Subsidiary Body on Scientific, Technical, and Technological Advice conduct a priority study of this issue. We are pleased to present this review as a collaborative effort between the Convention on Biological Diversity and the Ramsar Convention to demonstrate their continued cooperation toward achieving important common goals, particularly as a contribution to the World Summit on Sustainable Development's overall goal of significantly reducing the rate of biodiversity loss[5], [6].

This document's subject matter is difficult. Data and information are sometimes unavailable or difficult to get. This paper is not intended to be complete or final, but rather to serve as a starting point. By definition, "trends" indicate analysis across time. We aim to revise and update this material on a regular basis. Human activities are severely modifying and degrading freshwater habitats in many regions of the globe. Dams, river and stream embankments, and wetlands draining for flood control and agriculture, for example, have resulted in extensive loss of freshwater ecosystems, including waterfalls, rapids, riparian floodplains, and associated wetlands. Spiers provides an overview of the worldwide and regional extents of known inland wetland habitat losses and degradation. Freshwater ecosystem biodiversity has declined and been lost as a result of habitat loss, to the point that it is now significantly worse than that of forest, grassland, or coastal ecosystems. Degradation of habitat, physical change via dams and canals, water withdrawals, overharvesting, pollution, and the introduction of alien species all contribute to the reduction in freshwater biodiversity, either directly or indirectly. These stressors occur all around the globe, albeit the specific impacts differ from watershed to watershed. According to the findings of a freshwater fish research, habitat modification and the introduction of foreign species are the two primary drivers of species extinction.

The study attributed 71% of extinctions to habitat change, 54% to exotic species introduction, 29% to over-harvesting, 26% to pollution, and the remainder to hybridization, parasites and diseases, and intentional eradication. More than 20% of the world's freshwater fish species have been extinct, endangered, or vulnerable in recent decades due to a combination of stressors on freshwater systems. Some experts believe that this estimate is too low. Species are disappearing at a ever-accelerating rate in North America, according to study. Future extinction rates for freshwater animals are anticipated to be five times greater than for terrestrial species. Population development, industrialisation, and the expansion of irrigated agriculture will drive up demand for all water-related products and services, putting strain on freshwater species and ecosystems. Direct risks to several species groupings are examined in

length in this document's. The rest of this section focuses on worldwide risks to the integrity of freshwater ecosystems. It focuses in particular on the degree of alteration of river systems, the existing and expected level of water shortage, the influence of invasive species on inland water ecosystems, the state of inland water fisheries, and the effects of climate change on inland waters. Because of a lack of comprehensive data at the global scale, some of the most serious challenges to freshwater biodiversity, such as habitat loss and water quality, are rarely examined in depth.

Rivers have been changed since antiquity, although such changes peaked in the early to mid-1900s. River embankments are being built to enhance navigation, wetlands are being drained for flood control and agriculture, dams and irrigation canals are being built, and inter-basin connections and water transfers are being established. These modifications enhanced transportation, provided flood control and electricity, and increased agricultural productivity by providing additional land and irrigation water. At the same time, these physical changes in the hydrological cycle separate rivers from their floodplains and wetlands, slowing water velocity in riverine systems and transforming them into a network of linked reservoirs. This, in turn, affects fish migratory patterns and the composition of riparian habitats, opens up pathways for alien species, modifies coastal ecosystems, and leads to a loss of freshwater biodiversity and inland fisheries resources. Dams also have an impact on river seasonal flow and sediment transfer for an average of 160 km downstream. Some significant water projects, such as Egypt's Aswan High Dam, have a downstream influence that stretches more than 1,000 km.

Humans have constructed a significant number of dams across the globe, the most of which have been erected in the previous 35 years. Clearly, there are inconsistencies across sources, since include the aforementioned number for the share in China. Asia and South America have experienced the greatest recent rise in the number of reservoirs in terms of storage capacity. In Asia, 78% of total reservoir capacity was developed in the previous decade, whereas in South America, over 60% of all reservoirs were built since the 1980s. The inventory of dams and reservoirs for China and the former Soviet Union, which, together with the United States, rank first and second in the world in terms of the number of big dams. Reservoirs with a maximum storage capacity of more than 0.5 km3 intercept and trap an estimated 30% of worldwide suspended sediments. River fragmentation, defined as the disruption of a river's natural flow by dams, inter-basin transfers, or water removal, is a measure of the degree to which rivers have been modified by people. The World Resources Institute (WRI) examined the degree of fragmentation of the world's major rivers in partnership with the University of Ume in Sweden, with the exception of regions in South Asia and Oceania.

River fragmentation was classified into three categories: severely impacted, moderately affected, and free flowing. Rivers that had been severely impacted were those with fewer than one-quarter of their main channel remaining dam-free, those with at least one dam on the greatest tributary, and rivers whose annual flow patterns had altered significantly. Rivers that were unaffected had no dams in the main channel and, if tributaries had been dammed, river flow had decreased or been controlled in reservoirs by no more than 2%. According to the research, 37% of the 227 main river basins studied were severely impacted by fragmentation and changed flows, 23% were moderately affected, and 40% were untouched. In all studied areas, strongly or moderately fragmented systems were extensively spread. River systems having dry sections of their basins or internal drainage systems were particularly hard hit. The world's only big free-flowing rivers may be found in the arctic areas of North America and Russia, as well as in smaller coastal basins in Africa and Latin America.

It should be noted, however, that significant portions of some of the tropics' largest rivers, including as the Amazon, Orinoco, and Congo, would be categorized as unaffected rivers if a sub-basin study was performed. The Yangtze River in China, which was formerly classed as mildly affected, has become severely impacted following the completion of the Three Gorges Dam. Dams continue to be in great demand and have significant untapped potential in the developing world, notably in Asia. As of 1998, 349 dams taller than 60 meters were under development across the globe. Turkey, China, Japan, Iraq, Iran, Greece, Romania, and Spain, as well as the Paraná basin in South America, had the most dams under construction. The Yangtze River basin in China has the biggest dams under construction, with 38 dams under construction, followed by the Tigris and Euphrates with 19, and the Danube with 11. The rising number of dam removals that will be required in the future will have a significant influence on the hydrology and ecology of the impacted rivers. Over 500 dams have been demolished globally in the past 20 years.

The ecological consequences of removal, as well as proper removal tactics, are not thoroughly known. Dams' direct effects on diadromous fish species like salmon are extensively established. For numerous constructed reservoirs in Africa, the indirect influence of flow change on fish species assemblages has also been demonstrated. Reservoirs in these catchments have replaced rushing water habitats such as rapids and waterfalls, resulting in the extinction of lotic-adapted fish species and the spread of other, sometimes alien, lentic-adapted species. One example is the rapid drop in the population of two economically important fish species, Labeocongoro and Labeoaltivelis, in the Zambezi River. Before the dam was erected and Lake Kariba was established in 1958, these two cyprinid species were plentiful and supported a robust fishery. The dam's construction obstructed their spawning journey and drowned the riparian wetlands that served as their preferred habitat, resulting in a reduction in species abundance. Between 1960 and 1967, the species composition of the catch evolved from being dominated by Labeo to including almost no Labeo. When the Kariba dam was erected, it was believed that the lake would provide a profitable fishery.

DISCUSSION

In most places of the globe, exotic fish introductions are frequent, and they are becoming an increasingly significant component of aquaculture. Introductions are often made to improve food production and recreational fishing, as well as to eliminate pests like mosquitoes and aquatic weeds. Introduced fish, for example, account for 96.2% of South American fish output and 84.7% of Oceanian fish production. The 2,574 records of international fish introduction discovered in the FAO's Database on Introductions of Aquatic Species (DIAS) account for more than 80% of the total data. Exotic fish introduction inevitably has environmental consequences. A review of 31 research on exotic fish imports in Europe, North America, Australia, and New Zealand found that native fish populations were decreased or exterminated in 77% of instances after the introduction of exotic fish. In 69% of instances, the reduction was caused by the introduction of a single fish species, with salmonids accounting for half of the declines[7], [8].

In the last 100 years, there have been documented extinctions of 27 fish species and 13 subspecies in North America. The introduction of alien species was determined to be a significant factor in 68% of these extinctions, despite the presence of various pressures such as habitat modification, chemical pollution, hybridization, and overharvesting in nearly every instance. An excellent summary of the research on the impact of carp on freshwaters, including those in the United States. There is ample evidence that common carp have a negative influence on freshwater ecosystems in Europe. The negative effect of imported species on native fauna is also reported for Africa, Asia, and South America, but with less

information. The introduction of alien predators into Lake Victoria exemplifies the dramatic and unanticipated trade-offs that may occur when management choices are undertaken without concern for the ecosystem's potential consequences. Before the 1970s, Lake Victoria had over 350 species of cichlid fish, 90% of which were indigenous, making it one of the world's most varied and unusual fish assemblages.

More than half of these species are either extinct or have extremely limited populations. The introduction of Nile perch and Nile tilapia, which predated on and outcompeted the cichlids for food, was chiefly responsible for the lake's biodiversity decline. However, other factors contributed to the collapse. Overfishing decreased native fish supplies, which was the impetus for importing Nile perch and tilapia in the early 1950s. Changes in land use in the watershed resulted in increased pollution and sediment discharge into the lake, increasing nutrient load and triggering eutrophication. These alterations caused significant changes in the lake's fish populations. Cichlids used to account for more than 80% of Lake Victoria's fish biomass and produced a significant portion of the fish harvest. Bagrusdocmac and Clariasgariepinus, the two most significant catfish in the indigenous fish ecology, also fell with the introduction of Nile perch. The lake's fish biomass today comprises mostly of three species: Nile perch (60%), Nile tilapia (2.5%), and native tiny pelagic Rastrineobolaargentea (35%). Lake Kyoga in Uganda has had similar effects[9], [10].

Over the past 150 years, there have been three kinds of important fish imports to tropical Asia and America: piscivorous sport fishes such as trout and bass, as well as carps and tilapias for improving food fisheries. Temperate piscivores and carnivores seem to have had the greatest influence on indigenous fish species. Destructive repercussions have been documented in Cuban freshwaters, Lake Titicaca, and Lake Atitlan. In contrast, an assessment of introductions in tropical Asia and America concluded that, with the exception of a few occurrences in Latin America when piscivores were utilized, imported fishes did not cause serious harm to indigenous species. Tilapias have developed and become a significant contributor to inland fisheries in Mexico, the Dominican Republic, Northeast Brazil, and Cuba in recent decades. Although this does not always imply that native fish populations have disappeared, it does reflect a dramatic change in the makeup and organization of biotic communities in such systems. The majority of introduced species in tropical Asia are herbivores and omnivores such as Indian, Chinese, and common carps. Except for China, these temperate carp species have made little contribution to tropical fisheries productivity. Tilapias, on the other hand, have increased capture fishing in Sri Lanka and Thailand, as well as aquaculture in the Philippines, Taiwan, and Indonesia.

In China, the world's largest producer of inland fish, introduced species such as Black carp, silver carp, bighead, and Grass carp are widely distributed and contribute significantly to fisheries production. Although research on the influence of imported species on China's natural aquatic ecosystems is sparse, there are a few well-documented occurrences. In Yunnan Province, for example, where each river or lake system has a different fish species composition and a high number of endemics, the number of local fish species dropped following the introduction of over 30 foreign species in the early 1970s. Similarly, with the introduction of aquaculture, the fish community structure of Donghu Lake in Hunan Province shifted from a varied species assemblage to a system dominated by a few species.Freshwater crabs and crayfish both have a worldwide distribution, although their ranges are mostly mutually exclusive. Freshwater crabs predominate in tropical freshwaters, but crayfish thrive in temperate areas, and although certain species are found in the tropics and subtropics, they are far less common at these latitudes.

Their distribution is not limited to a single river basin. True freshwater crabs are only found in Central and South America, Southern Europe, Africa and Madagascar, South and Southeast Asia, China, and Japan. Australia, the Philippines, and New Guinea. They may also be found on the islands of the Gulf of Guinea, the Seychelles, Socotra, Sri Lanka, and areas of the West Indies. Freshwater crabs do not exist in the United States, Canada, Northern Europe, or Russia. They are also missing from Atlantic and Pacific oceanic islands such as New Caledonia, New Zealand, Tahiti, and Hawaii. There are at least 1,000 species globally, with a high endemism rate. Checklists of species may be prepared throughout the majority of this group's distribution. Africa, India and Burma, and the whole of the Indonesian archipelago have gaps. A freshwater crab limited to lakes in northern New Zealand has been reported to have reduced as a result of salmonid imports for recreational fishing. Crayfish are found in freshwater environments across the temperate globe, including Canada, the United States, temperate South America, Europe, China, Korea, Japan, Australia, and New Zealand. They may also be found in Mexico, Cuba, Haiti, the Dominican Republic, Madagascar, New Guinea, New Caledonia, and Australia in the tropics and subtropics.

There are around 600 species worldwide, with 400 of them found in North America. Endemism is common at the species level, particularly in the southeastern United States, Australia, Asia, and Madagascar. Freshwater crayfish diversity is concentrated in two area: the southern United States and Victoria, Australia. A global species checklist is accessible online. In freshwater, prawns are classified into two families: the Palaemonidae which includes the significant giant river prawns of the genus Macrobrachium and the lesser Caridinidae. Both are crucial in food-webs and constitute the foundation of significant fisheries in tropical rivers, floodplains, ricefields, and other wetlands. River prawns are also the foundation of a substantial aquaculture industry across the world. Despite their significance, freshwater prawns have received little attention, and knowledge of their biology and taxonomy is limited. Even little information is available on their socioeconomic worth, despite the fact that it is generally recognised.

Vanuatu presently has 19 species of freshwater crustaceans belonging to seven genera. In contrast to Fiji and New Caledonia, where endemics made between 12% and 35% of the total, Vanuatu has no endemics, which may be explained by the archipelago's recent origin. Freshwater crustaceans are found in 34 different species in New Caledonia. The freshwater palaemonid fauna of New Caledonia has ten species in two genera, which is equivalent to the ten species described from nearby Fiji. Except for one endemic, all New Caledonian species are widespread in the Indo-West Pacific. So yet, no large-egged palaemonids have been discovered in New Caledonia or the other Oceanian islands. This is in contrast to Australia, which possesses four of those species plus one that is unknown. In New Caledonia, atyid shrimps have also been studied, giving 21 species, 10 of which are endemic. The wetter, windward northeast coast has more diversity. The southern part's high endemism reflects an early geologic separation.

CONCLUSION

Wetland fisheries are really important for keeping a variety of plants and animals alive and making sure that the ecosystem stays healthy. This summary talks about how important wetlands are for fish. It says we need to protect them to keep different kinds of fish alive.Wetlands are special places with lots of water and different kinds of plants. They are very important for fish because they provide places for them to have babies, find food, and hide from predators. These ecosystems help fish in rivers and where the rivers meet the ocean. They are important for fishing and making sure there is enough food for everyone. But, wetland areas are in danger from damage to their natural habitats, pollution, and changes

in the climate. This puts the variety of fish living there at risk.Efforts to protect and preserve the various types of fish living in wetland areas are complex and involve many different approaches. This means doing things like bringing back natural habitats, managing fishing in a way that can continue long-term, and making strong rules to reduce pollution and damage to habitats. Additionally, it is important to involve and educate the community in order to gain their support for conservation efforts.Protecting wetland fisheries biodiversity is important because it helps keep a variety of plants and animals that live in water safe. It also helps improve important things like cleaning water, preventing floods, and storing carbon. This means it is important to keep wetlands safe and protect the fish that live there. This is not only important for keeping a variety of plants and animals, but also for the people who depend on wetlands for their food and resources. More research, creating rules, and working together are very important to protect wetland species in the long term.

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CHAPTER 5

MANAGEMENT OF WETLAND HABITAT: INCREASED FISHERY PRODUCTIVITY

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ABSTRACT:

Fisheries provide the protein requirements and livelihoods of over a billion people worldwide, mostly in underdeveloped countries, while also servicing highly profitable foreign markets. Fisheries and aquaculture provide a living for roughly 500 million people, especially in poor nations, whether directly or indirectly. Fisheries cover a wide range of finfish and shellfish species and include both capture and aquaculture fisheries. All rely on the health of various sorts of wetlands. Sustainable fisheries management is a complicated socioeconomic and ecological endeavour that requires a comprehensive, inclusive, and adaptable approach. Wetlands are necessary for some freshwater fish species as spawning grounds and nursery habitats for their young. Northern pike spawning on Lake Champlain in the spring is a prime example. Others, like as the black bullhead, yellow perch, pumpkin seed, and bluegill, migrate to shallow-water wetlands to spawn. Wetland loss has been connected to the failure of many elements of commercial and recreational freshwater fishing in the Great Lakes.

KEYWORDS:

Bird Species, Conservation, Natural Wetland, Species, Wetland Restoration.

INTRODUCTION

Wetlands that are good for growing things usually change a lot throughout the year because of rain, floods, lack of rain, and other natural events. Wetlands that stay the same for many years usually become less productive and have less wildlife. Performing management activities that imitate natural disturbances can boost and sustain the productivity of wetlands, in order to provide support for wildlife. In the Central Coast, the aim of wetland management is mostly to help resident and migratory birds that live in or visit the area. Many other types of birds and sea creatures that live in wetlands also get helped by these activities to take care of the environment. Some management activities are needed to stop or manage the spread of non-native plants that harm wetland ecosystems.Wetlands may be thought of as watery farmlands since they generate large amounts of food. The primary nutritional value of wetland plants is obtained when the plants' dead leaves and stems decompose in the water, forming microscopic particles of organic material known as detritus[1], [2].

This enhanced material is the primary food source for many tiny aquatic invertebrates, shellfish, and forage fish, which are eaten by bigger predatory fish. These bigger fish are then devoured by humans. Wetlands that are utilized for spawning by northern pike or that are vital for providing fish habitat are considered significant wetlands under the Vermont Wetland Rules. The Secretary or Panel must examine the degree to which a wetland is important for fish habitat when evaluating whether it is significant. Fish may use this environment for spawning, nursery, feeding, or cover. Lowers or moderates surface water temperature owing to the discharge of cool springs, the supply of shade, or other factors.

Wetlands have been proven to perform a number of ecological, biological, and hydrologic activities that benefit society in terms of economic, aesthetic, recreational, educational, and

other aspects. However, throughout the nineteenth and much of the twentieth century, these ideals were little acknowledged in the United States. Numerous federal incentives encouraged wetland drainage, ranging from direct support for reclamation of wetlands under the Swampland Acts of 1849, 1850, and 1860 to agricultural subsidies that indirectly supported wetlands conversion to crop production. Wetland conversion to agricultural production has had a significant influence on fish and animal habitats all over the globe. There were roughly 221 million to 224 million acres of wetlands in what is now the conterminous United States when Europeans arrived. By 1992, 45 percent to 50 percent of the lower 48 states' original wetland acreage had been converted to agricultural and other uses, with losses nearing 90 percent in certain places[2], [3].

The Wetlands Conservation provision of the 1985 Food Security Act and the 1986 Tax Reform Act essentially abolished indirect government funding for wetland conversion. Since 1985, the Conservation Title of the Farm Bills of 1990, 1996, and 2002 has funded wetland resource conservation and restoration via a range of U.S. Conservation initiatives run by the United States Department of Agriculture (USDA). USDA conservation programs and technical help offered by Natural Resources Conservation Service (NRCS) conservation planners to owners and operators of agricultural properties and other USDA customers adopt a range of conservation strategies that impact wetlands. The Farm Service Agency uses comparable wetland-related conservation methods with somewhat different codes and definitions for the Conservation Reserve Program (CRP).

For the purposes of this chapter, activities that are commonly thought to have a direct impact on wetland function have been chosen for treatment. Other conservation strategies linked to land treatment and management may and do have an impact on wetland functioning in a number of ways, however such activities are discussed in other chapters of this book. Other approaches often utilized in wetland restoration and management operations include dike construction, water control structures, tree/shrub establishment, and so on. However, similar approaches are also utilized in a broad range of other applications that have nothing to do with wetlands and are therefore excluded from this chapter. Several USDA conservation programs provide cost-sharing and technical help. The area of wetland conservation techniques proposed under several USDA conservation programs for fiscal year 2004. It is designed to provide readers an overview of the many sorts of wetlands conservation initiatives that are taking place within a particular planning year, rather than a full count of all wetlands impacted by all programs. This document gathers existing material that describes fish and animal responses to wetland conservation techniques[4], [5].

The impacts that have been documented are organized by the main taxa that have been described in the literature. Much of the literature is concerned with a mix of practices. In many cases, the reaction of fish and animals to wetland restoration and creation is indistinguishable. In other situations, the wetland enhancement strategies investigated are indistinguishable from wetland management practices, and many wetlands maintained for wildlife have already been subjected to wetland restoration. As a result, sorting the literature by the NRCS-defined conservation techniques mentioned problematic. Where possible, distinctions are drawn between two broad categories of wetland conservation activity wetland establishment which includes Wetland Restoration and Wetland Creation and wetland management which includes Wetland Wildlife Habitat Management, Shallow Water Development and Management, and Wetland Enhancement. The primary goal of this study is to summarize the information on fish and animal responses to wetland establishing strategies.

This report includes information from that assessment pertaining to wetland techniques and the reported fish and animal response, as well as new outcomes reported after the 2000 study

was completed. Invertebrates Several studies have demonstrated that wetlands are swiftly colonized by a range of aquatic invertebrates and other animals once they are restored or formed. Researchers discovered similarities in invertebrate species between wild and restored wetlands in New York. Insects that disperse by air colonized restored wetlands faster than less mobile invertebrates. Researchers discovered 66 and 44 invertebrate species in newly created coal surface mine sediment ponds, respectively, in the first and second years studied, showing fast invertebrate colonization. The invertebrate fauna of restored wetlands is often described as being quite comparable to that of natural wetlands with similar plant structure. Researchers discovered that the number and composition of diatom species in restored prairie wetlands in North Dakota were comparable to those of natural wetlands. Several years after the basins were reflooded, Researchers discovered 18 wetland invertebrate species in four recently drained prairie wetland basins. Researchers discovered 31 species of aquatic macroinvertebrates in restored wetlands in a study of 156 restored seasonal and semi-permanent wetlands of 12 various ages in Minnesota and South Dakota, 12 of which appeared in wetlands the first year after restoration[4], [6].

Although invertebrate community differences between restored and natural wetlands may have gone unnoticed due to the low taxonomic resolution at which most invertebrate communities are sampled, restored prairie pothole wetlands are generally thought to be readily and adequately colonized by invertebrates. Wetland vegetation is significantly related with benthic invertebrate assemblages. Researchers discovered that three of the five common Chironomid genera were more abundant in areas with greater than 50% herbaceous cover than in more open areas in a created freshwater herbaceous wetland in central Florida, and that all five common genera were more abundant in areas with greater than 80% vegetation cover. Transplantation of leftover wetland soil may boost overall invertebrate population in restored wetlands by increasing the pace of wetland plant development. Researchers employed invertebrate species to measure biotic response to restored wetlands. Significant geographical and temporal variance, however, must be addressed. Within six to seven years of restoration, Researchers found that zooplankton taxon richness in restored wetlands in Wisconsin matched that of least-impacted reference wetlands[7], [8].

DISCUSSION

Researchers discovered that geographical distribution within a restored wetland in Georgia varied significantly across nematode species, as did temporal variation within taxa. Nematode taxonomic distribution did not correspond well with soil resource patterns. Researchers discovered a varied community of Coleoptera in a recovered marsh in northern Spain, however the majority of the species observed belong to early successional groups or are ubiquitists. Researchers discovered aquatic Heteroptera and Odonata groups in the same restored wetland that were comparable to natural immature wetlands. In general, beetle, dragonfly, and aquatic heteraopteran communities are typical of recent wetlands, with signs of shifts toward a more stable and mature habitat. The presence of fish in restored wetlands may also impact how invertebrates adapt to the circumstances of the restored wetlands. Researchers discovered that the presence of fathead minnows had a significant impact on the invertebrate community structure in Minnesota's restored prairie wetlands. However, Researchers discovered that the presence of fish had little effect on the zooplankton population in restored wetlands in Wisconsin. Fish The impact of wetland development on fish populations has received little attention. The geomorphic and geographic context of wetlands seems to have a substantial impact on how the fish population reacts[9].

Researchers discovered a robust and plentiful fish habitat comparable to natural wetlands in the region within two years of developing a manmade wetland in east-central Florida. They

hypothesized that in this geographical situation, fish were introduced to the marsh by irrigation or transfer by indigenous wildlife. Fish have not played a substantial role in the formation of biological communities inhabiting shallow prairie wetlands, which are often separated from deeper water bodies. Recent research has shown that introducing fish into previously fish-free prairie wetlands may have a detrimental impact on local species such as invertebrates, amphibians, and waterbirds. Similarly, agricultural ponds in Minnesota that do not include fish have been shown to be more likely to maintain diversified amphibian populations than those that do. Several studies show fast amphibian colonization of built and restored wetlands. Researchers discovered that eight amphibian species quickly colonized restored wetlands in Minnesota, with all of them establishing reproductive populations. Researchers found 12 species of breeding amphibians in freshly created coal surface mine debris ponds in western Tennessee, and each of the nine ponds investigated had at least one breeding frog species[10], [11].

Researchers discovered American toads, green frogs, and leopard frogs in Wisconsin's newly restored wetlands. Researchers discovered that a wetland built to treat mine water drainage in east-central Ohio sustained more herpetofauna abundance and species richness than neighbouring natural wetlands. This was largely owing to the enormous quantity of green frogs and pickerel frogs as well as various snake species discovered at this location. Researchers discovered that anurans call more often from restored wetland basins on Prince Edward Island than from comparable reference wetlands. This might be attributable in part to the increased quantity of microtopography in restored wetlands as a consequence of the major restoration activity of fill material removal from these locations. The state of the landscape and the surrounding land use seem to be important factors influencing amphibian colonization and utilization in restored wetlands. Researchers discovered that amphibian species richness was lower in glacial marshes in Minnesota with increasing wetland isolation and road density at all geographical scales in both tallgrass prairie and northern hardwood forest ecoregions.

The sluggish colonization of restored wetlands by amphibians in fragmented settings is most likely due to limited dispersion capabilities. Similarly, the removal of tiny wetlands used by reptiles and amphibians may have a severe impact on habitat availability and animal numbers. Although studies have indicated quick amphibian colonization of restored and constructed wetlands accessible to dispersing individuals, long-term survival and population dynamics in these settings remain unknown. Birds' responses to wetland conservation strategies have been better studied than those of other wildlife species. Numerous studies have shown that restored freshwater wetlands are heavily used by birds. Several years after the basins were reflooded, Researchers discovered 11 bird species in four recently drained prairie wetland basins. Researchers saw ducks and duck broods, as well as breeding marsh wrens, sandpipers, and woodcock utilizing tiny restored wetlands in Wisconsin. Researchers discovered an increase in numerous bird species of management concern as a result of prairie-wetland complex restoration in Iowa. Despite the lack of quantitative data, Researchers observed significant increases in wetland-associated animal usage after the restoration of a 55-acre wetland in northern New York.

During the first year following restoration, Researchers observed wetland-dependent birds at an 80-acre restored wetland site in south-central Pennsylvania. Winter raptors, wintering and migratory ducks, geese and tundra swans, foraging wading birds, waterfowl and shorebirds, and other species were spotted. There were breeding mallards, wood ducks, soras, sedge wrens, common snipes, spotted sandpipers, and pied-billed grebes. During the first year after the marsh was restored, bird diversity rose by 60%. Researchers discovered that survival odds

for female nesting mallards in restored wetlands in central New York were equivalent to those of mallard populations in natural wetland systems. In most cases, birds colonized restored wetlands quickly, generally within the first year after restoration. During the second and third breeding seasons following restoration, Researchers discovered breeding black terns utilizing a restored prairie wetland. During the third mating season, up to 40 adults were found in the marsh, and at least seven young fledged. Researchers discovered 12 species of duck in Minnesota and South Dakota utilizing restored wetlands of varied ages.

Using a 1,246-ha previously drained northern prairie wetland that was restored and inundated with municipal wastewater, Researchers reported 50 shorebird species, 44 waterfowl species, 15 hawk species, and 28 additional new bird species in the first five years following restoration. Studies have demonstrated that birds associated with grasslands and scrub-shrub communities easily utilise bottomland hardwood wetland restoration sites when they migrate from open field to wooded habitats. These findings demonstrate how rapidly wetland-associated birds adapt to restored wetland environments. However, owing to the variety of existing wetland conditions, bird reaction to constructed bottomland hardwood wetlands may be less predictable. Researchers discovered, for example, that developed bottomland hardwood wetlands in Virginia had much lower bird species richness and diversity than comparable reference wetlands. The authors of this research suggested that the lack of bird response was caused by artificial hydrological patterns and poor plant establishment in developed wetland locations.

Most studies in the literature revealed that bird usage increased with the size of the restored wetlands studied. Larger prairie wetlands had more diversified bird groups. Researchers discovered that large restored wetlands in Wisconsin have a higher non-game bird species richness than tiny wetlands. Researchers discovered that the diversity of breeding bird species rose with wetland size in restored herbaceous wetlands in northern Iowa, independent of how long the wetlands had been restored or how long they had been drained. An examination of data gathered on bird usage of wetlands restored in central Iowa under the Farmable Wetlands Conservation Reserve program reveals a substantial relationship between wetland size and bird species richness. Others, however, have reported changes in the bird population with time after wetland restoration in response to plant changes. According to Researchers, total bird species richness rose with the age of restored prairie wetlands in Iowa, but waterfowl usage was impacted more by restored wetland area, independent of age. The structure of habitat in restored wetlands seems to be a significant factor determining bird usage of specific wetland locations. Borrow ponds built beside a roadway in North Dakota had lower density of waterfowl nesting pairs than natural basins of comparable size.

This was linked to the borrow area wetlands' absence of a shallow water region and emergent wetland vegetation. Researchers discovered that under drought circumstances, spring waterfowl pair usage was larger in semi-permanent natural wetlands and artificial stock ponds than in other wetland types, emphasizing the significance of surface water supply to breeding waterfowl. The usage of restored wetland systems by birds is comparable to that of wild wetlands with similar habitat structure. Researchers found no change in bird numbers, species richness, or species diversity between 39 natural prairie wetlands in North and South Dakota and 39 restored wetlands. Researchers discovered that among the three bird groups evaluated wetland-dependent, wetland-associated, and non-wetland birds, the number of bird species and individuals did not change between restored and natural wetlands in New York. They discovered that bird assemblages were more comparable across restored and natural wetland locations. Researchers discovered that restored and wild wetlands in Michigan had

comparable bird species richness and variety, with restored areas supporting larger numbers of wetland dependent birds.

Natural wetlands have a greater species richness of breeding birds than restored prairie wetlands. However, there was no difference in duck species richness or pair numbers between wild and restored wetlands. Drought during the research might have altered the findings. Researchers discovered that more plant species are beneficial as food sources for wetland birds in restored wetlands than in wild wetlands in New York. Bird similarity differences between wild and treated wetlands may vanish as restored wetlands mature. While the size of restored wetlands influences bird usage, so does the proximity to adjacent wetland habitats. Many bird species utilize restored wetlands based on the status of upland habitats close to wetlands and the surrounding environment. Local wetland characteristics govern habitat appropriateness for certain stationary wetland bird species, while wide-ranging species are highly influenced by the state of the terrain around wetland habitats. While pied-billed grebes and yellow-headed blackbirds used wetlands in South Dakota based on the condition of the habitat within wetlands, black terns, a widespread species, used wetlands based on the use and condition of the surrounding landscape.

Bird usage is related to habitat variety within specific wetlands. Researchers that the proportion of wetland area with emergent vegetation inside wetland complexes, total wetland area within three kilometres, and total area of semipermanent wetlands within three kilometres of wetland complexes were all positively linked with bird diversity. Similarly, Researchers discovered that the presence of emergent and submerged wetland vegetation, as well as the existence of neighbouring wetlands, were critical determinants in influencing waterfowl usage of mined areas in Wyoming. Black tern usage of prairie wetlands was shown to be substantially associated with wetland acreage, quantity of semi-permanent wetland area inside the wetland, and grassland extent in the surrounding upland matrix. The usage of black terns was linked to vast wetland basins in high-density wetland complexes, demonstrating the need of addressing whole landscapes in habitat evaluations and conservation efforts.

CONCLUSION

When considering wetland ecology and management for fish, amphibians, and reptiles, some areas demand special consideration. All of these areas are under danger from humans in some way. In the Florida Everglades, for example, alligator egg mortality has risen from 4.5% to 20%, coinciding with higher water level changes caused by present water management measures. Gator ponds are somewhat deeper regions amid the shallow expanse of the Everglades marshes. The activity of huge alligators maintains the depth and width of these ponds. Gator ponds provide refuge for fish and other creatures during times of low water and drought, but their numbers are diminishing owing to current water management techniques and a decrease in huge alligators due to hunting. Pond habitat and usage as a refuge are also declining as a result of these issues. Furthermore, more than 30 exotic amphibian and reptile species have been reported in the Florida Everglades, and these creatures are causing substantial changes in the ecology. This vast sawgrass prairie and mangrove complex, on the other hand, is home to 68 vulnerable and endangered species. The Everglades suffer from eutrophication, heavy metal poisoning, habitat modification, hydrologic disruption, and the introduction of exotic species, among other issues.

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CHAPTER 6

POLICY AND REGULATORY: FRONTIERS IN WETLAND AND FISHERY GOVERNANCE

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ABSTRACT:

Having a good system for managing wetlands and fisheries is very important for taking care of the environment and helping the economy grow. This summary emphasizes the importance of strong rules and regulations for managing wetlands and fisheries. It focuses on areas where improvements and new ideas are needed.Wetlands are important homes for different types of fish. They provide safe places for fish to lay eggs, grow, and help keep the environment balanced. So, the way wetlands and fishing work together needs a complete and well-rounded approach. We need strong rules and laws to make sure we take care of nature while also meeting the needs of the people who rely on it.The ways we manage wetlands and fisheries are improving. We are combining traditional knowledge and scientific methods to make these areas more sustainable. It is important to use adaptive management approaches that can respond to changes in the environment and the effects of climate change. It is important to have strong structures for governing at different levels, including local communities, governments, and international organizations. This will help coordinate and enforce rules effectively.Additionally, it is important to tackle illegal fishing practices, improve ways of monitoring and enforcing rules, and encourage sustainable practices in fish farming. These actions are crucial for effective wetland and fishery management.

KEYWORDS:

Aquaculture, Fisheries, Governance, Management, Wetland.

INTRODUCTION

Modern fisheries governance is a systematic term that refers to the exercise of economic, political, and administrative power. It is distinguished by guiding principles and goals, both conceptual and operational; the ways and means of organization and coordination; the infrastructure of socio-political, economic and legal institutions and instruments; the nature and modus operandi of the processes; the actors and their roles; the policies, plans and measures that are produced; as well as the outcomes of the exercise.Fishery governance defines the sector's overarching concepts and goals. It creates policy and regulatory structures. It bridges the gap between government and civil society, harmonizing individual, sectoral, and societal viewpoints while preserving social order and productive socio-ecological systems. It legitimizes and balances stakeholder involvement, enforces decisions and rules, and ensures consistency across jurisdictional, spatial, and temporal dimensions. Finally, it governs the distribution of power, resources, and rewards while preserving the governance system's ability to adapt and develop.

Fishery governance comprises global, national, and local components. It consists of legally enforceable regulations such as national policies and laws, as well as international treaties and customary social arrangements. It is multiscale, including both long-term strategic planning and short-term operational management, as well as local fisheries and whole ecosystems[1], [2]. It is important to have decision-making processes that involve everyone and take into account the concerns of all people involved. This is necessary for policies to be implemented successfully.In simpler terms, improving the way we take care of wetlands and

fisheries requires new policies that consider the environment, the economy, and fairness for everyone. Working together, being flexible in our approach, and using scientific knowledge in our decision-making are important for managing wetland fisheries sustainably. This will help protect these valuable ecosystems for both present and future generations.

It consists of public, private, and hybrid components that work together to ensure sector administration and regulation.The UNCED process is bringing about more environmentally conscious, precautionary, and participatory forms of fishery governance, with the following commitment, legitimacy, credibility, transparency, performance assessment, oversight, duty of care, equity, science and other knowledge, traditional values, ethics, systemic, multiscale, integration, coordination, adaptive, affordable, and context sensitive.In order to promote sustainable fisheries from harvest to table, the Fisheries and Aquaculture Division works on improving usage of harvested and cultured fish to extract maximum value from fishery resources while promoting sustainable fishing practices.Activities are centred on total global fish usage, with the goal of:

1. Decreasing post-harvest losses with a particular emphasis on safety and quality includes aquaculture products.
2. Value-added and small-scale processing.
3. Commerce and marketing: focusing specifically on enhancing domestic fish markets and market access criteria.
4. Commerce and the environment: this includes all international agreements ranging from wto and cites judgments to labelling and certification standards, food safety concerns, and market information access.

The FAO Fisheries and Aquaculture Division develops codes of conduct and standards for product safety, usage, marketing, and responsible trading.The Fisheries and Aquaculture Division's mission to facilitate and secure the sustainable development and utilization of the world's fisheries and aquaculture is dependent on how effectively and efficiently the Division compiles and collates fishery data and information, analyzes and integrates this data and information, generates new relevant and usable information products, and makes the information products available to a targeted audience. The Division continuously monitors the status and trends of the sector using a variety of global or regional fishery databases, including statistics on production, fleet, trade, etc.fishery and aquaculture country profiles, various collections of species, fishing technology, or governance fact sheets, complemented with GIS information. This monitoring takes many forms, including assessments of fisheries resources, analysis of fishing methods, policy and socioeconomic surveys, commodities markets, and seafood quality and safety monitoring. This source of information is expanded upon in the form of impartial assessments, forecasts, policy briefings, and strategic guidance[3], [4].The Division's information strategy is built on three primary pillars in order to expand its function as a knowledge source and exchange method for fisheries and aquaculture:

1. Increasing the quality of fisheries data and information gathered from a variety of sources ranging from government agencies to igos or ngos, by promoting information standards, implementing proper quality control, and developing information partnerships for data sharing.
2. Creating an information systems architecture capable of providing all users with simple access to fair and integrated information, while simplifying information flows and making information contribution more cost effective.

3. Properly packaging and presenting data and information in formats and media that react to the information demands of the target audience, so that it is relevant and useable in the context of users.

Finally, the Division supports member nations and fishing authorities in their efforts to collect and disseminate trustworthy information in accordance with international norms and standards.The Fisheries and Aquaculture Policy and Economics Division's (FIP) mission is to effectively and efficiently contribute to policy and institutional development for the promotion of sustainable capture fisheries and aquaculture, as well as to actively influence global capture fisheries and aquaculture agendas.FIP is in charge of all economic, social, institutional, governance, policy, and management aspects of all capture fisheries and aquaculture programs and activities, as well as their long-term development, with a focus on improving human well-being, food security, and poverty reduction. The Division advises, assists, and informs FAO Members on economics and policies, strategies, plans, and programs for the management and development of capture fisheries and aquaculture.Within the Department, FIP is in charge of developing and implementing international instruments pertaining to capture fisheries and aquaculture. FIP encourages the implementation of the Code of Conduct for Responsible Fisheries, its associated instruments, and other relevant international documents, as well as the development of further guidelines and international plans of action in specific regions[5], [6].

Technical help is available for the formulation of regional and national action plans.FIP serves as the Secretariat of the Committee on Fisheries (COFI), coordinating and supervising the provision of secretariat services in support of the COFI Sub-Committees, as well as coordinating the implementation of the programme of work; liaises with other units and coordinates departmental inputs to FAO's statutory bodies, and monitors the Department's follow-up action onFIP is also in charge of providing and coordinating overall departmental support to regional fishery bodies, as well as ensuring liaison and coordination with international intergovernmental and non-governmental organizations concerned with capture fisheries and aquaculture.By carrying out these responsibilities, FIP aspires to be an active, efficient, and influential player throughout the entire process of agenda setting, policy development, and implementation for responsible capture fisheries and aquaculture, as well as their increased contribution to food security and human well-being.Many different people want to use wetlands and water resources. People compete with each other to own or use wetlands and the things that come from them. This competition can happen between different people, groups, or governments, and can cross boundaries between different areas. So, we need to find fair and factual methods to study how wetlands are being used and plan for the future. We have to make sure to protect the functions and importance of wetlands while also considering immediate needs.

National wetland policies (NWPs) help achieve this complicated goal and, ideally, improve the understanding and support for the responsible use of wetlands as a priority for the public. A good policy-making process should allow local people, user groups, governments, and non-governmental organizations to express, compare, and assess their needs, interests, and responsibilities in relation to wetland conservation and sustainable use goals. This text is saying that it's important to identify and resolve conflicts between what a local area wants, what a country wants, and what international agreements require. There are 15 NWPs that can be used to show what choices have been made, set goals, and clarify who is responsible for what. Making the NWP successful and used could be made easier if it is seen to follow the promises made in the Ramsar treaty or other agreements. On the other hand, if there are no clear policies, it might mean that there are no clear goals, coordinated actions, or

understanding of wetland issues, even among the people in charge of making decisions. This can be made worse by problems within organizations, such as confusion in the administration or lack of effectiveness in their operations. In these situations, most people might not support wise use and conservation, or their support might be inconsistent[7], [8].

The implementation and enforcement of any measures related to wetlands can be seriously weakened. International environmental law now gives a strong foundation for planning across different areas. The CBD wants each country to make a plan for protecting and using biodiversity. This plan should be based on the country's specific conditions and abilities. If a country already has a plan, they may need to make changes to it to focus on conservation and sustainability. These goals need to be included in relevant plans and policies. When making decisions, national governments should consider the protection and sustainable use of plants and animals. They should also try to avoid or reduce harm to biodiversity. The Convention on Desertification and the Ramsar Convention both promote the development of integrated programs. Other environmental agreements also support these types of approaches. For example, Action Theme 2 of the 1995 Pan-European Biological and Landscape Diversity Strategy is focused on including biological and landscape diversity in different sectors. This is meant to help Europe follow Article 6 of the CBD. So far, the work has involved approving a two-fold plan that encourages discussions between decision-makers from different sectors and cooperation with relevant socio-economic groups, both at international and national levels[9], [10].

DISCUSSION

Wetlands and fisheries are critical components of global ecosystems, offering significant ecological, economic, and social benefits. Effective administration of these interrelated resources is critical for ensuring their long-term viability and striking a balance between environmental protection and human growth. This conversation will examine policy frameworks, regulatory obstacles, socioeconomic repercussions, and possible solutions to the complex dynamics of wetland and fisheries governance.Wetlands, which include marshes, swamps, and mangroves, are crucial habitats for a wide range of flora and wildlife and play an important role in biodiversity conservation. They serve as spawning places and nurseries for fish, hence maintaining the life cycles of numerous species. Wetlands also offer important ecological services such as water filtration, flood control, and carbon sequestration. As a result, their preservation is critical for overall ecological health.Fisheries, on the other hand, provide millions of people throughout the globe with food, cash, and jobs. Freshwater and marine fisheries both play an important role in global food security, with fish serving as a key protein source for many people. Sustainable fisheries management is critical not only for the preservation of fish populations, but also for the sustaining of livelihoods and economies.

Frameworks for Policy and Regulation

The creation and execution of strong policy and regulatory frameworks is essential for effective governance of wetlands and fisheries. These frameworks should handle the delicate interaction between environmental protection and socioeconomic growth.Integration of Traditional Knowledge and Science. Policymakers must understand the importance of indigenous and local populations' traditional knowledge in managing wetlands and fisheries. When this information is combined with scientific understanding, it may lead to more comprehensive and successful policy.Adaptive management techniques are critical given the dynamic character of ecosystems and the difficulties presented by climate change. These techniques include continual monitoring and adaptation of laws and regulations to changing environmental circumstances.Effective wetland and fisheries governance often necessitates

cooperation at numerous levels. Local governments, national governments, and international organizations must collaborate to guarantee effective regulatory coordination and enforcement.

Governance Issues in Wetlands and Fisheries

While acknowledging the significance of wetland and fisheries administration, it is critical to recognize the multiple problems and complexity connected with these ecosystems.Wetlands are threatened by habitat degradation, which includes urbanization, agriculture, and infrastructure development. These activities have the potential to upset the delicate equilibrium of wetland ecosystems.Pollution from industrial, agricultural, and residential sources endangers wetlands and fisheries. Excess nutrients and chemical contaminants may damage aquatic life and degrade water quality.Changes in temperature, precipitation patterns, and sea levels caused by climate change have an influence on both wetland and fisheries ecosystems.

These alterations may result in changes in fish populations and the loss of wetland habitat.Illegal and unsustainable fishing techniques, such as overfishing, may decrease fish populations and harm ecosystems. To overcome these difficulties, effective fisheries management is required. A prevalent issue in many places is a lack of regulatory enforcement. Inadequate funding, corruption, and insufficient monitoring may all hinder conservation initiatives.Balancing wetlands and fisheries protection with economic growth might result in conflicts of interest. Communities that rely on these resources may oppose conservation efforts that they see as harmful to their livelihoods.

Implications for Socioeconomics

Decisions over wetlands and fisheries have significant socioeconomic effects that must be properly studied.Fisheries play an important role in global food security, particularly in coastal areas and underdeveloped nations. Sustainable fisheries management is critical for ensuring a consistent supply of protein-rich meals.Wetlands and fisheries provide a source of income for millions of people. These industries give income and job possibilities, especially in rural and coastal areas.Effective administration may lead to the long-term expansion of the fisheries and aquaculture sectors, which contribute to national economies via exports and domestic consumption.Wetlands and fisheries have cultural and spiritual importance for many indigenous and local populations. Their preservation is critical for the preservation of cultural heritage.Wetlands, in particular, have the potential to attract visitors and promote leisure activities such as birding and boating, providing cash for local economies.

Innovations and solutions

Addressing wetland and fisheries governance concerns necessitates novel ideas and solutions.Adopting ecosystem-based management techniques that take into account the connectivity of wetlands and fisheries may result in more sustainable results.Efforts to rehabilitate damaged wetlands may aid in the rebuilding of fish habitat and the promotion of biodiversity. Re-establishing vegetation, minimizing pollutants, and managing exotic species are all part of this.Implementing sustainable fisheries management measures, such as catch quotas, gear limitations, and protected areas, may help preserve fish populations.Creating techniques to improve the resilience of wetlands and fisheries to climate change, such as restoring coastal mangroves, may help to offset the negative effects of climatic variability.Involving local populations in decision-making processes and giving alternative livelihood alternatives might help to reduce disputes and gain support for conservation initiatives.

Using technology such as satellite imaging and underwater sensors may enhance monitoring and enforcement activities, lowering illicit fishing and improving conservation results.To solve transboundary challenges, collaborative agreements and international treaties such as the Ramsar Convention on Wetlands and regional fisheries management bodies are required.Case studies may give information on effective wetland and fisheries governance initiatives. Restoration efforts in the Everglades ecosystem highlight the need of habitat restoration and adaptive management in wetland conservation.The need of multi-level governance and sustainable practices is shown by regional collaboration among Kenya, Tanzania, and Uganda to manage the shared Lake Victoria fisheries.Sundarbans Mangrove Forest, Bangladesh. Conservation efforts in the Sundarbans highlight the need of preserving important mangrove forests in order to maintain both wetlands and fisheries.The construction of marine protected areas in the Philippines has resulted in the recovery of fish populations and the development of a model for sustainable fisheries management.

To summarize, wetland and fisheries governance is a complicated and varied task that requires a comprehensive and adaptable strategy. These ecosystems' value for biodiversity protection, food security, and socioeconomic well-being cannot be emphasized. Effective policy and regulatory frameworks, informed by a blend of traditional and scientific knowledge, are critical to their long-term viability.Despite the various obstacles caused by habitat loss, pollution, climate change, and competing interests, inventive solutions and successful case studies provide hope. Effective governance is built on ecosystem-based management, habitat restoration, sustainable fisheries practices, and community participation.Furthermore, multi-level international cooperation and collaboration are crucial for tackling transboundary challenges and meeting global conservation objectives. As we go ahead, we must emphasize the protection of wetlands and fisheries, recognizing their critical significance in both our economies.

CONCLUSION

In summary, the management of wetlands and fisheries is very important for protecting the environment, promoting economic growth, and ensuring the well-being of society. Clear and strong rules and regulations are important to successfully navigate this complicated meeting point.To make sure wetland and fishery resources last a long time, we need to combine old knowledge with new science. It is very important to have plans that can change as the environment and climate change. These plans are called adaptive management strategies. Working together and having different levels of authority involved, like local communities, governments, and international organizations, are very important for effectively coordinating and making sure rules are followed.Dealing with problems like illegal fishing, improving ways to watch and enforce rules, and encouraging sustainable fish farming practices are very important in the way we manage wetlands and fisheries today. It is also important to include everyone and let them be a part of decision-making. This means considering the different needs and wants of all the people involved.In simple words, the future of wetlands and fisheries depends on coming up with new policies that can keep the environment healthy, help businesses make money, and make sure everyone is treated fairly. As we explore new ways of managing, what we do now will affect how long these important ecosystems will last for future generations. We all have a responsibility to protect these resources because they are important for nature and people.

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CHAPTER 7

EMERGING DISEASES IN WETLAND FISHERIES:| A COMPREHENSIVE REVIEW

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ABSTRACT:

Wetlands have a long history of being associated with infectious illness, which has led to their alteration in order to limit disease transmission. Simultaneously, water resource initiatives that raise the danger of illness have been developed. The rising pressure to make natural wetlands commercially profitable, as well as the desire for additional water development projects, necessitates an ecological approach to wetland management and health evaluation. There are several environmental and health linkages. Water development initiatives must include the terrain, geographical boundaries, and cross-boundary interactions, as well as alternate means of providing water for human needs. The research issues that must be addressed are outlined.Wetlands with fish are very important for food, jobs, and protecting different types of plants and animals all over the world. However, the well-being of fish in these ecosystems is in danger due to different diseases, which can have significant effects on the environment and economy. This chapter gives a detailed explanation of the diseases that can harm fish in wetlands. It focuses on how these diseases can affect the number of fish and the ecosystems they live in.

KEYWORDS:

Disease, Fish, Species, Water, Wetland.

INTRODUCTION

While the role of epizootic disease or low occurrence infection is always a possibility, interactions between hosts and infectious agents may be subject to stochastic events that influence cross-species infectivity and agents jumping from one species to another. Because biota may flow collaterally from source waters to receiving systems, we consider disease episodes to be "simple" outcomes related with interbrain water transfers in the present study. The brief life histories of concern biota that follow are intended to provide background and context for the risk evaluations considered in this work, and as such are organized into two major breakout groups: those disease agents primarily associated with fishes and those disease agents primarily associated with terrestrial and wetland vertebrates, including humans. The inclusion of illness agents with well-defined functions in human health should not be construed as key drivers in this study. Rather, human disease agents, which are frequently zoonotic in nature, serve as representative biological agents in the range of disease processes that may be of interest when it comes to biota transfers, particularly when transfers may be associated with increased likelihoods of the occurrence of emerging infectious disease[1], [2].

Fish are vulnerable to a variety of parasites and infectious illnesses, which may result in diminished health and lifespans, if not early death. Individual health losses may be reflected as higher morbidity and death throughout a region if they are visible among populations. If the sickness becomes widespread, it may be classified as an epizootic. Disease-related mortality is best documented for hatcheries and aquaculture facilities from a quantitative standpoint, though field observations of disease outbreaks are not uncommon for some diseases related to causal agents frequently associated with human interventions. Selected

disease pathogens on this list were identified as biota of concern as a result of interbasin water exchanges between these river basins. Many bacterial, viral, and fungal diseases affect fish in North American waters, including furunculosis, bacterial kidney disease (BKD), coldwater disease (CWD), vibriosis, and enteric redmouth disease (ERM). Disease manifestations can be conveniently assigned to categories, such as acute infectious disease, chronic infectious disease, diseases characterized by skin lesions, and diseases characterized at post-mortem conditions, whether considering disease agents and their impacts on wild stocks or stocks in hatcheries or controlled facilities[3], [4].

Unless changed states of morbidity or mortality are visible, forthright disease is difficult to identify in most cases, but notably in wild populations. For example, Saprolegnia spp. exposes fish to a variety of fungus during their life cycle. It is a frequent opportunistic infection in a broad variety of aquatic vertebrates and invertebrates. Furunculosis may also be a problem in freshwater fishes, and the illness affects a broad range of species. No natural rivers with resident fish populations are considered disease-free, and furunculosis may cause large mortality in wild populations, for example, if river water temperatures become extremely high for lengthy periods of time. Furthermore, bacterial kidney disease (BKD) is a chronic illness of salmonid fishes that spreads both vertically and horizontally in culture settings. BKD, once established, may be difficult to manage and almost hard to treat. BKD is found in both Canada and the United States. Prevention, and in the absence of prevention, control, of any disease process bacterial, fungal, or viral under field conditions is difficult, and under cultured conditions, while more manageable, still necessitates time and resources that, in the end, reflect investments that may not be fully appreciated in the long-term gains anticipated by resource managers. Enteric redmouth (ERM) and Infectious hemtopoietic necrosis virus (IHNV) were among the biota of concern in the present study[4], [5].

Enteric redmouth disease (ERM) is a systemic bacterial infection caused by the bacterium Yersinia ruckeri. Rainbow trout, Oncorhynchus mykiss, are especially susceptible to infection, and ERM occurs in salmonids in both wild populations and culture conditions across Canada and the United States. ERM is often shown by prolonged low-level mortality, which finally results in significant losses. Chronically infected fish may become eizootic if they are stressed during hauling or subjected to other bad environmental circumstances in the wild. ERM is treated in hatcheries using medicated diets or intraperitoneal injections for adult fish, or with commercially available vaccinations and surface disinfection of eggs in culture facilities. ERM was initially detected in rainbow trout in Idaho in the 1950s, and it was identified. Fish with epizootics often exhibit lethargy, anorexia, and subcutaneous hemorrhages in and around the mouth, oral cavity, and isthmus, as well as near the base of the fins. Petechial hemorrhages may occur on the surface of the liver, pancreas, pyloric caeca, and swim bladder, as well as in the lateral muscles. Splenomegaly is common, with the organ being very friable. The gastrointestinal system becomes inflamed throughout, with the lower intestine being charged with a thick, yellowish exudate. Exophthalmus develops, often with hemorrhages surrounding the ocular chamber and iris, and the eyes often explode as the condition advances[6], [7].

DISCUSSION

Tissues from infected trout show acute bacteremia and associated inflammatory reactions in almost all tissues. Bacteria are visible under the microscope in vascular tissues and petechial hemorrhage zones. Bacterial colonization occurs in the capillaries of highly vascularized tissue, followed by tiny blood vessel dilatation, petechial hemorrhages, erythrocyte congestion, and edema of the kidneys, liver, spleen, heart, and gills. There may be focal necrosis in the liver, as well as significant accumulations of mononuclear cells in periportal

regions. Hemorrhages form in the digestive tract's outer lining, and the mucosa becomes edematous and necrotic, often sloughing off into the lumen. Atypical infections sometimes occur, in which hemorrhages do not form on the mouth and gill cover and the fish simply darken and swim toward the surface. If a fish survives, its skin darkens and its behaviour changes; for example, the typical survivor avoids other fish and seeks refuge. These fish act as infection reservoirs. Virus infections in fish. Fish have a range of viral illnesses that appear in the wild as well as under controlled settings in hatcheries or other culture facilities. In hatchery culture salmonids, for example, commonly diagnosed viral diseases include infectious pancreatic necrosis virus (IPN), salmon papilloma, and infectious hematopoietic necrosis virus (IHNV), the latter disease identified as one of the biota of concern in the current investigation[8], [9].

Each of these illnesses may be found in wild populations. IHNV (infectious hematopoietic necrosis virus). IHNV (Infectious Hematopoietic Necrosis Virus) is a bullet-shaped rhabdovirus that mostly affects salmonid populations. IHNV is endemic to the Pacific Northwest, where it was discovered in 1953 during a disease epidemic at two fish hatcheries in the state of Washington. IHNV was documented across the Pacific Northwest during the rest of the 1950s and 1960s, causing unusually high mortality in salmon production. IHNV got its name from the necrosis of hematopoietic tissue in the anterior kidney, which is the major histopathological feature. However, this virus induces viremia with bleeding and necrosis of numerous organs and tissues and creates an acute, systemic infection. This virus has also been known as the British Columbia Virus, the Oregon Sockeye Virus, and the Sacramento River Chinook Disease Virus. The molecular weight variations of the viral components have resulted in the classification of five IHNV serotypes. The virus, which was initially found in the Northwest, has now spread across the United States and Canada, with cases being identified in Minnesota, Montana, South Dakota, Alaska, West Virginia, and British Columbia. In Europe and Asia, outbreaks have been documented in France, Italy, Belgium, Japan, Taiwan, and Korea. IHNV is thought to have spread initially as a result of the practice of feeding fry with meal made up of ground adult fish and viscera, but more recently as a result of shipping IHNV contaminated eggs and fry from the Pacific Northwest of the United States and Canada.

IHNV infections may be fatal in young fish, usually as fry or fingerlings. The age and size of the fish are closely connected to survival and % death from IHNV. The younger the fish, the more vulnerable to this sickness they are. Within a week of being exposed to the virus, young fish show visible indications of illness. Moralities often begin four to five days following exposure, with peak numbers occurring around 10 days later. There are frequently no more moralities after 40 or 50 days. The most common route of infection is via the gills, skin, or gastrointestinal tract. When fish initially develop IHNV, they may die without showing any clinical indications, although they are frequently moribund and sluggish, with intermittent spinning or hyperactivity. Fry may also be black, have a swollen belly, pale gills, expothalmia, bleeding of the muscle and vase of fins, and cast-like excrement trails. Internally, fish seem anemic, with petechial bleeding of mesenteries or visceral tissues and muscle, and milky or watery contents in the stomach or intestine. There is also significant necrosis of the anterior kidney and spleen's hematological components. Most internal organs of sick fish generally exhibit necrosis[10], [11].

Both species' management choices must be founded on sound research in terms of disease detection and importance. Improved management choices may be made if we have a thorough grasp of the virus's naturally occurring prevalence in both species' wild populations. Due to a lack of comprehensive information, management is now erring on the side of

caution when it comes to stocking positive or suspicious sturgeon. Decisions in the not-too-distant future will have to be based on the need to save the species from extinction as the natural population ages into senility and death. Fungal infections of fishes. Although not mentioned as a biota of concern, they are briefly considered for completeness. While fungal disease organisms that may be transmitted as a result of interbasin water diversions are already present in both source and receiving basins, the potential for metapopulation changes remains, albeit at a low level. Fungi may become an issue when fish are stressed due to illness, poor environmental conditions, low diet, or injury. Fungus may infest the fish if these things weaken it or destroy its tissue. Fungi can also prevent successful hatching by invading fish eggs.

All fungi produce spores that readily spread disease, because fungal spores are relatively resistant to heat, drying, disinfectants, and the natural defence systems of fish. The three most common fungal diseases are Saprolegniasis, Branchiomycosis, and Ichthyophonus disease. Saprolegniasis is a fungal illness of fish and fish eggs caused mostly by the Saprolegnia species, sometimes known as "water moulds." The disease is frequent in fresh fishes, particularly those found in warmer waters. The genus Saprolegnia spp. can grow at temperatures ranging from 32/ to 95/F, but seems to prefer 59/ to 86/F. The illness will target an existing damage on the fish and has the potential to spread to healthy tissue. Saprolegnia infections are often linked with poor water quality with limited circulation, low dissolved oxygen, or high ammoniaand high organic loads, including the presence of dead eggs. Columnaris sp. Saprolegniasis is also often associated with bacteria or external parasites. Disease Symptoms. Saprolegniasis is often recognized as fluffy tufts of cotton-like material ranging in colour from white to grey and brown on fish skin, fins, gills, or eyes, or on fish eggs. For correct diagnosis, these portions are scraped and put on a microscope slide. Saprolegnia appears as hyphae under a microscope.

Control and management. adequate management methods, such as adequate water quality and circulation, avoidance of crowding to reduce harm, and appropriate diet, are the greatest ways to prevent saprolegniasis. After identifying Saprolegnia in an aquatic system, sanitation should be investigated and rectified. Disease outbreaks are typical in cultured environments, and if mortality is seen, therapy is indicated. The taxonomy of the whole myxozoan group, and particularly the Myxobolus/Myxosoma group, is quite dynamic and the subject of considerable research. While a full evaluation of the species' present taxonomic position is beyond the scope of this study, a quick synopsis gives the evolutionary background necessary for the research. Some workers consider Myxozoa to be phyllum, whereas others consider them to be highly specialized, reduced forms of parasites with complicated life cycles as members of the Cnidaria. Regardless of these higher-level taxonomic disagreements, the myxozoans have over 1200 species, with roughly 50 genera having been identified. Regardless of the basic concerns underpinning the group's classification, the Myxozoa are all parasitic life forms, with parasitic life-cycles mostly reliant on teleost fish, but examples from invertebrates, amphibia, and turtles are also known.

Their life cycles are quite complicated when completely defined. In a nutshell, spores are multicellular in origin, with each spore consisting of 1 to 3 valves, each holding one to many sporoplasms. Each sporoplasm includes one to many polar capsules, each with a polar filament that is released after host invasion. A generalized myxozoan life-cycle commonly finds the parasite's early developmental stages as trophozoites inside cells of fish. The cell type targeted will vary depending on the species, for example, cartilage for the causal agent of whirling sickness. The trophozoite grows and produces amoeboid cytoplasm, while the nucleus undergoes recurrent karyokinesis to generate a plasmodium. Plasmodia develop

connected to the epithelium in the coelomic region in coelozoic forms or inside tissues in histozoic species. Many coelomic forms of plasmodia form sheet-like aggregates over the winter, then grow long, finger-like extensions that bud off as free-floating plasmodia in the late spring and summer. Spores develop inside the fingers and buds and are expelled with the urine . Some cells inside the plasmodia are destined to become spores, and a variety of sporulation procedures have been described.

An envelope cell envelope a sporogonic cell in all kinds of sporulation, when numerous cell divisions of the sporogonic cell create new cells that finally form two distinct spores inside the envelope cell. The amount of spores produced by the same cells fluctuates, but spores are eventually released into the environment and consumed by tubificid oligochaetes. When sporoplasm enters the final host, polar filaments are ejected, spore valves split, and sporoplasm invades the gut. Sporoplasm then divides asexually, typically by multiple fission, which is followed by gamogony, in which cells formed from the fusing of distinct plasmodia. Cell fusion produces 3-valved triactinomyxon spores, which are then discharged into the gut lumen and finally expelled during feces. When triactinomyon spores reach water, they adhere to fish through polar filaments and sporoplasms enter primary host cells. Fish may get infected by consuming infected oligochaetes, which are intermediate hosts. Given the number of Myxozoa species, only a few are well defined in terms of life cycle and identification of main and intermediate hosts.

Chloromyxumtrijugum in the gall bladder of centrarchids in North America, Henneguyaexilis in the gill filaments of channel catfish in North America, Myxidiumserotinum in the gall bladder of anurans in the Western hemisphere, Myxobilatusmictospora in the urinary bladder of large The present inquiry focuses on the causal agent of whirling sickness, which may have arrived in North America via European brown trout transplants. Whirling sickness and Myxoboluscerebralis. Whirling illness is caused by the parasite myxosporean protozoan Myxoboluscerebralis infecting trout and salmon. This parasite attacks cartilagenous tissue, and infection may result in axial skeleton abnormalities and neurological damage, resulting in blacktail. The condition is called for the erratic, tail-chasing whirling seen in juvenile fish that are frightened or fed. Young fish that are heavily infected may die or become unmarketable due to deformities. Although the parasite was initially discovered in central Europe in 1903, its whole life cycle was not documented until the early 1980s. Whirling illness is seen across Europe, where it most likely originated.

It is found throughout the former Soviet Union and seems to have been imported into British surface waters, where it is now widespread. It was accidently introduced into New Zealand and the United States. Because their interrelationships with other members of the phylum are murky, poorly described, and poorly understood, parasitic members of the Cnidaria are systematically fascinating. The Phylum Cnidaria contains the genus Polypodium, which is the representative disease-causing organism of interest in this study. In relation to whirling illness and the literature on M. P. hydriforme has fewer publications than P. cerebralis, but the work documented for the parasite shows the species now inhabits regions in both the Missouri and Hudson River drainages. Cnidaria are aquatic organisms, with the majority of them being marine, while freshwater examples are widely documented in the literature. The phyllum is distinguished by its radial symmetry, and the majority of its members contain a gastrovascular chamber and tentacles at some point in their development. Tentacles are body wall extensions, with the majority of species equipped with nematocysts. Most species are distinguished by generational alternation, with an asexual phase that is polyploid in nature and sexual generations that take the shape of medusae. Most species have one phase dominate their life cycle, with the other diminished or even missing.

In summary, diseases in wetland fisheries are a complex problem that needs comprehensive solutions for successful management, conservation, and sustainable growth. The chapter has talked about important things.The importance of wetland fisheries is that they provide food, jobs, and help keep different types of living things around. Understanding how important they are to the environment is very important for keeping them safe for a long time.Fish living in wetlands can get various types of diseases, such as viruses, bacteria, and parasites. Knowing how these germs work and spread is important to control the disease.When fish get sick, it can greatly reduce their numbers and cause changes in their genetic variety. This has a big impact on the whole ecosystem.Managing diseases properly is very important. This can involve keeping an eye on diseases, protecting habitats, giving vaccines, and following sustainable fish farming methods.Collaboration from different experts like ecologists, veterinarians, fisheries managers, and local communities is needed to effectively manage diseases in wetland fisheries. It is important to combine environmental, community, and financial viewpoints together.

Taking care of diseases in wetland ecosystems should be done while also considering the conservation efforts to make sure the ecosystems stay healthy in the long run. It's very important to use practices that keep fish populations and their homes safe and healthy.We need to keep studying and finding out more about fish diseases in wetlands. This will help us create rules and plans that are based on scientific evidence and will actually work to solve the problem.In simple words, it is very important to address diseases in wetland fisheries to keep these ecosystems healthy, help the people living nearby, and protect the underwater animals and plants. To deal with the dangers of diseases and ensure lasting wetland fisheries, we need a comprehensive and cooperative plan that can change as needed.

The discussion part delves further into the implications and issues raised by the research of diseases in wetland fisheries, offering a more in-depth knowledge of the subject. Diseases in wetland fisheries may have serious ecological and social repercussions. Diseases may disrupt food webs, change species assemblages, and influence nutrient cycling in wetland ecosystems. They may lead to lower fish harvests, economic losses for fishing communities, and food security issues.Wetland fisheries have traditionally shown tolerance to a variety of stresses, including illnesses. Increased human pressures, such as habitat loss, overfishing, and climate change, may, however, impair this resistance. Understanding how illnesses interact with various stresses and the possibility for response is a critical area of study.Diseases in wetland fisheries are not isolated problems; they are part of larger ecological and human health dynamics. The One Health concept, which emphasizes the interdependence of human, animal, and environmental health, is becoming more popular. Integrated disease control techniques that take into consideration both the health of fish populations and the well-being of human communities should be created.Effective illness management requires adequate disease surveillance and data collecting.

Monitoring disease frequency and spread in wetland fisheries is critical for early identification and intervention. Collaboration among government organizations, researchers, and local communities may help to improve surveillance activities.Wetland ecosystems are dynamic, and disease effects may change over time. It is vital to use adaptive management techniques that can modify tactics in response to changing situations and fresh research results.Many local communities rely on wetland fisheries for a living. It is critical for the effectiveness and sustainability of initiatives to include these communities in disease control and conservation activities. Local knowledge and habits may be used to create more effective and culturally appropriate solutions.To manage illnesses in wetland fisheries completely, effective policies and governance structures are required. Regulations on fishing techniques,

habitat conservation, and health management should all be included. Collaboration among governments, non-governmental groups, and international organizations is essential for creating and implementing such policies.Finally, the debate emphasizes the complexities of illnesses in wetland fisheries and the need of addressing them holistically, adaptively, and collaboratively. Because ecological and socioeconomic elements are interrelated, it is critical to strike a balance between conservation and sustainable development to preserve the long-term health of wetland ecosystems and the well-being of the populations who rely on them.

CONCLUSION

The chapter talks about how wetland fisheries are important for the environment and for the people who live nearby. They provide food and money for the local communities. The text explains different diseases that affect fish in wetlands, such as illnesses caused by viruses, bacteria, and parasites. Every illness is explained in terms of what causes it, how it spreads, the signs it causes in fish, and how it can harm fish populations and their homes.In addition, this chapter emphasizes the significance of dealing with diseases in wetland fisheries. This includes strategies like watching out for diseases, preventing them, and taking control measures. This text is saying that it is important to use a variety of approaches when managing diseases. These approaches should take into account the way diseases affect the environment, society, and the economy.Finally, this chapter talks about the importance of taking care of wetland fisheries, considering how diseases can affect them. It highlights the importance of using practices that help both the environment and the local communities. We need to do research, make policies, and manage wetland fisheries to protect them from diseases and make sure they can survive for a long time.In summary, it is very important to learn about and control diseases in wetland fisheries in order to keep these ecosystems sustainable, support the people who rely on them, and protect the diverse range of aquatic life.

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CHAPTER 8

AQUACULTURE EXPANSION THROUGH WETLAND RESTORATION

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ABSTRACT:
Aquaculture growth is seen as an important plan to satisfy the increasing worldwide need for seafood while reducing strain on wild fish populations. Wetlands have special ecological features and can be used for sustainable fish farming. This summary looks at the idea of making aquaculture bigger by restoring wetlands. It says we should find a way to help nature and make money at the same time.The summary starts by talking about how aquaculture is becoming more important in providing seafood and helping to prevent overfishing. Then it suggests using restored wetlands for aquaculture production, taking advantage of the natural benefits that these ecosystems offer, like cleaning water, recycling nutrients, and creating habitats.Making sure that fish farming doesn't harm the environment by being kind to wetland homes, protecting different species of plants and animals, and keeping the water clean.Using sustainable methods in aquaculture, like integrated multi-trophic aquaculture (IMTA), to reduce harm to the environment. Community engagement means involving people who live nearby in activities related to fish farming. This helps create job opportunities and makes sure everyone is treated fairly and accepted socially.Creating and enforcing rules that find a middle ground between protecting the environment and promoting economic growth, using the most effective methods and precautions to ensure nature is preserved.Studying how to improve and make wetland-based fish farming systems more efficient, productive, and friendly to the environment.The summary says that by restoring wetlands, we can increase aquaculture and achieve multiple benefits. This includes making sure we have enough food, protecting important ecosystems, and promoting sustainable economic growth. But, to reach this balance, we need to plan carefully, involve everyone who is affected, and promise to do things responsibly to make sure that both wetlands and aquaculture industries stay healthy for a long time.

KEYWORDS:

Fish, Farming, Restoration, Wetlands, Water.

INTRODUCTION

Fishing and fish farming are really important ways to get food from watery areas. Different ways of fishing and raising aquatic animals have been created to take advantage of different kinds of wetlands. Both fishing and aquaculture can help increase water productivity and biodiversity when combined with rice cultivation. Having different types of species and habitats is essential for this aquatic ecosystem to function properly and to better cope with changes and challenges. Culture-based fisheries refer to the practice of growing fish and other aquatic organisms in bodies of water without much interference. This is commonly done in wetlands, lakes, and reservoirs, particularly in upland and highland regions of South and Southeast Asia. Culture-based fisheries are often created to help people make a living in fishing communities and to make sure that poor and vulnerable rural communities have enough food. Some people also think that culture-based fisheries can help create more jobs and make more money from tourism and fishing. They can also help produce more food so that people don't have to fish as much in the wild. The idea is to add more fish to bodies of water to improve the quality of the water. This can help reduce the growth of unwanted plants

and insects, and make the water clearer by removing nutrients. Putting young fish in stocking is expensive, and there are risks to the environment, society, and economy with this type of fishing. Putting fish and other aquatic animals into wetlands has made it hard to tell the difference between fishing, efforts to improve fishing, and farming fish[1], [2].

According to Gurung (2002), carp fish have been placed in many lakes in highland regions of Nepal to increase the amount of fish available and decrease the number of native fish being caught. This is done to protect the jobs and money earned by traditional fishing communities, until steps can be taken to conserve the local fish that are at risk. The amount of fish caught in rivers and lakes, including fish, shellfish, and other water animals, was more than 11. 2 million tons in 2010. Most of the fish were caught in Asia (68. 7%), followed by Africa (22. 9%), the Americas (4. 9%), Europe (35%), and Oceania (0. 1%)Another study focusing on small-scale fishing in developing countries shows that the amount of fish caught in those countries is even more significant. It is estimated that 14 million tons of fish are caught annually in these countries.

These catches help support 60. 4 million people by providing them with food and jobs. Around 33 million of these people are women. Aquatic ecosystems, like oceans and rivers, are important for fishing because they have a lot of fish and other animals that people can catch. Breeding and nursery sites, which are far away from places where fish are caught, are important for the survival of fish populations. These sites can be managed better if they are part of a larger farming ecosystem. Similarly, the way we use land and the ecosystems that exist on land affect the water quality and how water flows. This is important because it determines which plants and animals can live in different areas. Adding aquatic animals to wetland farming areas with connected fields and ponds can greatly help farming families and local communities with their food and nutrition needs. We need to have good management and rules in place to make sure that everyone is treated fairly when it comes to how much things cost and who benefits. We also need to think about people who are poor and don't have land when we make decisions about who can have access to things. Aquaculture and fishing rely on different services that aquatic ecosystems provide. These services include having clean and oxygen-rich water for the organisms to live and breathe, getting new organisms to grow, providing food and waste, removing waste from the water, absorbing nutrients, and storing carbon dioxide[3].

Many aquaculture businesses have failed because they have used up too much of the environment's resources when trying to meet the demands of growing numbers of farms and culture units. A simpler way to explain this is that there were a lot of fish dying in the Saguling Reservoir in Indonesia. This happened because there were too many fish being kept in cages, which caused pollution that harmed the fish. Initial evaluations of how much environmental resources aquaculture systems use suggested that more intensive production systems have a bigger impact on the ecosystem compared to less intensive systems. After looking at it again, they found that some things were used more effectively in intensive production systems than in semi-intensive systems. When we talk about the ecological footprints of a production system, it helps us understand how much we rely on the ecosystem for support. However, when we assess the ecological footprints per unit of production, we can better compare different management strategies for the same area of land. Building large dams and numerous small to medium-sized structures for hydroelectric power has caused significant harm to the environment and society. Some important effects on the environment include: immediate harm to flooded water ecosystems, harm to wetlands and farming ecosystems downstream, and interruption to connections and movement between different ecosystems. Building dams can lead to the flooding of rich farmland where crops are

grown[4], [5]. This can harm the availability of food and make it difficult for people to buy enough basic food items to sustain themselves, even if they can access more valuable items from new water sources or forests. Increasing pressure on the forests affects how water is collected and stored, and the temptation of valuable harvests might bring in fishermen from other places who have the skills and tools to catch fish in deep lakes. This could mean that the benefits of this fishing don't end up going to the local communities. Water management in wet farming areas often involves using water for many different things and can be improved by thinking about all the benefits the environment provides, and by taking into account the needs and perspectives of both men and women. Some good examples include combining fish farming with other types of farming like livestock, using rice fields for fish farming, using reservoirs and water management systems for fish farming, and fish farming using wastewater.

We need to evaluate all the ways that aquatic ecosystems provide resources for people, not just fish. This is important if we want to understand and protect the value of wetlands and wetland agriculture in people's lives and the economy. Currently, the way we use aquatic resources, like fishing in lakes and wetlands, and how we produce fish in farms, is not sustainable and could cause harm to the environment. Just like we assess marine capture fisheries, we need to be careful about introducing changing starting points or setting too high limits or inappropriate conservation goals. It's important to find a balance between fishing and other benefits from bodies of water. While fishing is usually seen as the main benefit, other services provided by aquatic ecosystems can benefit more people and have a greater impact on the well-being of poor women and men, marginalized groups, local communities, or regional populations. Furthermore, it is important to consider the environmental needs for water when evaluating and distributing water resources.

DISCUSSION

The main goal of this Briefing Note is to make everyone aware of the possible advantages of restoring wetlands. The goal of this initiative is to help stop the decline and damage of wetlands, improve how they work, and increase their positive impact. This Briefing Note builds on the information already provided in Ramsar documents about wetland restoration. It also refers to other available documents in the last section. Important points: We need to stop losing wetlands. Wetlands all over the world are being destroyed and damaged very quickly because of what people are doing. So, the important benefits that wetlands give to people are getting worse. The advantages we get from wetland ecosystem services are special and diverse, and they affect many areas. However, we don't always fully recognize or understand their importance when making decisions about managing wetlands. We need to understand the benefits of wetlands better so that we can stop them from being lost or destroyed. We also need this understanding to help protect the plants and animals living in wetlands and to make sure they can continue to survive. Make the protection and fixing of wetlands a top priority. The best way to stop wetlands from being harmed is by getting rid of anything that is causing damage to them. If that's not possible or if there's already been damage, we should think about fixing the wetlands. The Ramsar Convention requires us to use wetlands wisely and prevent them from being lost or damaged[6], [7]. The Convention has also given national governments and others a plan on how to prevent, lessen, and make up for wetland damage. This plan includes chances to restore wetlands. To put it simply, restoring wetlands should not be used as an excuse to harm them further. Restoring wetlands should not replace protecting and responsibly using them. We should not destroy wetlands with the hope that we can restore them later. Moreover, although restoring wetlands can help improve their benefits, it is important to note that a wetland that has been restored does not typically offer

the same level and variety of services as a wetland that has not been damaged. In the past, some attempts to restore wetlands have not been successful because they only focused on one specific benefit or a few benefits. It is important to encourage restoration efforts that consider the well-being of the entire wetland ecosystem. In some cases, people have not been able to understand or value the many ways that wetland restoration can benefit different areas. This has prevented them from using cost-effective and inclusive methods to restore wetlands, which could have been more successful in bringing benefits and long-term sustainability for both people and the environment. Decision-makers should act quickly and appropriately to understand and appreciate all the positive impacts on the environment, culture, and economy that come from restoring wetlands. In tropical areas, mangroves and peat swamp forests are very important for storing carbon and regulating the climate. Not understanding these many advantages often weakens the reasons for fixing wetlands and harms our future happiness[8], [9]. Wetlands are important places where there is water, like marshes and swamps. These areas can be natural or made by people, and the water can be fresh, salty, or in-between. The Ramsar Convention is a group that helps protect wetlands all over the world. The Convention understands that humans and wetlands rely on each other and that wetlands provide important resources to society that cannot be replaced. Wetlands are areas where different kinds of living things, like plants, animals, and micro-organisms, live together with non-living things like water and land. These areas are part of bigger landscapes like rivers, streams, and basins. The variety of water conditions in wetlands is what decides how many different plants and animals live there and how well the ecosystem works. Because wetlands are very different, they are important and do a lot of good things for the environment. They provide many services that help all living things, no matter where they are.To summarize, the notion of increasing aquaculture via wetland restoration is a potential path for meeting global seafood demand while also encouraging environmental protection and long-term economic prosperity. This method emphasizes many crucial points:

Sustainable Seafood Production: Aquaculture growth is critical to meeting rising seafood demand while relieving pressure on overfished native fisheries. Using restored wetlands for aquaculture contributes to the objective of supplying a sustainable source of protein to the world's rising population.Wetlands provide vital ecological services such as water filtration, nitrogen cycling, and habitat supply. Integrating aquaculture with restored wetlands capitalizes on these natural advantages, possibly improving aquaculture operations' efficiency and sustainability.

Environmental Protection

It is critical to ensure that wetlands aquaculture techniques are environmentally suitable, conserving wetland biodiversity and water quality. Adhering to sustainable and ethical behaviours is critical for avoiding negative environmental consequences.

Community and equity

Involving local people in wetland-based aquaculture may create opportunity for livelihood and economic development. It is critical for social acceptability and long-term success to ensure equal distribution of benefits and to include communities in decision-making processes.

Policy and Research

To lead wetland-based aquaculture growth while striking a balance between conservation and development, effective rules and regulations are required. Continuous research and innovation are required to maximize the efficiency and sustainability of these systems.

In conclusion, developing aquaculture via wetland restoration has enormous potential as a solution for addressing important global issues such as food security, environmental protection, and economic growth. To realize this potential, however, ethical practices, multidisciplinary teamwork, and a long-term view that emphasizes the well-being of both wetland ecosystems and the populations who rely on them are required. We can build a more sustainable and resilient future for aquaculture and the environment by doing so.Wetlands do a lot of important things on small, medium, and large scales like giving animals a place to live and helping humans with their basic needs, as well as controlling things in the air and chemicals in the earth. Although these advantages may not always be clear or easy to measure, they are still very important. Wetlands offer different important benefits depending on what kind they are, how big they are, and where they are located. The important Millennium Ecosystem Assessment recognizes that wetlands are very valuable to the world's economy[10], [11].

We now understand more about why wetlands are important and we appreciate them more. Many societies and governments acknowledge the benefits of wetlands and have laws and cultural practices to protect them. However, these efforts have not been enough to stop the loss and damage of wetlands in many areas. Some benefits of wetlands, like providing water for farming or fish for fishermen, can be measured or have a specific value. Most services provided by wetland ecosystems, like filtering water and providing homes for wildlife, benefit society as a whole and are therefore considered as public or non-market benefits. It is hard to assess and measure the indirect benefits of wetlands, so they are often not considered as important compared to other things wetlands can do. When deciding how to use wetlands, governments and managers have to take care of them, make sure they are fair and give equal benefits to everyone. The fact that these indirect or public benefits are not based on competition gives many people a good reason to protect and restore wetlands. When wetlands are damaged, the many good things they provide start to get worse and eventually disappear. Sometimes, degradation happens when people prioritize one benefit over everything else. For example, in farms, they might focus too much on having enough water for irrigation and ignore other important things.

Wetland degradation means changing a wetland in a way that makes it simpler and less effective. This can harm the plants and animals living there and the services the wetland provides to the environment. This usually happens because people do things too often or too harshly, and it makes it hard for nature to bounce back on its own. The world's wetlands are suffering from human activities like growing populations and climate change. Climate change causes rising sea levels, higher temperatures, and changes in flooding and droughts, which also harm wetlands. This affects the quality and availability of services that wetlands provide. If wetlands keep being lost and damaged, it will cause fewer benefits and harm people's health and well-being in the future, especially for those who are poor and marginalized. This is because these people rely more on the advantages provided by wetlands.

The Ramsar Convention says that restoring degraded wetlands is important. Restoration can mean making a wetland go back to how it used to be or improving how it works without making it exactly like it was before it was disturbed. Restoring wetlands is beneficial for many reasons. This idea of restoration comes from the commonly-used definition of ecological restoration as helping a damaged ecosystem to recover. The qualities of successful wetland restoration actions includeusing plants and animals that naturally live in wetland areas and arranging them in groups that function well together, creating wetland environments that can survive on their own and are part of a bigger landscape, and getting rid of the causes of wetland damage or making them lesser. In 2002, the Ramsar Convention

created rules for fixing and improving wetlands. Restoring wetlands that have been damaged or lost is a good and affordable way for society to improve people's health and well-being. It can also help protect against storms and other dangerous events, improve access to food and water, and help us deal with climate change. Restoring mangroves and habitats near the shore helps provide food, like fish and other small animals, and things we need to live. It also gives a home to birds, reptiles, and mammals. This helps to store carbon and protect against climate change. It also helps coastal communities be more strong and able to handle tough times.

Restoring a wetland can be expensive, but it is worth it because the benefits it provides are usually much greater than the cost. The value of these benefits, combined with the value of the benefits that were lost when the wetland was degraded, can be several times higher than the cost of restoration. Nature is really good at providing services that help the environment, and it does so at a lower cost than things that humans make. So, fixing up wetlands can be a good and affordable way to help protect nature and also help with other goals like development. Rewriting: Restoration can help improve and bring back lost benefits to wetlands. However, it has been observed that a wetland that has been restored typically does not provide the same level and variety of services as a wetland that has not been damaged. Therefore, the most important thing to do is to protect and responsibly use wetlands instead of letting them get worse. Unfortunately, because of the way the wetlands are being harmed, conservation alone is not enough to protect and improve the good things they provide. In many countries, restoring wetlands is now seen as a necessary way to manage them effectively and ensure a good and long-lasting future for them.

Restoring wetlands can have many advantages for different areas like farming, fishing, water, forests, health, energy, industries, leisure, transportation, education, development, and native communities all at the same time. The importance of different benefits from wetland restoration will vary depending on how much information decision-makers and wetland managers have. When thinking about fixing wetlands, we need enough evidence to show all the good things it can do and explain why it matters to different areas of society. In simple words, sectors are different groups within our society that include people who own land and businesses, governments at different levels, and organizations that work for the betterment of society like NGOs and indigenous and local communities. In the past, people focused on restoring wetlands to help animals and plants. They mainly wanted to make sure there were good places for wildlife to live. To get support from different groups interested in restoring wetlands, we need to make them aware of all the benefits for the environment, culture, and economy.

We should also give them a chance to be involved in the planning and doing of the restoration. When people in a community work together to restore wetlands, it usually helps them succeed in the long run. This is because it teaches the community about why the wetlands are getting worse, and it creates jobs and fairer ways for everyone to benefit. However, it is important to train community volunteers correctly and give them guidance from experienced managers and restoration professionals. Likewise, using local or traditional knowledge can help make wetland restoration projects better by giving us information about how things used to be and how we can make it better. These are important parts of the way the Ramsar Convention suggests we do things. Restoring wetlands in a way that focuses on a few specific benefits and causes trade-offs with other benefits often prevents a fair range of advantages from being achieved. For instance, projects or programs that only focus on improving water quality and flow in cities or farms may forget about the needs of animals, the build-up of sediment, and the recycling of nutrients, which also contribute to many other important functions. To make sure that wet land restoration is fair and lasts a long time, it is

usually best to use an Ecosystem Approach. This helps manage how restoration activities are planned and done, and makes decisions about which benefits are most important.

The Ecosystem Approach is a plan for taking care of the environment by looking at the big picture. It includes taking care of land, water, and living things in a way that is fair and doesn't use up resources too quickly. The Ramsar Convention's idea of wise use is one of the oldest examples of how to take care of the environment. It focuses on conserving and using natural resources responsibly. Restoration projects and programs need to consider the whole watershed or river area and involve collaboration and participation from different sectors and stakeholders. This includes sharing knowledge and resources, addressing governance problems, and promoting fair social and economic development. In these situations, restoring wetlands can be beneficial for both people and nature even with limited resources. Restoring wetlands improves the quality of life for both. Two of these principles are important for thinking about restoring wetlands. Principle 1 acknowledges that different sectors have varying needs when it comes to wetland restoration because of their economic, cultural, and societal requirements. This means that it wants people to talk and work together from different groups, so they can agree on what to do and make sure everyone gets fair benefits. Principle 3 states that it is important for different industries and people involved in wetland restoration to think about how their actions will affect other ecosystems and the overall environment.

When we can, it's best to plan and design the restoration of wetlands in a larger area like a river basin, watershed, or catchment. This helps them work well and bring benefits to the surrounding landscape. A way to restore wetlands is by considering their connection to the larger landscape and using a combination of small and big changes over time. This approach helps to increase the variety of plants and animals in the wetlands and improves how the ecosystem works. It also provides many different advantages. Because wetlands connect land, tidal, and marine environments, it is important to improve these connections in order to make wetlands work better without harming nearby ecosystems, both in water and on land. Activities to restore wetlands that aim to bring back a certain water flow pattern should think about how this may change the water and how neighboring ecosystems work. The improvements from restoration may not always make the people living nearby happy or be what they wanted.

Therefore, the increased advantages of wetland restoration should be thought about on a larger scale, like a whole area or region. For instance, if we take water away from a river to bring back a wetland, it could lessen the amount of fresh water that reaches an estuary. This could harm fish that are sensitive to salt in the water, which could then hurt the people who make a living from fishing. But, not having enough detailed scientific information about bigger areas should not stop smaller wetland restoration projects and programs from being planned and carried out. These smaller projects still need the right information specific to their location. Efforts to restore wetlands should also aim to keep a wide variety of wetland ecosystems in the area. This helps protect different species, habitats, and functions. It is important to understand that the advantages of wetland restoration, like replenishing groundwater or providing a home for migratory birds, might be seen in places away from where the restoration is happening. The strategies of integrated river basin management and coastal zone management acknowledge that wetland conditions are influenced by big ecological processes, like how much water is available, how sediment builds up, and how the land is shaped.

These factors often affect wetlands and cause them to be lost or damaged. Examples of these factors include an increasing population, changing wetlands into farmland, and cutting down

trees in higher areas. To make wetland restoration successful and get many advantages from it, it is important for everyone involved, both public and private, to have the same goals and work together in planning and coordinating. It's also crucial to know the past ecological changes of the area where the restoration will take place. By restoring wetlands, we can provide education, recreation, and opportunities to make money to many different people in the community. Wetland restoration is important because it helps to fix the damage done to wetlands and the benefits they provide. Many countries need to prioritize and advocate for wetland restoration in their decision-making. There are different reasons why people start restoring wetlands. These can range from obligations under international agreements to opportunities in local communities and initiatives started by the community itself. This document does not have a prioritization framework. Instead, it explains when we should think about restoring wetlands and gives suggestions on how to prioritize wetland restoration for people making decisions.

The most important thing in deciding to restore wetlands is to understand how it can help people. But, for people to understand the importance of wetland restoration in different areas, they need to know about the different opportunities it can bring. We should increase awareness in different areas of society and within different parts of the government. There are many areas where wetland restoration can be useful, such as climate change, economic investment, development planning, housing, sanitation and water resources, food production, transport, and education. Governments should promote conversation and guidance in these areas to make sure that people receive positive effects on society, the economy, and the environment. Some of these methods support a smart way to bring wetlands back to their natural state. This includes focusing on restoring damaged ecosystems to fulfill goals of protecting biodiversity. These methods are included in national plans to protect biodiversity. Similarly, there are a variety of worldwide agreements that have promises that can be fulfilled by repairing damaged wetlands, even if restoration is not specifically mentioned. Wetland restoration helps us achieve the Millennium Development Goals, especially for environmental sustainability. It also helps us meet the targets set by the United Nations Framework Convention on Climate Change by reducing pollution and increasing the amount of carbon stored in forested wetlands.

Under the promises of the Ramsar Convention and shown in National Wetland Policies, a smart plan should focus on fixing wetlands first to protect special areas called Ramsar Sites. If these areas are harmed, the plan should work to bring back their natural balance. In simple words, wetland restoration should be done as part of managing protected areas and the land or sea around them. Many things can affect decision-making, like if it's right to restore something, if it's possible to do so without harming the environment or breaking the bank, if it's really important, who should help make the decision, and what we hope to achieve. To begin with, it is important to assess information related to the goals of the organization or place and any rules set by the local or national government. A careful examination of conservation plans and actions from different regions and countries can provide valuable information for creating a wetland restoration project. For instance, plans made by countries, regions, or the whole world to tackle problems like invasive species or climate change can affect what goals we choose for restoration projects. However, there will also be local chances and situations to bring back wetlands.

For example, restoring mangroves or salt marshes can help protect communities and coastlines from storms. Although we don't have exact numbers, we can use wetland inventories and our knowledge of how much damage has been done and how important wetlands are to determine which wetlands need to be restored first at a local or national level.

Wetland restoration can bring many positive effects to society, the economy, and the environment, which go beyond just protecting endangered species. Local or national plans that don't specifically focus on protecting plants and animals, like how we manage water or deal with disasters, can still help us understand the importance of wetlands. To prioritize wetland restoration, it is important for different groups to recognize and agree on the benefits it brings. This should then be incorporated into various policies that cover different areas. When both government and non-government organizations are deciding which wetlands should be restored first, they should look at multiple sites of different sizes within the landscape or seascape, instead of just focusing on one site. When determining if restoration activities should be done, it is important to think about how possible and necessary they are for the environment.

We also need to think about how we will take care of them and make sure they last for a long time. Feasibility often depends on having enough resources that are not infinite or unlimited. By considering the needs of different areas, we can try to combine our limited resources to make wetland restoration more effective and increase the variety, quality, and amount of benefits it provides. Here are some examples that show how restoring wetlands can help achieve multiple goals, not just recovering biodiversity. Damaged swamplands - People have caused harm to the environment in many places around the world, leaving them polluted and in poor condition. In many situations, wetlands have been dirtied, changed, or filled in.Restoring wetlands to contaminated areas helps bring back the natural environment, which is good for living things. This has many benefits like providing homes for plants and animals, helping the economy, and giving people places to learn and have fun. It also improves the quality of water and provides spaces for wildlife to live.

Sometimes wetlands are damaged so badly that it's impossible to restore them to their original state. For example, if all the organic material in the soil is lost, restoration efforts would have to be done on a different type of soil. In simpler words, it is possible to bring back wetland processes and restore important benefits to the environment, even in difficult situations. This focuses on restoring the functions of wetlands rather than just their specific types. Right now, a lot of people around the world don't have access to basic toilets and cleanliness. Efforts to make access better have always been a significant part of development plans. Restoring wetlands can be an effective and long-lasting way to improve access. Finding ways to solve problems with water supply and sanitation can be difficult and challenging because the government handles wetlands, water supply, and sanitation separately. This is a chance that was not taken to make sure development happens in a way that lasts and the environment gets better. Actions should go beyond the usual ways of doing things, like making plans for river basins that take into account different sources of water and wetlands. These plans should find ways to improve both people's well-being and biodiversity in a more complete and interconnected way. Fish are very important for a lot of people who need protein. But the number of fish in the world is getting smaller. More than two-thirds of the fish we eat come from coastal wetlands like mangroves and estuaries. These wetlands need other wetlands, like lakes and rivers, to survive. Most of the fish that are caught in the world come from developing countries, but recreational fishing is also very important for the economy in developed countries. It is believed that recreational fishing contributes about $116 billion to the economy of the USA each year.

Using and fixing wetlands in a smart way can help make sure we have enough water for important things in the future. It can also help people make more money. A case in North West England shows that fixing peatlands in the highlands has made the water better for over seven million people living there. It has helped tenant farmers by providing them with a way

to make a living. It has also helped bring back important plant and animal diversity, while also saving money on water treatment. Tourists enjoy swimming, canoeing, diving or snorkeling, observing wildlife, learning about nature, or simply appreciating beautiful views. Tourism, both local and from other countries, often relies on places like beaches, lakes, rivers, mangroves, and other wetland ecosystems. In many places, especially in poorer countries, lots of people depend on wetlands to live and have enough food. Research and observations have proven that when wetlands are being destroyed, poverty usually gets worse, causing more problems. To achieve sustainable urban drainage, wetlands can help control excessive rainwater in cities, while also improving the quality of water, promoting more diverse wildlife, and creating more recreational activities for people to enjoy. Restoring wetlands can help prevent floods and avoid the costly construction of systems to control excess water or treat water before it flows downstream.

By carefully planning the design of a wetland area, we can make stormwater cleaner and create nice, useful open spaces in cities. People who live in cities can get extra social, cultural, and mental advantages from being able to see or visit restored natural areas. For information on how to combine wetland restoration with sustainable urban drainage methods.

CONCLUSION

Following a description of the present state, relevance, and production of natural wetlands, the chapter examines the role of wetland biological processes to the maintenance of essential ecosystem services. Wetlands are vulnerable to a variety of anthropogenic pressures, including land use change, disruption of regional hydrological regimes due to abstraction and impoundment, pollution and excessive nutrient loading, invasive species introduction, and overexploitation of biomass, plants, and animals. Natural wetlands are often modified to facilitate agricultural and aquaculture production, or wetlands are generated when farming systems are established. Prospects for well-established approaches such as cultivating fi sh in rice fields, culture-based fi sheries, and integrating aquaculture with livestock production or with water storage and irrigation systems are critically examined.

The apparent conflicts between agricultural expansion and intensification and wetland protection are examined, as are options for reconciling opposing needs. Wetlands, whether natural or agroecosystems, provide a wide range of ecosystem services that contribute to water and food security, but their use must be balanced with adequate provisions for sustaining environmental stocks and flows, as well as conserving and protecting aquatic biodiversity.

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CHAPTER 9

WETLAND-BASED RECREATIONAL FISHERIES AND ECO-TOURISM

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ABSTRACT:

Wetlands are special places that have lots of different plants and animals. They are really pretty and great for activities like fishing and nature tours. This summary talks about the complex connection between wetlands, recreational fishing, and eco-tourism. It stresses the importance of finding a middle ground that combines conservation with outdoor activities and sustainable tourism.The start of the abstract recognizes that wetlands are very important for the environment and provide essential homes for many different species. This shows that there is an increasing worldwide interest in fishing for fun and eco-friendly travel, which can help local economies and raise awareness about the environment.Highlighting the importance of using sustainable fishing methods and engaging in eco-friendly tourism activities to reduce harm to wetland ecosystems.We understand that the well-being of wetlands is important for recreational fishing and eco-tourism to succeed. To keep these places attractive, we need to actively work on preserving them.Including local communities in the management and benefits of activities like fishing and ecotourism, so that they feel ownership and get a fair share of the profits.Using education and awareness to teach people about wetlands, why they matter, and why they need to be protected.Creating and putting into action rules and guidelines that consider the needs of protecting nature, providing enjoyable activities, and promoting tourism, which leads to steady and responsible growth in these areas.The summary says that wetland conservation, recreational fishing, and eco-tourism can work well together. By using responsible methods, this can help the local economy and also make people care more about protecting wetlands. This fair plan wants to make sure that the next generations can still enjoy the amazing beauty of wetlands, while also protecting these extremely valuable ecosystems for many years in the future.

KEYWORDS:

Fishing Fun, Local Communities, Mahseer Fish, Recreational Fishing, Tourism.

INTRODUCTION

A wetland is a special place that people like to visit. It is an ecosystem that helps many things. It gives food and homes for fish, plants, and animals. It also protects against floods and stops the ground from eroding. Wetlands clean dirty water and store carbon. People can also have fun there and learn about nature and culture. Additionally, a wetland has many practical and beneficial uses. It provides jobs and money. People use wetlands for farming, fishing, cutting down trees for building materials and using reeds to make mats and roofs for village houses. So, a wetland is really important for the environment, the economy, and for fun activities. Researchers studied 89 cases and found that Asian wetlands contribute a total of $1. 8 billion each year out of the $3. 4 billion worldwide Also, millions of hectares of these wetlands are used for farming. In countries like India, there is not much information about wetlands. However, many studies show that a large number of people in India depend on wetlands for their jobs and to support the economy. In 2014, it was found that about 61% of all fish in Orissa, India came from wetlands located within the state. The research showed that having wetlands surrounded by mangrove forests helped to protect the countryside and

reduce the losses to $33. 31 Without the protection of the mangrove forests, the losses could be as high as $153. 75 per household A research on the Tsomoriri wetland, a protected area in Ladakh, northern India, found that local people make around US$ 700–1200 every summer. Tourist spots like wetlands and natural reservoirs help boost the economy by attracting many visitors[1], [2].

Researchers found that nature-based tourism is becoming a growing industry in India. It creates jobs, utilizes resources, and follows good practices. The research also revealed that tourism related to nature saw a 15% increase. Out of this, 80% were tourists from within the country. Tourism is known to help countries make money and create jobs. So, it is very important to take good care of places like wetlands so that people can enjoy them and do fun activities there. This will help to decide how many tourists and activities can happen at the site. Wetlands are like coral reefs, lakes, reservoirs, and other water areas. Some people make money by being tourist guides, giving people rides on boats, catching fish, and selling things. A study by Researchers showed that tourism has a lot of potential for making money and creating jobs in India. The tourist spots in the Jammu and Kashmir area of India bring in a lot of money by attracting people from all over the country and the world. Since a long time ago, the lakes, mountains, landscapes, forests, and waterfalls of the state have helped the tourism industry in the country. The Kashmir region has great potential for tourism and is making great progress in development. Many years ago, the Mughal emperor Jahangir was extremely impressed by the beauty of a place and said that if there was a paradise on Earth, it was this place. Kashmir is a very beautiful place with stunning landscapes, lots of plants and animals, protected areas for wildlife, snowy mountains, and wetlands[2], [3].

People from all over the world like to visit Kashmir because it is very beautiful and they can have fun there. It is an important place in the Hindu Kush Himalaya region. As a result, tourism brings in money for the state, creates jobs, and makes up 6. 68% of the state's total income. The Dal Lake is very important and brings in a lot of tourists because it is a beautiful and popular place to visit in the state. The lake is very attractive because of where it is situated, how beautiful it looks, the peaceful environment, the gardens that float on the water, the small decorative boats called Shikara, and the houseboats that are available to stay in. This makes the lake stand out and makes it more important and different from other wetlands and tourist spots. The visitors get really excited and use a lot of time and money to have fun and enjoy the beautiful nature and services it offers. The lake is very important in the valley because it is more beautiful than other lakes. Furthermore, near the edge of the lake, there are many tourist spots like beautiful gardens and religious sites. The lake is also known for keeping a balance in its environment by supporting various plants and animals throughout the year. The lake is in danger because of people. There are more people moving in, polluting it, and using it for farming and other activities. In addition, when tourism gets involved, it can have both positive and negative effects on communities and the environment[4], [5].

DISCUSSION

In simple terms, recreational fishing is seen as an important part of ecotourism. This involves traveling to places with untouched wildlife and cultural heritage as the main attractions. It gives local communities a way to make money and allows travelers to learn and care more about nature and its resources. Fishing is when people catch fish for fun or to compete, in lakes or rivers made by nature or people. The most popular way people go fishing for fun is by using a fishing rod, reel, line, hooks, and different types of bait. Fishing for fun has become very popular after adventure travel and is now a thriving international business opportunity. We are trying to explain about different ways of eco-tourism and recreational fishing for the Scheduled Caste people in Northeastern India. We want to make use of the

rivers, streams, and lakes in this area to promote tourism and fishing activities. We will focus on important fish species like mahseer, trout, catfish, and carp. The mahseer is a big fish that lives in rivers in Asia. It is important because it brings in money and is fun to catch. Mahseer is a very popular fish for people who like fishing in India. It is considered the strongest and toughest fish in freshwater sports. That's why it's known as the king of Indian freshwaters[6], [7].

Mahseer are a type of fish that can be categorized into three groups called Tor, Neolissochilus, and Naziritor. However, most of the mahseer fish belong to the Tor group, but there are different opinions on the types of mahseer fish found in different groups. In this situation, the rivers in the Northeastern region are noteworthy. These rivers have untouched and clean resources, and they are home to mahseer fish. People can go fishing and enjoy recreational activities in this area. Fishing enthusiasts have caught golden mahseer weighing between 12. 5 to 400 kg in these rivers. There are several rivers in Arunachal Pradesh and Assam like the River Kameng, River Subansiri, River Siang, River Yamne, River Pare, River Poma, River Lohit, River Dihang, and River Dibang. These rivers have very few people living near them and are popular among adventure enthusiasts who like to go fishing. They are home to a type of fish called Tor putitora or golden mahseer. Neolissochilus species. The people who live in these river valleys have a strong connection with nature. Recently, there has been a focus on developing ecotourism in these areas. This includes providing things like rafts, fishing rods, tents, and other basic amenities for tourists. Many tourists from nearby states like Nagaland, Meghalaya, Sikkim, and West Bengal, as well as tourists from countries like Nepal and Bhutan, are invited to visit and explore these areas[8], [9].

The fishing competitions follow a rule of catching and releasing the fish without hurting them. The fishing competitions and festivals can help bring the local community together and promote eco-friendly tourism in undiscovered areas of the Northeastern region. The river Manas is a big river that flows between southern Bhutan and Assam in the Himalayan foothills. It joins with the river Brahmaputra. It is said that the upper parts of the river Manas and its smaller rivers are mostly home to mahseer fish species like Tor putitora, Tor tor, and N. Hexagonolepis is a term or word that is not commonly used or easily understood. It may refer to a specific concept, object, or name that requires further explanation or context. In the hill districts of Assam called KarbiAnglong, West KarbiAnglong, and Dima Hasao, there are thick forests and many rivers that flow into the Brahmaputra River. These areas are home to the fish species Tor tor, Tor putitora, and Neolissochilus spp. The hilly districts of Assam have great potential for fishing. Some good places for fishing in rivers are the banks of the river Kopili which has nice waterfalls, the banks of the river Amreng where there is a tourist lodge and an old bridge from the British era, the Amtereng Dam site of the KarbiLangpi Hydro project which has a big reservoir, and the river island Siloni on the river Longnit which is popular for day fishing trips.

Sikkim has many rivers that are great for fishing. The Teesta and Rangeet rivers are especially good for catching golden and chocolate mahseer fish. This makes Sikkim a great place for people who like to fish. Fishing has been a long-standing tradition for the people of Mizoram. They use simple tools like a hook and line to catch fish like carps, catfishes, murrels, and mahseer. This tradition continues to this day. Trout is a type of fish that is really enjoyed by people who like to fish. It is popular all around the world because it is really good for sport fishing. The most popular types of trout for fishing in natural bodies of water are the brown trout and rainbow trout. These fish are part of the salmon family and can be found in rivers and smaller streams in the colder parts of the Northeastern region. This kind of fish was brought to India from Europe by British people around the start of the last century. They

did this mostly for fun fishing or relaxing. The Yargyap river in Menchukha, in the Shi Yomi district, is said to have big brown trout weighing between 8 and 12 kilograms, according to enthusiastic fishermen.

The highland lakes and rivers in Tawang and West Kameng districts of Arunachal Pradesh, near the Indo-China border, could be a great place for colorful rainbow and brown trout to live. This would make it a perfect destination for fishing enthusiasts. ICAR-DCFR has tried to put young exotic trout in the upland lakes of Tawang district. This is to create opportunities for locals through ecotourism focused on fishing. Furthermore, trout raceways have been built in Nagaland with the cooperation of the Department of Fisheries, Government. Nagaland wants to support and grow trout farms in the state. The snow trout, also called Schizothoracids, is a type of fish that is found in the high-altitude areas of the Northeast region. It is a major and important part of the fishing industry there. The most common types of snow trout found in the area are Schizothoraxrichardsonii, Schizothoraxplagiostomus, and Schizothoraxprogastus. One way to catch snow trout in the deep pools and fast-moving water of the eastern Himalayas is by using a noose and line. This fishing tool is made up of a long stick, a spinning wheel, a long string with loops, small circles, bait, and a heavy object[10], [11].

The people who live in this area really enjoy fishing. They make and use their own fishing equipment for fun. This way of using natural water resources is very important for the nearby communities to make money and have fun in the mountainous area of the eastern Himalayas. The wetlands in Assam, called beels, have a lot of different types of fish. Some common ones are carps, catfishes, and featherbacks. The fishery in these wetlands mainly catches small fish like Puntius, Chanda, and Mystus. There are also carnivorous catfish like Bagarius and Wallago, as well as air-breathing species like Heteropneustes and Clarias. Murrels such as Channa punctatus are also caught in these wetlands. The text is about some types of fish called sturgeons, featherbacks, and eels. There are many different ways of fishing in the Brahmaputra river area and the wetlands around it. People use gear that is mostly made locally. These tools made by indigenous people are mostly old-fashioned and different from what we are used to. They have a big economic effect in the countryside because they help to use natural resources for getting food and having fun. The tools commonly used by fishermen are baskets, traps, lift nets, poles and lines, and drift lines. Women also use these tools during the day. This is known as traditional community fishing. They do this in beels, which are like ponds. None of the people participating in this event are professional fishermen. They fish because they enjoy and have fun doing it. The Assam Bhoreli Angling and Conservation Association (ABACA) is an organization that is located near the river JiaBhoreli in Nameri, Sonitpur district, Assam. They focus on promoting adventure sports and raising awareness about protecting fish.

The camp currently offers activities like fishing, camping, rafting, hiking, bird-watching, and exploring heritage and culture. The camp also sets up a place to breed and grow golden mahseer with help from ICAR-DCFR, Bhimtal. Fishing competitions are happening often at places like Seppa, Nameri, and Bhalukpong. The main goal is to promote safe and responsible fishing with a rod and reel, and to raise awareness about protecting the river system and its animals, especially the local fish species called pithia and shilghoria. These fish have been harmed a lot recently due to illegal fishing, using chemicals, electrocuting them, and using explosives. The Anglers Association Nagaland (AAN) organizes fishing festivals and competitions to promote tourism and raise awareness about protecting the local fish species in Nagaland. They also celebrate special events like World Fish Migration Day. Some important rivers in Nagaland that have mahseer fish are Dhansiri and Intangki in

Dimapur, Milak and Dikhu in Mokokchung, Doyang in Wokha, Arachu, Lanyi, Seidzu, Tesuru and Tizu in Phek, and Zungki and Likhimro in Kiphire.

Meghalaya refers to the activity of paying to fish in the state, which is known for its high levels of rainfall and abundant water resources. The state is mostly populated by the Khasis, Jaintias, and Garos who really enjoy fishing as a traditional activity for fun. There are two types of fish called chocolate mahseer, namely Neolissochilushexagonolepis and N. Hexastichus are local business people from the areas of Mylliem, Smit, Mairang, Umsning, and Laitlyngkot in the Khasi hills. They have started offering fishing opportunities to anglers by allowing them to fish in their own ponds and tanks for a fee. Fishing contests are held once or twice a year in these places, and the people who win receive money as a prize. In Meghalaya, they are trying to make angling popular and part of tourism. They also want to promote other adventurous sports like rafting, water sports, mountaineering, trekking biking, paragliding, and hot air ballooning. Please provide the original text for simplification. A fish sanctuary is a safe place for fish where they are protected and fishing is not allowed. Fish sanctuaries, also known as Wari in the local dialect, are being set up in Meghalaya as part of the Meghalaya State Aquaculture Mission (MSAM).

The goal is to protect and improve the variety of fish species in the area, while also promoting lesser-known tourist destinations to help the rural population. There are a few fish sanctuaries in the state, including the Amlayeemahseer fish sanctuary at Nongbareh, the AsimBibra fish sanctuary over the Chibok River, the DekuDobagre fish sanctuary over the Bugai River, the Wachi Wari fish sanctuary over the Simsang river, and the Songkal Wari fish sanctuary between Tura and Williamnagar. These sanctuaries protect certain species of fish, like the chocolate mahseer, and allow visitors to participate in sport fishing while still conserving the fish. The sanctuaries also aim to develop livelihood options for the local communities and provide a place for people to observe the fish. Because the results were good, 'wari' was created in Rombagre and Selbalgre. Within five years, this idea spread to over a hundred places in the area. This has caused an increase in the number of mahseer fish in Meghalaya because anglers are catching and releasing them instead of keeping them. Women in the state are not too far behind and definitely have the highest number of female anglers in India.

Watching fish platforms have become very popular recently because it is believed to have many good effects on human health. Many lakes, tanks, rivers, streams, and pools in the higher areas are places where you can watch fish. You can see Mahseer fish the best in Saly and Mehao lakes in Lower Dibang valley, also in lake Ganga in Papumpare district of Arunachal Pradesh. Ward's lake, Jarain Pitcher Plant Lake, and Thadlaskein lake in Meghalaya are other lakes that are good for fishing and also have recreational activities like boating, a children's park, and food courts. The tanks and water bodies in Assam, whether man-made or natural, can be improved for watching fish. This would have various benefits like fishing, enjoying the beautiful views, watching birds, and going on hikes. The people who live in the area can protect these water bodies by not allowing any unwanted human activities. This will create the chance to encourage fishing for fun by adding certain types of fish for people to watch. It can also be a good opportunity for young business owners to make money. The Jasingfaa Aqua Tourism Centre, located in the Nagaon district of Assam, is a great place for people who enjoy fishing and watching birds and fish. It offers wonderful amenities for those passionate about these activities.

It was specially raised for breeding and observing, with the goal of saving biodiversity for people. The fish was protected in controlled environments so that future generations can have the chance to see and enjoy this beautiful river fish. There is a fishing festival and workshops

on how to fish that are regularly happening at the center. Home accommodations are popular in the hilly states of the country. Homestays in the northeastern part of India, specifically in the Ziro valley of Arunachal Pradesh, also have fishing activities available for guests to enjoy. Cottages are being built by the ponds and tanks, preferably using bamboo. Tourists are given fishing equipment, like rods and lines, to fish in the ponds and tanks. The fish is caught and then sold to be eaten by tourists. This combining of people's homes with fishing helps the locals make more money from fishing. The common types of fish kept for fishing are grass carp, catla, common carp, silver carp and catfish. This idea is becoming popular in mountainous regions of northeast India. Nowadays, it is common to see homestays in the mountainous states of the country. These homestays are also connected to fishing for fun in the northeastern region of India, particularly in the Ziro valley of Arunachal Pradesh. Cottages are being built on top of the ponds and tanks using bamboo. Tourists are given fishing rods and lines to catch fish in these ponds and tanks. The fish is caught and then sold to the tourists to eat. This helps local people make more money by combining homestays with fishing. Some types of fish commonly caught for fishing are grass carp, catla, common carp, silver carp, and catfish. This road is becoming very popular in the hilly areas of northeast India.

CONCLUSION

Northeastern India has great potential for recreational fishing and tourism. In simple terms, the kind of ecotourism that focuses on fishing and observing fish in the country has both good direct and indirect effects on protecting fish. In this situation, mahseer fish has been declared as the 'state fish' in 7 states of India because it is well-known for its beautiful colors, strong fighting abilities, and large sizes. Other types of fish that can be found in these streams and lakes are trout, catfish, and carp. These fish are important for both the local economy and for recreational purposes. Every year, many people from both here and other countries come to this area to go fishing. Fishing has been a popular activity for a long time. People can have exciting experiences rafting down fast-moving rivers while also being able to fish in the water. Fishing in these streams needs to be controlled and managed according to the State Fisheries Act. This is important for creating plans to protect and preserve the streams for the future. The fishermen can get help from experts who organize fishing trips. This way, they can reach the most isolated fishing areas and experience local hospitality. Visitors can get a fishing license for catch-and-release fishing by paying a small fee. This fee will bring in money for the state and also stop people from fishing illegally in these areas. Moreover, we can encourage the use of rice-fish farming and aquatic home stays in other states of the area to attract more tourists. This will help the local communities by providing them with more money and job opportunities.

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CHAPTER 10

GENOMIC INNOVATIONS: TRANSFORMING FISHERY AND AQUACULTURE DEVELOPMENT

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ABSTRACT:

This chapter explores how genomic advancements are revolutionizing breeding programs, disease management, and conservation efforts in aquatic organisms.The abstract begins by acknowledging the pivotal role that fishery and aquaculture play in global food security and economic development. It underscores the challenges faced by these industries, including increasing demand, disease outbreaks, and ecological sustainability concerns.The chapter then delves into the genomic tools and techniques that are reshaping these industries. This includes the utilization of high-throughput sequencing, genome mapping, and molecular markers for selective breeding, which enhance the efficiency and precision of breeding programs. Additionally, genomics has revolutionized disease detection and management by enabling the rapid identification of pathogens and the development of targeted interventions.Furthermore, the chapter discusses how genomics aids in the conservation of endangered aquatic species by providing insights into their genetic diversity and population dynamics. It emphasizes the importance of genomic data in designing effective conservation strategies and restoring threatened ecosystems.It showcases how genomic innovations are not only enhancing production but also contributing to the sustainability and conservation of aquatic ecosystems. The chapter underscores the continued importance of advancing genomic research to address the evolving challenges faced by fishery and aquaculture sectors in the 21st century.

KEYWORDS:

Aquaculture, Fisheries, Genetics, Marine, Species.

INTRODUCTION

Fisheries and aquaculture genetics means using genetics to study fish and aquatic organisms in order to manage them better and make sure seafood is safe to eat. This method uses certain markers like allozymes, mitochondrial DNA, and microsatellites, along with the latest sequencing technology called next-generation sequencing (NGS), which has helped us find a lot of variations in our DNA called single nucleotide polymorphisms (SNPs). We use these markers and SNPs to study the patterns of diversity in water-dwelling organisms, both at a broad scale and at a specific gene level.Fisheries genetics involves several tasks such as identifying fish specimens and using barcodes for their identification. It also includes studying the population structure and mixing of fish stocks, keeping track of efforts to introduce or reintroduce fish to an area, studying the genetic diversity and differences among fish populations, and helping with conservation efforts for wild fish resources. Aquaculture genetics is the study of genetic variability and how it affects the health and survival of aquatic animals. It also looks at inbreeding and how it can impact the animals. Another focus is on selectively breeding animals to have specific traits that are wanted, such as being larger or growing faster. Alternatively, problems with seafood safety involve checking if the seafood is real and keeping track of where it comes from using special markers in its molecules[1], [2].

The use of genetics and molecular techniques in fisheries and aquaculture has grown quickly in the past 20 years. However, there aren't many ways for scientists to share and spread their

new research findings in these fields. The decline of wild fish resources, the effects of climate change on the ocean and lakes, and the fast growth of aquaculture have created many chances for genetic research in these areas. Genetic diversity allows researchers to create new and better fish breeds that have the traits fish farmers and breeders want. So, understanding genetic differences is really important when choosing which organisms can survive in different environments, like dealing with new diseases or weather conditions in the future. Furthermore, DNA markers can be used to ensure that seafood products are safe by confirming the authenticity and traceability of the ingredients used in fresh and processed seafood. Using these methods for genetic traceability in the agro-food industry is a strong way to protect both the people who produce food and the ones who consume it. It helps guarantee people have the option to choose what they want to eat and ensures that seafood products are labeled correctly. So, Frontiers in Genetics would be a good place to share new discoveries and progress in the study of genetics in fisheries and aquaculture[3], [4].

Aquaculture is the process of breeding and farming fish and shellfish, and it is becoming more popular than traditional fishing with lines and nets. This change is very important for giving people who live far from the coast an important source of protein and nutrients.In simple terms, the success of aquaculture depends on using similar methods that are already being used in modern agriculture. When breeders want to increase crop, livestock or fish production and make them healthier and stronger, they now need to use genomic resources.The Earlham Institute has been involved in creating important information about genes for breeders. They have worked closely with partners like WorldFish and the Roslin Institute. This information will help with problems of genes moving around in domestication and how animals adapt to their environment, especially with climate change.The word 'epigenetics' was made up by Waddington in 1942 and it means changes in how an organism looks or behaves without changing its genetic makeup. Research on changing the chemicals in DNA has been happening since 1948. In the 1970s, scientists discovered that DNA methylation plays a role in controlling genes. In the years that followed, scientists discovered that DNA methylation is connected to how genes are turned on and off. This led to the finding of drugs like 5-azacytidine, which can prevent DNA methylation. Basically, epigenetic changes are controlled by two things: chemical changes to DNA called methylation and changes to proteins called histones that are attached to the DNA[5], [6].

Recent developments in high-throughput sequencing (HTS) have improved the accuracy of studying genomes at the level of individual DNA base pairs. This breakthrough has made it simpler to chart the complete epigenomes of living organisms. As a result, we can now identify specific biological indicators that can predict the progress of diseases, infections, reproduction, growth, and adaptation to new environments. As a result of these improvements, scientists have been studying epigenetics in aquaculture more and more over the past few decades. They are trying to find signs in the biology of farmed aquatic animals that can help improve their production. In aquaculture, scientists use different technologies to study epigenetics. These includeRNA sequencing in Medaka and Nile tilapia. Methylated DNA immunoprecipitation sequencing in Nile tilapia and Medaka. Bisulfite sequencing in smooth tongue sole, rainbow trout, and Nile tilapia. Genetic linkage map analysis using simple sequence length polymorphisms in medaka. Methylation sensitivity amplified polymorphism in Atlantic salmon, grass carp, brown trout, sea urchin, and sea cucumber. 5-methylcytosine immunolocation in sea lamprey. Restriction endonuclease hydrolysis of DNA using methylation enzymes in Zebrafish.

Epigenetic factors related to the development and productivity of underwater creatures include growing up quickly, controlling muscle growth, and fighting off diseases. Early

maturation in Atlantic salmon has become a fascinating topic because young fish can become sexually mature and successfully reproduce before they migrate. Around 60% of all fathers in wild populations are these early-maturing male parr or 'sneakers'. To find out why some fish grow up early, Morán and Pérez-Figueroa compared two groups of young fish and adult fish from two different rivers. They looked at the differences in genes and how genes are turned on and off. They found that there was no genetic difference between the young fish and adult fish. However, when the researchers studied the way genes are influenced by an organism's environment, they found that there were important differences in certain spots in the DNA of the gonads of parr compared to mature fish. The same differences were also seen in the brain and liver[7], [8].

This suggests that the process of early maturation in parr is controlled by epigenetic factors, and not by differences in the genes themselves. When it comes to being able to fight off disease, the study by Shang and colleagues found that. The study found that specific types of DNA methylation in a gene called CiMDA5 in grass carp are strongly linked to their ability to fight against a virus called GCRV. In the research, they discovered certain areas of the CiMDA5 genome with lots of methylation, called DMEs. These areas were more common in fish that were likely to get sick from GCRV compared to fish that were resistant to it. When it comes to building muscles. Scientists discovered a link between the increase of certain DNA enzymes in fast muscle and prolonged exposure to light. This suggests that the length of daylight might affect the regulation of muscle growth in Atlantic cod. In the same way, Nagasawa and his colleagues. Researchers discovered that there were high levels of a specific gene called mixed-lineage leukaemia (MLL) in the fast muscles of Atlantic cod fish that were exposed to light for a long time. This gene was linked to an increase in the production of other genes involved in muscle growth and development. In simple words, these studies prove that certain changes to the DNA in fish can affect how their muscles grow, how well they can fight off diseases, and when they reach sexual maturity.

Certain things like what an organism eats, moving around, the amount of salt in the water, and the amount of light it gets can cause changes in its genes. These changes help the organism adapt to its environment. Some studies have found that rainbow trout has high blood sugar when they eat diets that are high in carbohydrates. To better understand why certain things, happen, Scientists studied the liver of rainbow trout that were given high carbohydrate diets. They discovered that the DNA in the liver had lower levels of methylation, which is a process that affects gene activity. They also found that a specific histone protein called H3K9 had reduced levels of acetylation. These changes in gene activity resembled the conditions of high blood sugar and diabetes in both zebrafish and mammals. They also found that certain genes that make the glucose-6-phosphatase enzyme involved in gluconeogenesis were not properly modified at specific spots on the DNA sequence. This suggests that what rainbow trout eat can change how their liver cells function. Regarding the characteristics of migration, Scientists found differences in DNA methylation patterns between migratory smolts and resident rainbow trout juveniles. These differences were mainly found in areas of DNA that code for proteins related to migration. This suggests that changes in gene expression caused by epigenetic variations are connected to migration traits in anadromous fish.

DISCUSSION

Reduced ocean productivity and resource availability will have a domino effect, possibly causing catastrophic changes in the quantity and diversity of marine organisms. With the broad and fast decline of marine life variety, there is a growing need to design the effective and sustainable use of the oceans for food via fisheries and aquaculture. Effective actions to

reverse biodiversity loss will need a deeper knowledge of the effects of climate change on natural systems, as well as documentation of the underlying causes and consequencescontemporary biotechnology and genomics are two examples of contemporary technologies that are extending our knowledge of the underlying patterns and processes that influence the variety of life in the seas. Since Frederick Sanger developed the first gene sequencing tools in the 1970s, genetic science has witnessed significant and fast increase in many different fields of biology and technological applications. In biodiversityresearch, genomic sequencing has now become a routine technique[9], [10].

Although most genomes research has concentrated on terrestrial species biodiversity, the use of genetics to the study of marine species and ecosystems is gaining traction. The recent sequencing of a diverse set of fish genomes is yielding crucial insights into vertebrate genome evolution, including unexpectedlypertinent information on the function of genes implicated in human disorders. Furthermore, by combining the most recent advances in genomics with post-genomics technologies, new insights into the evolutionary history of marine species and their responses to environmental stress, as well as key features of global marine biodiversity and ecosystem dynamics, are now possible. This study gives examples of current discoveries and breakthroughs in the creation of genomic, transcriptomic, and proteomic resources to better understand marine biodiversity and promote aquaculture development. We also explore the importance of scientific policies in addressing the issues that smaller countries have in the proper supervision of this expanding area as they strive to ensure food security and the protection of their natural resources.

Marine Biodiversity Genomic Applications

Scientific developments in DNA sequencing are assisting biodiversity assessments and discovering previously undiscovered genetic and functional variety, as well as giving technologies that have the potential to significantly change the way we think about marine life.NGS stands for next-generation sequencing. With the recent development of next-generation sequencing (NGS) tools in marine biology, we now have unprecedented access to the genomes, transcriptomes, and metabolomes of many marine organisms. Model fish genetic variation research are giving critical data on adaptation and persistence processes that are important for biodiversity assessment and conservation biology in marine habitats.Tursiopstruncates' DNA has offered information on the development of the dolphin nervous system and shown similarities with other large-brained animals like as humans. The newly sequenced dolphin genome was utilized in a wider research of mammalian genomes to compare over ten thousand protein-coding genes with matching matches in the genomes of numerous other mammals, including dogs, elephants, and humans.

The research discovered over 300 genes in the dolphin lineage that have experienced considerable modifications due to positive Darwinian selection in comparison to other animals. Some of these genes are linked to the nervous system, such as synaptic plasticity, sleep, intellectual impairments, microcephaly, schizophrenia, and Alzheimer's susceptibility in humans. Dolphins and humans share a slowing in the molecular rate of change shown by their DNA sequences over time.Further whole-genome-wide scans of the dolphin genome, focused on positively selected genes, are elucidating the genetic grounds of species diversity and adaptive evolution in marine mammals. Using a Uniprot tissue annotation database to investigate the tissue specificity of more than 300 positive selection genes, PSG, the study discovered that these PSG were largely expressed in tissues associated with the nervous, reproductive, and immune systems, implying possible functional roles for these tissues in processes requiring aquatic adaptation, such as body fluid balance and breathing in

mammals.Similarly, the genome of the African coelacanth provides information on how fish originally adapted to terrestrial life, giving birth to amphibians, reptiles, birds, and mammals.

The coelacanth, a deep-sea fish that closely resembles its fossil from at least 300 million years ago, features four massive, lobed fins that are thought to be the precursors of limbs. The genome sequences suggest a sluggish pace of evolution, which fits with the prevailing belief that this lineage evolves slowly. Using the letter L. The African coelacanth genome, chalumnae genomic DNA, was sequenced by Illumina and assembled using the short read genome assembler software ALLPAHTS-LG. A phylogenomic data set based on 251 concatenated protein and 100,583 amino acid locations was used to investigate protein-coding gene evolution, and it was discovered that the protein-coding genes of L. When compared to other sequenced vertebrates, chalumnae have a lower substitution rate.The lungfish lacks large-scale sequencing data because to its massive genome size of about 100 billion base pairs, which makes it impossible to sequence, assemble, and analyze. As a result, a comprehensive genomic comparison of coelacanth and lungfish is now impossible. Nonetheless, even with just a few genes, it was able to collect high-quality data sets. The genetic composition of the lungfish will reveal important insights into how certain vertebrates evolved to life on land, as well as vital pointers for the study of vertebrate evolution in general.

The RNA content of coelacanth was compared to that of lungfish, another lobed-finned species (sarcopterygian), to answer the question, which living fish is the closest relative to the fish that first made the critical transition from water to land? a contentious phylogenetic issue. To address this, RNA-seq data from P. annectens brain, gonad, kidney, stomach, and liver tissues were compared to gene sets from 22 jawed vertebrate species, including L. chalumnae, and confirmed that the lungfish, not the coelacanth, is the closest extant fish to the tetrapod. A series of unusual discoveries were made by looking at the missing genes lost during the water-to-land transition and the newly acquired regulatory elements, including some relevant to the sense of smell for detecting chemicals in surrounding environments, immune-related regulatory changes, and evolutionary development. A coelacanth HOXcluster area was discovered that may have had a role in the formation of extra-embryonic structures in tetrapods, including the eutherian placenta. Hox genes were previously hypothesized to have a function in the control of limb development. It is possible that this sequence from the coelacanth was co-opted by tetrapods to help generate hands and feet.

With the availability of marine species genomes, new 'omics' technologies such as transcriptomics, proteomics, and metabolomics are allowing for more extensive investigations of marine species' evolutionary history.The application of evolutionary ecology to non-model species is aided by next-generation sequencing technology (NGS) and newly developed genomic techniques. Streblospiobenedicti, a segmented tube-dwelling benthic polychaete that exhibits offspring dimorphism and is being used to examine the evolutionary repercussions of larval life history, is one of these creatures. The transcriptome of S. cerevisiae embryos, larvae, and juveniles has been characterized using 454 pyrosequencing. benedicti, yielding 715 400-bp reads and 3.08 times coverage. PipeMeta discovered 2,817 single nucleotide polymorphisms (SNP) from a total of 7,222 contigs. These SNPs were confirmed by genotyping individuals at various developmental stages using the BeadXPress Golden Gate assay, and 84 novel SNP markers were discovered to be useful for discriminating across geographic and phenotypic populations of S. benedicti. Given the paucity of marine polychaet genomic resources, this transcriptome technique should be ideal

for conventional population genetic studies to investigate the molecular and regulatory processes driving their life-history changes.

Transcriptome studies are becoming more widely accessible, especially when genomic data are lacking. A transcriptome study of the Atlantic herring was recently completed, an abundant fish found in the pelagic zone of marine waters and a vital protein source in both Europe and North America. Understanding C.'s genetic structure is important from a biological standpoint. Harengus is of particular significance due to its well-defined adaptation to salinity, being one of the few marine species capable of reproducing in both the North Atlantic and the Baltic Sea. Several investigations employing isozyme loci, microsatellites, and SNPrevealed markedly low levels of genetic difference across geographically distant and physically diverse forms. This approach was expanded by looking at skeletal muscle mRNA to build a transcriptome and match genomic reads to the transcripts, resulting in a exome assembly. It was feasible to uncover crucial genetic markers for phenotypic variation in C. using these methods. harengus, allowing for more population genetic research on adaptability and natural selection.

A more in-depth transcriptome study of other C. Harengust problems, as well as the whole genome sequence, will support utilizing the herring as a model organism for evolutionary genetics. The entire genome sequencing of this enormous genome, estimated to be over 900 Mbp, may still be a significant task. However, SNP development using a combination of next-generation sequencing (NGS) and a high-throughput genotyping approach has the potential to make the most efficient use of cost and time by avoiding the costly and time-consuming laboratory stages involved in genomic work for ocean population studies.The widespread availability of NGS technology has undoubtedly resulted in direct deployment in model marine species. Their use to the ecological and evolutionary study of non-model species is gaining popularity. SNPs in the transcriptome of the European hake, Merlucciusmerluccius, have been discovered using two sequencing systems, the Roche 454 FLX (454) and the Illumina Genome Analyzer (GAII). These tools and data are an important resource for Atlantic cod, a significant marine species that is underrepresented in genomic databases.

Metagenomics and proteomics.With breakthroughs in metagenomic sequencing and proteomic technologies, the study and characterization of uncultured biological samples is becoming more practical, revealing the compositions, functions, and interactions occurring in microbial communities present in various environments. Faster sequencing technologies and the ability to sequence a broad range of uncultured microbes collected directly from their habitats are maturing and revolutionizing our understanding of the microbial world, as well as their effects on global processes such as the carbon, nitrogen, and sulphur biogeochemical cycles. The analysis of microbial communities in coastal and marine settings utilizing high throughput sequencing technologies for the conventional 16S ribosomal RNA gene and whole genome shotgun (WGS) sequencing is revealing the distinctive structure and identity of bacterial, archaeal, and viral populations. Metagenomics provides access to the functional gene composition of entire microbial communities, resulting in more reliable and comprehensive studies.

In the past decade, whole genome sequencing has been utilized to sequence whole coastal and marine ecosystems. Similarly, by sequencing a community of DNA from a very low diversity microbiotain acid mine drainage, able to use a whole genome assembler technique to assemble the lengthy capillary sequencing reads with high accuracy. The functional potential of oceanic microbial communities in the Sargasso Sea was investigated using similar technology and a complex bioinformatics approach, yielding at least 1,800 different

genomes, 48 unknown bacterial phylotypes, and 1.2 million previously unknown genes. Subsequent metagenomic investigations persuasively shown that this approach may be used in a variety of marine habitats.Along with metagenomics, there has been a surge in marine environmental proteomics in recent years, which is the large-scale characterization of proteins collected from various coastal and marine habitats. While 16S rRNA data provide important information about a sample's species membership and metagenome sequences account for all possible gene products in an environmental sample, proteomics is used to determine protein expression profiles of microbial communities, greatly expanding our understanding of marine microorganisms and their impact on the ocean.

Environmental proteomics research has discovered crucial links between protein diversity and ecological function in microbial communities. Proteomics may be an effective method for detecting phylogenetic links and answering critical problems in metapopulation biology and adaptation. High-resolution capillary liquid chromatography coupled with an LTQ mass spectrometer was used to create an accurate mass and time (AMT) tag library as a tool for analyzing protein profiles of the marine alpha-proteobacteriumCandidatuspelagibacterubique, as well as identifying adaptation mechanisms and differentially expressed proteins from the exponential and stationary growth phases. The majority of proteins found in greater abundance in the stationary phase were those involved in stress response, protein refolding, transcription regulation, and oxidative damage mitigation, implying that these adaptive responses are important for this alphabacterium's long-term survival under nutrient-limited conditions. The analysis of proteome changes of microorganisms in response to growth circumstances has become a common method for identifying metabolic and regulatory mechanisms.

Metabolomics. The study of all metabolites found inside cells, tissues, and organs, as well as in populations, has become a vital tool that goes beyond just listing bioactive molecules. Metabolomics is advancing research into changes in protein abundance and their subsequent post-translational modifications, as well as wider biological topics such as how metabolites reflect and impact cell function, and how the environment affects the biology of marine species. Nuclear magnetic resonance (NMR) and mass spectrometry (MS)-based techniques, as well as a combination of the two, are increasingly being used to perform high throughput profiling of metabolites and to investigate interactions of marine organisms with their environment, known as marine metabolomics. Studies on marine fish and other ocean animals have recently been published. Targeted metabolite profiling in harbour seals and porpoises has also been documented to evaluate contamination by chlorinated and brominated substances. Metabolite profiling by MS has also recently been utilized to analyze the metabolism of an amussel (Mytiluscalifornianus) in both the aerobic and anaerobic stages of its life cycle. Similarly, NMR-based metabolic profiles have been used to identify the metabolites responsible for the fluctuation in the metabolic profile of pathogenic Vibrio coralliilyticus under harsh natural conditions, such as fluctuating temperatures.

Metabolomic applications have enormous promise for detecting marine species' physiological responses to changing biotic and abiotic environments. They also provide a unique chance to learn about the processes behind the varied impacts of closely related species and individuals within the same species. Furthermore, metabolomics, as well as other recent 'omics' technologies and their applications to marine biology research, are giving useful information for understanding microbial ecosystems, as well as biogeography and species diversity in the ocean.While most genomic and post-genomic applications to marine biodiversity research are still in their early stages, new and exciting methodologies for discovering and comprehending life history stages and new species that would otherwise be difficult to identify using

traditional taxonomic methods are emerging. Fast large scale DNA barcoding is one such approach. Although unquestionably useful for species identification, taxonomic techniques based on phenotypic features are inefficient for uncertain taxonomic groupings or for identifying closely related species with slight morphological variations.

DNA barcoding employs mitochondrial cytochrome c oxidase subunit I sequences to reliably identify any species. For more difficult taxonomic groups, DNA barcoding must be used in conjunction with morphology-based identification systems, as well as a variety of molecular identification strategies based on the analysis of homologous gene regions such as ribosomal RNA molecules (16S and 18S) and the internal transcribed spacer region, ITS. To present, the effectiveness of molecular barcoding is finding practical applications in a wide range of taxonomic groupings, including marine species, providing more support for the consistency and accessibility of DNA barcoding for identifying marine creatures. This is an intriguing method that will almost certainly be useful in ecological investigations.

Aquaculture Genomic Applications

Modern biotechnology and genetics have been utilized to uncover previously unknown aspects of biodiversity in the seas. The implementation of these technologies also offers significant social and economic advantages in global aquaculture output.As it relates to aquaculture and fisheries, genomics is rapidly gaining traction, with thousands of publications published each year covering cutting-edge topics such as aquaculture biotechnology, genomics, epigenomics, and post-genomics applications in aquaculture nutrition, stress, health, and reproduction, among many others. We will use specific examples to demonstrate the influence of genomics on our present knowledge of genome evolution and its possible implications for important characteristics and infectious illnesses in aquaculture.Adaptive evolution studies in population genetics of marine fish and other invertebrates are offering useful insights into local adaptability, climate change response, and the ecological effect of selective harvesting and global fisheries. This kind of study, such as clam transcriptomics and sea cucumber transcriptomics, is critical for both advancing our understanding of natural evolutionary processes and identifying coastal and marine conservation priorities. The availability of precise clam transcriptomics has opened up new avenues for determining the physiological function of different metabolic systems and population responses to environmental stress.

Distinctive genes involved in clam bed growth or response to temperature variations might provide useful information for fisheries management assessments.Salmon is a well-studied fish that serves as a model species for fish genetics and evolution. Since 2010, genomic data generated by the International Collaboration to Sequence the Atlantic Salmon Genome (ICSASG) has served as a reference sequence for other salmonids (salmon, whitefish, trout, and char), increasing the number of salmon-specific molecular markers applicable in population genetics to distinguish and monitor various geographic populations. A variety of genomic techniques have been developed to generate SNPs and genome-wide markers of importance for breeding programs (repetitive elements, intron/exons, gene duplication) at a low cost. Recent uses of restriction site-associated DNA sequencing (RAD-Seq), for example, have aided in large-scale marker identification and genotyping. RAD markers are useful for QTL and association mapping, as well as population genetics and evolutionary study. They have significant advantages over other methods and are rapidly finding application in non-model organism SNP discovery and genotyping studies, where they can be used in genotype-phenotype association mapping, population genetics, and scaffolding genome assemblies through linkage mapping.

SNP arrays have been effectively utilized to examine the genetic structure of salmon populations, allowing for a better understanding of the molecular basis of adaptation to a broad variety of geographical conditions. Furthermore, chromosomal rearrangements have shown some karyotype variations between European and North American Atlantic salmon. These applications might have a significant influence on the aquaculture business by giving genetic information on salmon production qualities crucial to industrial development, as well as enhanced evaluations of wild fish population sustainability.Without a doubt, SNPs are rapidly becoming the preferred markers for genome research and genetic enhancement projects. Their use in aquaculture is becoming more important due to their practical utility in the research of trait-genotype relationships. Similarly, as more sequencing information for marine species becomes accessible, new markers are increasingly being used in aquaculture genome research. The availability of well-established genetic linkage maps serves as the foundation for future genome scans for Quantitative Trait Loci, or QTL, to research features of considerable importance in aquaculture.

In the last decade, genome-wide association studies (GWAS) have made important contributions to the area. GWAS and QTL locus mapping may be used to study genetic connections with phenotypic features. GWAS investigate the relationship between common genetic variations and particular features (phenotypes), often quantitative, in the genome, transcriptome, or proteome. Because of their extensive genome coverage, assay throughput, and quality assurance, SNPs are typically the first option. Although the concepts behind GWAS and QTL analysis are quite similar, it is critical to stress that GWAS tests at marker sites, whereas QTL analysis looks at the relationships between markers.Recent advancements in SNP technology for marine species now enable aquaculture genome-wide association studies (GWAS) to discover and pinpoint candidate genes for quantitative features in a variety of marine species. However, because to a scarcity of SNP genotyping arrays, the first GWAS for quantitative characteristics in fish, for example, were reported very recently. This method has been used to find a large number of genetic loci that are linked to illnesses and are relevant for marker-assisted selection programs. Nonetheless, the number of genetic and metabolic mechanisms found to explain illnesses and immunity has not risen much.

While QTL mapping is thought to be a strong tool for identifying areas of the genome that co-segregate with a given characteristic, one restriction is that only allelic variation that segregates between the parents of the specific F2 cross may be assessed. GWAS, on the other hand, gives insights into the genetic architecture of the trait after identifying the phenotypes of interest, enabling informed choice for QTL analysis and recommending candidates for mutagenesis and transgenics. Given recent developments in high throughput genotyping technology, GWAS may potentially improve the efficiency of aquaculture breeding and selection. Furthermore, epigenetic characteristics will be included in GWAS in the near future.SNPs and microarrays may be used to address the possibly harmful influence on the gene pool of wild fish caused by the unintentional introduction of farmed fish. SNPs are currently the primary instruments for tracking interactions between wild and cultivated fish populations. DNA microarrays, which provide expression information for hundreds of genes at the same time, are having a significant influence on functional genomics research in marine animals such as Atlantic salmon and common carp. NGS approaches have recently been utilized to discover markers suitable for population screening of changes in wild and farmed fishes.

Similarly, new NGS approaches have been used to identify mislabeling and avoid species substitution in a number of situations and goods on the commercial market. Pyrosequencing, for example, has been utilized effectively in high-throughput identification of seafood species

in various products, as well as in species-specific PCR tests or microarrays. Furthermore, biomonitoring programs and conservation studies are presently combining DNA barcoding with high-throughput NGS technology. High-throughput proteomics advances now allow us to compare protein composition across diverse biological systems. Host-pathogen interactions, including pathogenicity and virulence, may now be investigated using a global proteome approach, potentially leading to the discovery of new vaccine targets and novel treatments in marine aquaculture. A two-dimensional gel electrophoresis (2-DE) proteomics technique was employed in shrimp to explore crustacean molecular responses and change of protein content in hemocytes following Taura syndrome virus (TSV) infection. The same method was used on another shrimp, Penaeusmonodon, to study immunology and discover differently expressed proteins when infected with the luminous bacteria Vibrio harveyi.

The 2-DE patterns of hemocyte proteins from unchallenged and V. harveyi-challenged shrimps revealed that hemocyanin and arginine kinase were up-regulated, whereas proteins like alpha-2-macroglobulin, calmodulin, and 14-3-3 protein epsilon were down-regulated. The role of Penaeusmonodon alpha-2-macroglobulin in response to bacterial infection was further characterized using RNA interference (RNAi), leading to the conclusion that this protein plays a role in the blood coagulation system, enhancing bacterial sequestering by protecting blood clots against fibrinolysis. Overall, the availability of high throughput techniques for investigating shrimp responses to bacterial infection at the transcriptional and translational levels, as well as functional expression analysis, is critical for better understanding of immunity-related mechanisms in crustaceans and disease control in shrimp aquaculture.Aquaculture is an important source of food and employment globally; the use of genetics to this field has enabled a systematic improvement in wild stock management. A number of issues must be adequately addressed if the use of genomic techniques in conservation genetics/genomics for aquaculture is to develop.

The first important scientific problem is developing new methods to manage the large volumes of data created everyday by whole-genome sequencing initiatives, as well as their integration with phenotypic data and data from other disciplines. A critical enterprise for the whole scientific community is the scarcity of effective platforms and techniques for efficiently mining, retrieving, processing, and investigating massive volumes of genetic data and integrating them with other information from diverse sources. Second, given the importance of local populations of marine creatures in terms of genetic diversity, population genomics research on those local species should be explored. Many native fish populations may already be extinct as a result of overfishing and environmental deterioration; there is an urgent need to understand the core population structure of many commercially important species. Third, the genomes of less well-known and non-model species may also be essential for identifying crucial genes, metabolic processes, and polymorphisms that may or may not become economically significant.Furthermore, the application of genomics in small-scale aquaculture, which is the most frequent dimension of aquaculture worldwide, offers unique obstacles that vary from those encountered in industrial size aquaculture. As a result, governments must seek public financing schemes and establish enabling policies to promote small-scale farms for the purpose of employment in disadvantaged rural regions in order to favour this model, which brings significant local economic and employment advantages.

CONCLUSION

The importance of fishery and aquaculture is very significant because they are essential for ensuring enough food for the world, promoting economic development, and maintaining the environment's stability. However, they have many problems to deal with, such as more and more people needing their help, diseases spreading, and worries about protecting things.New

technologies in genomics, like high-speed sequencing, mapping genes, and identifying molecules, are changing the way breeding programs work in these fields. They help make selective breeding better and more efficient, which improves both the amount and quality of what is produced.Genomics is very important in finding and treating diseases in underwater animals. This tool helps in quickly finding out the harmful germs and making specific treatments, which helps in decreasing the financial losses caused by disease outbreaks.Conservation efforts are important for protecting endangered water species. Genomic data is very valuable for this purpose. It helps understand different genes and how populations change over time, so we can come up with good ways to protect nature and fix ecosystems that are in danger.This chapter highlights how important it is to continue researching genes in fishery and aquaculture. As problems change over time, genomics will be very important in solving them and making sure these industries can last and recover from difficulties.In simple words, genomics has brought about a new time in fish farming and aquaculture. Science is leading the way in improving breeding, managing diseases, and protecting fish. This chapter talks about how important it is to keep investing in genomics research. This research helps us meet the increasing need for aquatic products while also protecting the health of water ecosystems and the people who rely on these industries.

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CHAPTER 11

MANAGING WETLANDS FISHERIES USING TRADITIONAL PRACTICES: A BRIEF OVERVIEW

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ABSTRACT:

This chapter explains the important knowledge and proven techniques that indigenous communities have learned and used for a long time to protect and take care of wetlands.The beginning of the abstract acknowledges that wetlands are very important for the environment. They play a crucial role in preserving biodiversity, purifying water, and regulating the climate. But these important ecosystems are being harmed more and more by damage to their homes, pollution, and too much use.The chapter also talks about the valuable information known by native groups who have lived near wetlands for a long time. This knowledge includes different things like wetland ecology, patterns that change with the seasons, and ways to manage resources in a sustainable way.Indigenous people often focus on protecting the variety of plants and animals in wetland ecosystems. They understand how everything is connected.Indigenous communities have found ways to responsibly use and gather resources from wetlands. They have also created systems to make sure these resources will still be available in the future.Wetlands are very important to indigenous groups because they have a special meaning to them and help them stay committed to protecting the environment.Climate resilience refers to being prepared and able to handle changes in the environment. Indigenous people have knowledge and strategies for dealing with changes in wetlands, which can be helpful for everyone in preparing for climate changes.Working together to care for wetlands is important. Indigenous communities are important in this. They should be included in wetland management and work together with other conservation efforts.This text emphasizes the importance of recognizing and including traditional practices in current wetland management strategies. By doing so, we can adopt a more comprehensive and long-lasting approach that values the ecological and cultural importance of wetlands.

KEYWORDS:

Communities, Development, Fishing, Management, Wetland.

INTRODUCTION

Workshop 1 of the 2nd International Conference on Wetlands and Development, held in Dakar in November 1998, was titled Strategies for Wise Use of Wetlands: Best Practices in Participatory Management. It aimed to address the complexities and challenges of developing and implementing wetland co-management systems with local stakeholders bypromoting experience exchange and strengthening south-south networks and identifying and refining strategies for wise use, as well as reviewing best practices of participatory wetland management from around the world, particularly from Africa. This workshop was a follow-up to the inaugural International Conference on Wetlands and Development, which was held in Kuala Lumpur, Malaysia, in October 1995. The Dakar workshop relied heavily on the seminal publication that included the proceedings of the first workshop in Kuala Lumpur. To date, evidence suggests that local people's engagement in wetland management may considerably help to sustaining or restoring ecological integrity and community well-being. The Dakar workshop urged participants to concentrate on solutions and honest appraisals of actual experiences in participatory wetland management, based on the premise that every

successful co-management project has the potential to promote beneficial initiatives elsewhere[1], [2]. It also allowed for the ground-truthing of guidelines for establishing and strengthening participatory processes to involve communities and indigenous people in wetland management, which were being developed for the 1999 Conference of Parties of the Ramsar Convention on Wetlands. The Ramsar guidelines summarize five critical elements for effective co-management, incentives for local and indigenous peoples' participation and responsible use in the long run, everyone must benefit from, trust among stakeholders, flexibility, knowledge sharing and capacity development and continuity of resources and effort. The workshop was divided between plenary sessions, poster sessions, and discussion groups in order to produce findings and suggestions for the conference's final plenary session. The co-management of wetlands outside of protected areas was the subject of two-thirds of the oral presentations at this workshop. Half of the case studies in this book deal with coastal wetlands, while the other half deal with inland wetlands. The workshop, which served as a sounding board for practitioners, emphasized that success must be measured from a variety of perspectives, including stakeholder satisfaction, government agency satisfaction, and ecosystem health[3], [4].

In the attempt to discover and enhance techniques for sensible usage, eight themes were highlightedSupporting frameworks, suitable modifications in land tenure, resource access, property rights, and acknowledgment of co-management regimes in national and municipal policies, laws, and development plans, as well as how they have influenced local efforts. Local environmental knowledge, co-management systems that have successfully integrated traditional knowledge and technology. Economic valuations evaluations of wetlands' advantages and functions that go beyond theory and are employed in management planning. wetlands management systems in which women and men have equal say in establishing management aims and tactics. Participatory monitoring: collaborations between management and local residents to monitor the natural nature of wetlands as well as progress toward the community's own goals. Addressing wetlands concerns effectively via ecomanagements. where socioeconomic growth and wetland protection have coexisted, and Exit strategies where co-management projects have planned for, and then successfully executed, scaling down and phasing out of external support[5], [6].

The awareness that people are not distinct from the natural system underpins the concept of community-based resource management. Wetlands today, especially the most pristine, are the product of intricate interactions between physical, biological, and human factors across time. Almost all of the world's wetlands have been impacted and transformed by patterns of varying intensity of human usage. Wetland management by local people may have a thousand-year history in the case of First Nations. Participatory management is now commonly characterized as a partnership in which government agencies, local communities and resource users, and maybe other stakeholders, such as non-governmental organizations (NGOs), share power and responsibility for managing a given region or set of resources. intergenerational justice based on the ecosystem's carrying and assimilation capability 4. System orientation: the community operates in relation to other communities and stakeholders, much as resources are naturally related to larger ecosystems. The degree of community participation in the wise use of wetlands varies with the local context: from high levels of empowerment to effective partnerships between government authorities and local communities, to situations where government remains firmly in control and stakeholders are consulted on decisions. There is a growing recognition that power for resource and ecosystem management must be delegated as much as possible to the local level in places where indigenous and traditional peoples have lived for hundreds, if not thousands, of years. Indigenous peoples throughout the globe are asking that their rights be recognized and that

they have a bigger role in choices that impact their lives. Fortunately, there is a growing recognition that diverse biodiversity often correlates with cultural variety. The tendency in ecosystem management in these places is moving toward systems of collaborative management with indigenous peoples. To date, one obvious lesson has been learned: unless a relationship of trust between communities and government institutions can be built and maintained, even the most basic co-management system is difficult to persist. Unfortunately, in the majority of cases where communities are in a subsistence relationship with resources, trust in government agencies is extremely low or non-existent, and long periods of dialogue and shared learning are required to build the trust required for co-management to work.

Once communication channels are operational, the best method to establish a firm foundation of confidence is to guarantee that mutually agreed-upon objectives and targets are accomplished by communities and appropriate government institutions. A sufficiently long initial period of analysis and problem identification can assist in ensuring that resource management plans are developed based on genuine mutual agreement derived from a clear analysis of the benefits and costs to all stakeholders, both short and long term. The Ramsar recommendations for developing and enhancing local community and indigenous peoples' engagement in wetland management include an incredibly useful set of indicators to assist quantify the level of community involvement. A solid legal foundation is required for developing a participative management system. Transparent decision-making procedures and multi-sectoral planning therefore considerably improve the odds of success. The bare minimum contribution from government that will always be necessary is a policy and regulatory framework that legitimizes the engagement of local people in resource management[7], [8].

Tenure, resource access, resource ownership, and the nature of co-management must all be addressed. Lessons learned from incorporating people in maintaining marine protected areas in Belize, Mauritania, Mozambique, and Zanzibar emphasize the significance of a solid legal foundation to assist local people's activities. In Cameroon, a legislation establishing participatory management of forests and protected areas was approved in 1995. However, in many nations, national law does not support co-management. Furthermore, many government organizations lack participatory management training. In many situations, legal, regulatory, and implementation frameworks must yet be updated to allow for true community empowerment models. Thailand's freshly amended Constitution, approved in May 1998, fully recognizes the broad concept of people's involvement in government, resource management, and development planning. However, legal acknowledgment alone is insufficient. According to Erftemeijer and Bualuang, there are still significant cultural hurdles to successful grass-roots engagement in Thailand's highly stratified, hierarchical society. Japan has an unusual success story of community-based fisheries.

After experimenting with western resource management systems in the late nineteenth century, Japan repealed the new legislation and reverted to traditional community-based management for all inshore coastal fisheries around the turn of the century. Local fishing cooperatives were awarded exclusive, irrevocable rights. Membership in the cooperatives is not transferable and is dependent on residence and a term of apprenticeship. The cooperatives decide on operating norms based on the experience of the fishermen. Because management choices are made by fishing groups that share the same fishing grounds, and errors are borne by the individuals who make them, the system offers a strong form of accountability. According to Weinstein, Japan's inshore fisheries is quite robust, as judged by macro-level sustainability metrics. Government agencies, according to Claridge and O'Callaghan, are typically sluggish to adopt participatory wetland management, and their support for co-

management may be merely lip service. They found that one of the primary issues confronting wetland conservation was the development of approaches for enhancing government acceptability and commitment to co-management.

Although this is still true in many regions, certain case studies presented at the current session gave promising examples of successful enabling structures. The Djoudj National Park in Senegal, for example, is executing a management plan established in collaboration with nearby people. The proposal includes an institutional system comprised of four committees. The Orientation and Scientific Committees offer supervision, while the Park Management Committee, which includes village representatives, is directly involved in the management plan's execution. Furthermore, an Inter-Village Conservation Committee encourages neighbouring villages to participate, facilitates the exchange of ideas and decisions, and coordinates the development work of the various technical committees on ecotourism, replanting, waterways, health, and forestry/pastoralism. These enabling frameworks for participatory management were carefully designed, with beneficial outcomes. When the participative management strategy was implemented, a climate of trust was established between the public and the park agents, and the number of violations inside the park decreased to zero. Lessons from Pattani Bay in Thailand give numerous helpful insights into recognizing and building success conditions, as well as possible pitfalls, of constructing enabling frameworks for participatory management. Til and Banda's study in this book on the Bangweulu wetland in Zambia shows the difficulty of comanagement in an environment marked by skepticism, mistrust, and open hostility - between government officials and local people.

DISCUSSION

Decentralized approaches to natural resource management, of which community-based management is one, have received increased attention from governments around the world in recent years as a result of the failure of centralised management and the need to seek out better approaches. In the case of West African inland fisheries, such as the River Niger, the River Benue, and Lake Chad, it has been documented that riparian communities frequently serve as de facto managers, despite the fact that national governments have overall de jure responsibility for resource management. Based on recent studies in N.E., this dichotomy and its implications for the future management of inland fisheries in West Africa are discussed in the following study. Nigeria will be investigated. Special emphasis will be placed on the impact of socioeconomic factors community organization and decision-making processes, income sources on the effectiveness of fisheries management, as these factors have been identified as playing an important role in understanding how fishery systems work. As an approach within the study of planned development, community-based approaches to natural resource management have their origins in the convergence, largely during the 1980s, of two elements: a rediscovered movement towards community development and empowerment, and a growing consciousness of the limitation of natural resources as a factor in development.

One liberal legacy may be found in India's National Community Development Programme of the 1950s and 1960s, while another radical tradition can be found in Paulo Latin American work. The work of animateurs rurales in Francophone nations is maybe a third, distinct tradition. In India, the community development movement was founded on Christian missionary and philanthropic work on the one hand, and the Gandhian rural social transformation program on the other. Following independence, the Nehru administration asked an American, Albert Mayer, to carry out a pioneering programme in Uttar Pradesh, which was ultimately nationalized as the National Community Development Programme. However, the early examples' significant success proved unreplicable on a national scale by

bureaucratic procedures.From the beginning, a stream of populist critique followed this model of centralized growth, advocating the necessity for empowering local people within their communities to determine their own needs and run their own affairs. However, it was not so much the moral power of this criticism as the apparent failure of centralised development to fulfill its goals that shifted the focus of development professionals to local institutions and community-based participatory engagement.

There is a sense that the community-based approach to development has a natural affinity with Non-Governmental Organizations (NGOs) and pluralist approaches to funding and intervention, and many small-scale NGO initiatives working with local communities have been successful when compared to much larger centrally-planned projects. However, in the 1970s, several large-scale state bureaucracies started to experiment with de-bureaucratising themselves and establishing local-level self-management organisations. The best-documented example is the Philippines National Irrigation Administration. Communities and natural resource management In many developing nations, post-colonial governments inherited colonial practices of "protecting" natural resources from the people who exploited them in the form of government departments, which typically survived the handover of power relatively intact. However, under the new regimes, the funds and staff available for resource management were inadequate, and expanding populations placed additional strains on the system, which could not be efficiently policed. The inadequacy of governmental bureaucracy to effectively protect natural resources in developing countries became apparent in the 1970s.

Desertification and starvation in the Sahel have drawn attention to the relevance of resource management challenges. While these disasters were first largely blamed on local users' ecological ignorance and mismanagement, empirical research eventually revealed the close understanding that many rural people possessed of their ecosystems. Many development workers gradually developed a worldview that inverted the prior scale of values, depicting governments as the enemy of conservation by dismantling old management systems that had lived "in harmony with nature." This new view, together with growing interest in community-based development programs, converged in the 1970s and early 1980s to give users of natural resources main responsibility for managing them. As a result, numerous experiments have been conducted with local communities in many nations to encourage the formation of local institutions to govern the community's own environment for the benefit of the community. In many developing nations, fishing plays an essential socioeconomic role[9], [10].

Fisheries employ 14 to 20 million people directly, with the total number potentially reaching 50 million including the post-harvest industry. Around 1 billion people depend on aquatic goods as their primary source of animal protein. Not unexpectedly, fisheries have been the focus of many development projects financed by organizations such as the World Bank and the United Nations Development Programme (UNDP) during the past 30 years. The majority of projects have been technology-led, with the premise that increased production would lead to increased living standards for fishers and their communities. They have also advocated for and attempted to transfer Western-originated and centrally-controlled fisheries management systems. More recently, there has been a general change in fisheries specialists' views about fisheries development techniques as a consequence of the convergence of a number of aspects, as well as an examination of alternate solutions to fisheries challenges. To begin, it has been acknowledged that technology-led methods to fisheries development have been largely ineffective. Second, it is widely acknowledged that fisheries are becoming progressively overexploited, and that centrally managed management regimes have had minimal effectiveness. Third, the issues of overfishing and fishing community impoverishment must be considered in the context of the larger social, economic, and

political systems, of which fisheries are just one component. The need to enhance policy, which has an influence on the fisheries sector directly or indirectly, is closely related to this, with special reference to the establishment of policy goals for management and development. Fourth, it is now acknowledged that many fisheries, as an example of a common property resource, were efficiently managed in the past by local community-based fisheries management institutions, which were often displaced or neglected by centrally-controlled management systems. Traditional systems have often emerged in both inland and coastal areas based on the delimitation of property rights and their management by communities or fishing groups. The organization of usage rights and the group's capacity to exclude other users has resulted in advantages for system members. Management tactics in conventional systems might be purposeful or unintentional. The former often involves limits on fishing time and gear usage. Inadvertent measures have included fishing area prohibitions and technological deficiencies. Traditional fisheries management methods may be found in Japan, Sri Lanka, the Pacific, the Ivory Coast, North America, and many other areas. Through a co-management approach, several agencies are now investigating the prospect that conventional fisheries management practices might offer a foundation for enhanced management in specific scenarios.

The sort of common property regimes that arose via conventional management techniques in fisheries may seldom currently give the solution to modern management difficulties. A more practicable approach would be to form a co-management plan in which fishing communities and government share responsibilities for fisheries management. Community-based management is seen as a critical component of co-management, with the primary notion being that self-involvement in resource management will result in, for example, a greater commitment to comply with the management plan and sustainable resource usage. However, the ICLARM effort recognizes that co-management may not be feasible or appropriate for all fisheries, and that the preconditions or supporting elements for growth must be carefully examined.

The contemporary fisheries management regimes in N.E. Nigeria has been founded on Western top-down techniques to fisheries management and is relatively recent, having been developed during the course of the contemporary Nigeria State's establishment. Fisheries are classified as state property, which means that the nation state owns and manages them. The de jure arrangements incorporate a broad variety of aims, with a production-led orientation that is tacitly supposed to result in welfare benefits for fishermen. Methods include using effort and catch restrictions to maximize yield. The decision-making authority are the Federal and State Governments, who interact with fisher communities via State Department of Fisheries field personnel. The present system's de facto arrangements have deviated from its de jure arrangements. The case study of WuroBokki on the Upper River Benue exemplifies this. Most crucially, although a good fishing program has been implemented to address fish stock conservation, the State Fisheries Department's aims and activities have recently been re-directed towards income creation for the State Government via licence fees.

The contemporary fisheries administration's pervasive passivity on practically all fronts has been ascribed mostly to a lack of finance and other assistance from the national government. More frequently than not, the contemporary government's fisheries administration collaborates at the local level with the more prominent traditional administration in some operations, such as resolving disputes. Traditional fisheries management methods in N.E. Nigeria developed among the communities involved and adhere to the concept of traditional offered by Berkes and Farvar i.e. practices that have historical continuity within a group of people. However, three goals have been identified: control of fishing rights and conflict

reduction, creation of food/income for the community, and protection of fish populations. The major technique of management is access control, and the decision-making authority are the leaders of the community and conventional government, albeit under specific conditions, all users may have an input into the process. The de facto arrangements for traditional systems differ from the de jure ones. In addition to the de jure goals, community leaders are increasingly attempting to make monetary flow via the conventional system. This method does not necessarily contradict the de jure arrangements' communal focus.

However, there is a propensity among local elites to want to privatize fisheries resources and monopolize monetary earnings, resulting in changes in management techniques, decision-making, and application levels. Finally, an example of a "mixed system" is offered in the community and fisheries setting of KwatanDawashi village in Lake Chad. Traditional government authorities and the Local Government which has no official de jure involvement in fisheries management work together to regulate and license fishing zones. The arrangements are relatively new, having arisen as a result of recent migrant fishermen' use of dumba fishing tactics. The hybrid approach is effective in ensuring that fishing sites are assigned without major controversy and that income is collected and distributed to Traditional and Local Government leaders. Overall, the "mixed system" arrangements show how local-level fisheries management arrangements may be modified to suit a new fishing system with the cooperation of both traditional and contemporary government. The techniques of controlling fisheries are similar among the 12 casestudy communities. The vast majority of strategies are concerned with controlling fishermen' access to the fishery. The aquatic habitats in each of the research locations are highly seasonal depending on the flood condition, hence this is most often done on a temporal basis. Access to fishing is often allowed throughout the peak flood, and only after the flood starts to ebb is access limited.

The second most common technique is via limits on the permissible fishing gear and practices. For example, during the retreating flood of Lake Chad, the use of lines of fish traps is permitted, but access to fishing with many other gears is free; the use of cast nets is forbidden by one Local Government in the Nguru-Gashua Wetlands. Seasonal and gear limits are sometimes mixed with prohibitions based on whether the prospective fisher is a member of the regulators' family, community, or ethnic group. In the Nguru-Gashua Wetlands and along the Upper River Benue, for example, individuals of ethnic groups who claim to be the original settlers in the two places are given preferred access to fishing with specific gear. Not only were conventional management systems the most prevalent, but when they were identified, they tended to overlap and interact with traditional systems. It should be highlighted that, whilst the IFMS findings are unique to individual systems evaluated in case-study fishing villages, the FIMS results are specific to distinct fisheries settings as a whole. However, each of the village sites might be located in a specific setting in order to compare the outcomes of the two studies (IFMS and FIMS).

As a result, the description below is a synthesis of the general results per study location, with the function or effect of certain management methods noted where possible. In recent years, each of the case-study villages has seen major changes in their natural surroundings. These changes have often involved a shrinkage of the aquatic habitat, which many people have seen as harmful to fish harvests. Many of the case-study communities ascribe the drop in catches to a variety of other causes, such as contemporary fishing techniques, competition from migrant fishermen, and the availability of alternative vocations, such as dry season farming. Many traditional systems have adapted to changes in the natural resource base and how it is utilized. However, in two situations, Gashua and Worro-Bokki, traditional and mixed fisheries control regimes were unable to deal with the changes brought about by fast

urbanisation. Worro-Bokki's growth as an important international border town has coincided with the breakdown of the old fisheries control structure; in Gashua, noncompliance with fishing restrictions is generating serious conflict.

CONCLUSION

In summary, chapter emphasizes the significant role of indigenous knowledge and traditional practices in protecting and taking care of wetland ecosystems. This chapter has described some important points.Wetlands are important areas of nature that do very helpful things for the environment. They help to support many different types of plants and animals, clean water, and control the climate. Taking care of their health is very important for the environment and for people.Indigenous people have a lot of knowledge about wetlands because they have lived near them for a long time. Their traditional knowledge includes methods of managing resources so they last a long time, preserving different types of plants and animals, and adjusting to changes in the environment.Wetlands are very important to indigenous groups because they have a strong cultural and spiritual connection to them. This connection to their culture makes them even more dedicated to protecting these important environments.Sustainable Resource Management means using resources in a way that will allow them to be available for future generations. Indigenous practices focus on prioritizing this kind of sustainable resource use, specifically in wetland areas.Working together with indigenous communities is very important when taking care of wetlands. Working together with native knowledge holders and conservation efforts can help us better protect wetlands, while also respecting different cultures.In short, this chapter emphasizes the importance of including the knowledge and customs of native people in current wetland management plans. By doing this, we not only help the environment of wetlands but also show respect for the traditions and history of indigenous communities. It is important to have both traditional and modern knowledge to take care of wetland ecosystems and make sure they stay healthy for a long time.

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CHAPTER 12

MARKET TRENDS IN WETLANDSEAFOOD: ADVANTAGES AND CHALLENGES

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ABSTRACT:

This chapter looks at the market trends that affect how seafood from wetland ecosystems is made, distributed, and eaten. It talks about both good chances and difficult problems in the industry.The summary says that wetland seafood is important to many communities worldwide because it provides them with food, money, and a sense of culture. This emphasizes the increasing need for seafood that is both sustainably sourced and of good quality in the world market.Consumer preferences are changing when it comes to seafood. People now care more about their health, the environment, and knowing where their seafood comes from. More and more people are realizing that seafood production harms the environment, and they want products that are sourced in a responsible way. This is causing the market to change.The problems caused by things like damage to wetlands, catching too many fish, and destroying habitats. These problems can harm the ability to produce seafood from wetlands in the future.Technological advancements help improve how seafood is produced, traced, and kept safe. This leads to new market opportunities.Global seafood supply chains can be quite complicated. One specific area of concern is the challenges faced by wetland seafood producers in selling their products in these markets. These producers struggle with accessing and finding their way through these markets, but there are also potential opportunities for them.Building community strength in wetland areas is important for dealing with challenges and taking advantage of opportunities. Local knowledge and flexible strategies play a crucial role in this process.

KEYWORDS:

Fish, Market, Seafood, Wetland, Water.

INTRODUCTION

This chapter shares the findings of studying how much fish people ate in two wetlands for 7 years and in another wetland for 5 years. Around 950 families had their fish weighed and their fishing activities, where they got their fish from, what they ate, and how they used water resources recorded by local observers every three days during this time. In the beginning of the study, there were no efforts from the communities to improve the wetland habitat or control fishing activities. After that, MACH assisted the communities in planning and digging areas to make more places for fish to live during the dry season. They also set up protected areas called sanctuaries and made rules to reduce harmful fishing methods. Fish consumption has gone up by 23% in Hail Haor, by 49% in Turag-Bangshi, and by 47% in Kangsha-Malijhee site when compared to the starting point or baseline. These numbers are the average, but the pattern is similar during the months when people eat less fish and when they eat more fish. However, the numbers also change from year to year because of things in the environment. These changes have helped poor people the landless and marginal farmers ate more fish in all three places[1], [2]. Only a few fish that households eat in these areas were caught by the people living there. Most of them were bought from local markets. This matches with other research that shows more than half of the fish eaten in rural Bangladesh are bought. Furthermore, the amount of fish that they have caught and eaten has decreased in

all three areas. In Hail Haor, it went down from 31% to 21%. In Turag-Bangshi, it went down from 27% to 19%. And in Kangsha-Malijeesite, it went down from 43% to 32%. There are two reasons for this: more people focusing on specific jobs like MACH helping fishermen find new work and more fish being sold in local markets from fish farms. The cost of pond fish has not gone up as much as other types of fish in the wild. Because of this, it may be more appealing for people to catch and sell the wild fish that are now more plentiful. Although more people are eating fish that are raised in ponds, the fish and prawns that live in small beels and wetlands are still the most commonly eaten by all households, especially those with less money. In Hail Haor and Turag-Bangshi, people reported eating more than 110 types of fish in seven years[2], [3].

In Kangsha-Malijhee, they reported eating 98 types of fish in five years. During the early years of MACH, people ate more meat and fish, which suggests that the households involved had a better quality of life. In all three places, people often collect and use aquatic products. In Turag-Bangshi, 80% of households do this, while in Hail Haor, it is 67%, and Kangsha-Malijhee only has 25% of households doing it. The products collected include grasses, snails, aquatic fruits and plants that are eaten as vegetables, and many other things. More ongoing tracking of how much fish people eat, as well as how much different types of fish cost, would help us understand how fishing, fish farming, and the variety of species are changing over time. In the past, Bangladesh has had a lot of different types of fish that live in fresh water. Bangladeshis eat a lot of rice and fish. A saying that goes "fish and rice make a Bengali" is still true. Fish is a very important and cannot be replaced food in the diet of people who live in rural areas in Bangladesh. The typical meal includes rice, vegetables, and fish, and it is eaten at least twice a day. We don't eat meat, pulses, and fruits very often, and when we do, we eat a small amount. In a survey about food in rural Bangladesh in 1981-1982, it was found that people there ate about 23 grams of fish each day on average, while they ate about 5 grams of meat each day on average[4].

Rice provided more than 80% of the energy and protein in our diet. Fish was the third most eaten food, after rice and vegetables, when looking at how much it weighs. Fish is very important in the diet of people in Bangladesh. It is the main source of animal food for poor families in rural areas and cannot easily be replaced. The number of fish people eat can be influenced by different things like the time of year, the season, where they are, how much water there is, and how much money they make. In the 1990s, a group of researchers. In 1997, researchers discovered that people living in areas prone to flooding ate about 12-34 grams of fish per person per day. This text talks about a study conducted by Thompson and others. In 2002, researchers looked at different studies and discovered that people were eating different amounts of fish each day, usually between 15 to 80 grams per person. This varied depending on where the person lived and the type of house they had. People who lived near floodplains and had less money tended to eat less fish, while wealthier people and those who farmed fish ate more. However, these studies did not show patterns or changes over many years. Fish consumption is mainly made up of catching and eating small wild fish.

The study found that the fishing activity and catch rates in these households follow similar patterns to the catch monitoring in certain parts of the wetlands. Additionally, there is a strong connection between the amount of effort put into fishing and the amount of fish caught at the household level. In the TuragBangshi area, most households catch about one kilogram of fish each day they go fishing. This amount slightly increased over time. However, in 2004, during the peak late monsoon months, people spent more time and effort fishing because there was more flooding that lasted for a longer period of time. In comparison, the amount of effort put in by the households in Hail Haor has not changed much over the years and is

slightly more than in Kaliakoir. However, the number of fish caught is much higher in Hail Haor, ranging from 2 to 4 kilograms per household per day, depending on the season and year.

Since MACH began and productivity improved, more people who were not part of the monitoring program have started fishing in the Turag-Bangshi floodplain system. This is shown by the fact that the catch per hectare in Turag-Bangshi has increased to be similar to the Hail Haor level. In the Kangsha-Malijhee site, people don't work as hard and catch very few fish, usually less than a kilogram per household each day. In simple words, there are more fishing activities happening in Hail Haor during the dry season compared to other areas. This is because there is more water on the surface of the haor during that time. Fish consumption patterns change based on the availability of fish and when households catch fish. People tend to eat more fish during the monsoon and after the monsoon. In all three places, the most fish was eaten during the months after the monsoon season (October to December), which is when there is the most fish to catch and eat.

During March and April, which are the driest months of the year, people consumed the least amount of water per person. This is because water levels are typically at their lowest during this time. The number of fish people eat each month can vary based on how much fish is available and how much money they have to buy it. The amount of fish people eat starts to go up quickly from June to July during the rainy season. During the rainy season, when the beels are filled with water, people who live in the area catch fish using different tools because they can freely fish at that time. During the postmonsoon season, the amount of fish caught is highest because this is when most fishing in beels occurs. As a result, more fish are available in local markets. The designs look alike on all three places.

DISCUSSION

The wetland seafood sector is important to global food supply and local economies, with wetland ecosystem seafood providing nourishment, revenue, and cultural identity. This section discusses the significance of the wetland seafood industry and its larger context in the global seafood market.Consumer tastes for fish have shifted dramatically in recent years. The conversation will look into how customers are increasingly valuing elements like health benefits, sustainability, and traceability when making seafood purchases. The increased demand for sustainably sourced fish and the growth of health-conscious customers will be investigated.The wetland seafood business is facing a number of sustainability issues. This part will go through the environmental threats to the sector, such as wetland degradation, overfishing, and habitat loss. The importance of sustainable approaches in ensuring the long-term sustainability of wetland seafood production will be emphasized.Technological advancements are revolutionizing the fish sector, increasing productivity, traceability, and safety. This section will look at how technological breakthroughs like aquaculture automation, blockchain technology, and monitoring systems are creating new prospects for industry growth and sustainability[5], [6].

Global fish supply networks are complex and multidimensional, bringing possibilities as well as problems for wetland seafood producers. This section will go into the complexity of entering and navigating various markets, including transportation, logistics, and international commerce.Wetland seafood markets are heavily influenced by policies and laws. This section will look at how government laws and international regulations affect several parts of the sector, such as environmental protection, commerce, and food safety requirements. The significance of developing a supportive policy environment will be underlined.In wetland environments, community resilience is critical for handling market possibilities and limits.

This section will go through the significance of incorporating local people in sustainable wetland seafood production, emphasizing the relevance of indigenous knowledge and adaptive techniques in guaranteeing the industry's long-term viability.This section will underline the importance of embracing sustainability and ethical production techniques in the wetland seafood business. It will address how market trends must be aligned with these values not just to suit consumer desires but also to preserve wetland habitats.

We will highlight the major lessons from the conversation in the last part, emphasizing the significance of responding market changes while guaranteeing sustainability in the wetland seafood business. The importance of good practices, community participation, and legislative support in the industry's resilience and success will be emphasized.Within the word restriction, this organized conversation will offer a detailed understanding of the issue. If you want to go further into any particular subtopics or have any more questions, please ask.In the TuragBangshi area, around 80% of households have gathered non-fish aquatic resources every year since the study began. The data from the starting year may not accurately show the usage of certain resources because it is unlikely that some plants suddenly became much more common in 2000-2001. More people who live near wetlands are using the water resources. They are also using a variety of resources like grass and edible water plants. Some people even collect frogs to use as bait for fishing. In addition, households with less money often spend more time each year gathering these resources. This shows that these resources are more necessary for their lives[2], [7].

However, more and more people in Turag-Bangshi are hunting birds, which is a problem. The project in Hail Haor has been successful in stopping bird hunting, but it seems like there's an increase in bird hunting in Turag-Bangshi. Interestingly, in Kongsha-Malijhee site, fewer households collect non-fish aquatic resources because they have lower average incomes. Only about a quarter of households are involved, and those who are more well-off are more likely to participate. Only a small number of water resources were said to be used there. We should investigate these unexpected patterns more at this site. At first glance, the resources should be similar to those at the Turag-Bangshi site. However, because this site is prone to flash floods in the upper part of the river basin, there may be fewer aquatic resources present. Finally, for Hail Haor, we carefully observed and studied the use of non-fish resources from the water in the starting year and the following three years. This showed that there was a significant amount of exploitation happening. For instance, each household that was watched collected about 20 kilograms of snails and 70 bunches of grass in one year. With around 30,000 households using the haor, this means that 600 tons of snails and 2. 1 million bundles of grass are collected every year. Most of the things found in nature that are not fish were used by families for their own needs, but some of these things were sold, especially fruits from the water like fokol and shinga, as well as turtles. Only a small number of turtles were caught, but the worry is that there is a demand for them to be sold. This is concerning because most of the turtle species in Hail Haor are in danger in our country and their population has greatly decreased. Many people want to buy certain things from the water, so the prices of those things have either stayed the same or gone up during the project time[8].

CONCLUSION

In summary, chapter shows that the wetland seafood industry has many different aspects. This emphasizes the importance of using sustainable, science-based methods to manage wetland seafood markets. It also highlights the need for stronger community involvement and policies that can adapt to changes. This will allow us to maximize the benefits of these markets while keeping wetland ecosystems healthy in the long run. To succeed in a changing

world, it's important for the wetland seafood industry to follow market trends that focus on sustainability and responsible production.The chapter emphasizes customers' evolving preferences for sustainably produced, high-quality seafood. This trend reflects increased concern about the environmental effect of seafood industry, highlighting the need of responsible sourcing and traceability.Wetland seafood is subject to environmental restrictions such as wetland degradation, overfishing, and habitat loss. Addressing these issues is critical to the industry's long-term success.Technological advancements have the potential to improve the efficiency, safety, and traceability of seafood production. These technologies provide up new potential for market development and sustainability.For wetland seafood producers, the intricacy of global seafood supply networks brings both possibilities and problems. Getting into and navigating these marketplaces requires adaptation and resilience.Policies and regulations have a huge impact on wetland seafood markets, with ramifications for environmental protection, commerce, and food safety standards. A favourable policy environment is essential for long-term development.Addressing market possibilities and restrictions requires building community resilience in wetland regions. Local expertise and adaptable methods are critical to the industry's long-term viability.The wetland seafood business can not only fulfill market needs but also help to the preservation of key wetland habitats by adopting sustainability, responsible production, and community participation. Finally, adopting these market trends may result in a resilient and successful wetland seafood business that benefits both local people and worldwide customers while protecting the ecosystem.

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CHAPTER 13

WETLANDS AND AQUACULTURE IN A CHANGING WORLD: FUTURE RESEARCH DIRECTIONS

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ABSTRACT:
The chapter looks at the important connections between wetland environments and the aquaculture industry as our world continues to change quickly. This chapter emphasizes the importance of doing research that looks ahead to solve the changing problems and opportunities in wetland-based fish farming.The first summary talks about how wetland areas are changing, including how climate change affects them, how their habitats are being changed, and how the quality of the water in wetlands is constantly changing. This text stresses the significance of comprehending these changes and how they affect the sustainability of aquaculture.The second summary discusses what needs to be done in future studies to make sure that wetland ecosystems and aquaculture can exist together. It talks about how important it is to use new technologies, flexible strategies, and working with different fields together to deal with this complicated situation.To summarize, these summaries highlight the importance of conducting research quickly because the world is changing. In this changing world, wetlands and aquaculture need to adjust and thrive together.

KEYWORDS:

Aquaculture, Fish, Farming, Future, Wetlands.

INTRODUCTION

Wetlands are important ecosystems that offer a variety of ecological services such as animal habitat, water purification, flood control, and carbon sequestration. Simultaneously, aquaculture, or aquatic creature farming, has arisen as a vital business for meeting world food needs. However, cohabitation of wetlands with aquaculture has particular problems, which are worsened by a changing world typified by climate change, habitat degradation, and oscillations in water quality. This conversation will look at the changing environment of wetland-based aquaculture, the research paths needed to overcome these obstacles, and the need of sustainable methods.In a changing world, wetlands confront tremendous changes. Climate change causes changes in precipitation patterns, temperature variations, and sea-level rise, all of which have an influence on wetland hydrology and ecosystems. Wetlands are further threatened by habitat degradation and loss, putting the plants and species that rely on them in jeopardy. Furthermore, changes in water quality caused by pollution and fertilizer runoff have serious consequences for aquatic life and aquaculture operations. Understanding these changes is critical to ensuring the long-term viability of wetlands-based aquaculture[1], [2].

Future research should concentrate on improving the climate resilience of wetland-based aquaculture. Developing climate-adaptive aquaculture systems and breeding programs that can flourish in shifting climatic circumstances is part of this. It is critical to investigate the possible effects of climate change on water quality and temperature changes.Wetland rehabilitation should be prioritized. The efficiency of restoration strategies such as re-establishing natural vegetation and developing artificial habitats for aquaculture species should be studied.It is critical to do research on effective water quality management

solutions. This includes researching nutrient cycling, pollution reduction, and the effect of wetland vegetation on water quality. Sustainable aquaculture strategies that reduce nutrient runoff and pollution should be investigated as well.Disease outbreaks are common in aquaculture. Disease prevention and control measures particular to wetland aquaculture systems should be the focus of future study. Understanding the significance of marsh microorganisms in disease suppression is one example[3], [4].

Technological advancements in aquaculture, such as recirculating aquaculture systems (RAS), may play a critical role in increasing efficiency and sustainability. The viability of combining RAS with wetland ecosystems should be investigated, as well as the environmental effect.To solve the multiple difficulties at the interface of wetlands and aquaculture, interdisciplinary cooperation is required. Collaboration is essential among ecologists, aquaculturists, hydrologists, and policymakers. This multidisciplinary approach has the potential to provide complete solutions that balance environmental protection with aquaculture output.It is critical to include local populations, particularly indigenous groups, in wetland-based aquaculture research and management. Indigenous knowledge is often useful for gaining insights into sustainable resource management and ecological resilience. Collaborative activities with communities may improve research, encourage adaptive behaviours, and promote wetland ecosystem care.

In a changing world, effective policy frameworks are critical for guiding wetland-based aquaculture. These policies should support environmentally friendly behaviours, safeguard wetland habitats, and give incentives for research and development. Collaboration between governments, non-governmental organizations (NGOs), and industry players may result in the creation and implementation of policies that promote both environmental protection and economic growth.To summarize, cohabitation of wetlands and aquaculture in a changing environment requires a proactive, interdisciplinary approach. Climate resilience, habitat restoration, water quality management, disease prevention, and novel technology must be the focus of research. Collaboration across disciplines, community participation, and solid policy frameworks are critical components of a sustainable future for wetland-based aquaculture. As we face the difficulties of a changing world, we must remain committed to both the protection of wetland ecosystems and the expansion of aquaculture. We can guarantee that wetlands and aquaculture coexist in the future by linking research efforts with sustainability and ethical practices[5], [6].

DISCUSSION

Wetland aquaculture can help meet the growing need for seafood without harming the environment. We must find and focus on research that tackles problems and takes advantage of opportunities in order to make sure it can continue for a long time. This talk discusses important areas of research for sustainable fish farming in wetlands.Climate resilience refers to the ability of individuals, communities, and systems to cope with and recover from the impacts of climate change. It involves building resistance and adaptive capacity to changes in climate patterns, extreme weather events, and related challenges. Climate change is causing significant alterations to our environment, with rising temperatures, changing precipitation patterns, and increased frequency of extreme weather events. These changes have severe consequences for humans, ecosystems, and economies worldwide. Climate resilience is crucial for minimizing the negative impacts and ensuring the well-being of individuals and communities. One aspect of climate resilience is building physical infrastructure that can withstand and recover from climate-related events. For example, constructing buildings with stronger foundations and using resilient materials can reduce damage and the need for costly repairs in the face of floods, hurricanes, and heatwaves. Similarly, designing and maintaining

resilient transportation systems and energy infrastructure can prevent disruptions during extreme weather events. Another aspect of resilience is enhancing the capacity of individuals, communities, and institutions to adapt to changing conditions. This involves providing education, training, and resources to empower individuals to make informed decisions regarding climate risks[7], [8].

By increasing awareness and knowledge, people can take necessary actions to protect themselves and their communities. Community engagement and participation are essential for building climate resilience. Strengthening social networks and fostering collaboration among community members can lead to more effective responses and recovery efforts in the face of climate-related challenges. Additionally, empowering marginalized groups, such as low-income communities and indigenous peoples, is crucial to ensure that climate resilience actions are equitable and inclusive. Natural ecosystems play a vital role in climate resilience. Conserving and restoring forests, wetlands, and other natural habitats can enhance their ability to absorb carbon dioxide and provide essential services like regulating water flow and reducing flood risks. Furthermore, protecting biodiversity is crucial as diverse ecosystems are more resilient to climate change, providing multiple benefits to society. Climate resilience also entails integrating climate considerations into development planning and decision-making processes. By incorporating climate change projections and risks into policies and strategies, governments, businesses, and organizations can make informed choices that promote long-term resilience. Investing in climate resilience is not only essential for adapting to the current impacts of climate change but also for preparing for future challenges. By building the capacity to withstand and recover from climate-related events, individuals, communities, and systems can ensure their sustainability and well-being in a changing climate[9].

Climate change is a big problem for fish and plants that live in wetlands. We need to do research to create aquaculture systems that can handle changes in temperature, rainfall, and rising sea levels caused by climate change. This involves breeding programs to create robust fish farming species. In addition, it is important to evaluate how climate change affects the quality of water, including changes in nutrients and the spread of diseases.Wetland Restoration and Habitat Enhancement is the process of bringing back and improving wetlands. Wetlands are areas of land covered with water, like swamps and marshes. These places are important because they provide a habitat for many different plants and animals. Restoring wetlands means undoing any damage that has been done to them. Sometimes wetlands are drained or filled in to make room for buildings or agriculture. This destroys the natural habitat and disrupts the balance of the ecosystem. Wetland restoration aims to reverse these changes and bring back the original wetland conditions. There are several methods used for wetland restoration. One common method is to remove any obstacles that are blocking the flow of water, such as dams or dikes. This allows the water to move freely and helps recreate the wetland environment[10], [11].

Another method is to replant native wetland plant species. These plants are adapted to the wetland conditions and help restore the ecosystem. Habitat enhancement is another important aspect of wetland restoration. This involves creating a better environment for the plants and animals that live in the wetland. For example, introducing more food sources or providing nesting sites for birds can improve the habitat. This helps attract more wildlife and increases biodiversity in the wetland. Wetland restoration and habitat enhancement have many benefits. They improve water quality by filtering pollutants and absorbing excess nutrients. They also help prevent flooding by absorbing and storing water during heavy rainfall. Wetlands are also important for climate regulation as they store carbon dioxide and release oxygen.

In addition to these ecological benefits, wetlands provide recreational and economic opportunities. Many people enjoy visiting wetlands for bird watching, hiking, and fishing. Wetlands can also support local economies through tourism and natural resource use. Overall, wetland restoration and habitat enhancement are crucial for preserving these important ecosystems. By undoing human-made changes and improving the habitat, we can help protect the plants, animals, and other organisms that rely on wetlands.When wetlands are damaged or disappear, it becomes harder to find good places to farm fish and other aquatic animals. Research should investigate new ways to restore wetlands, such as bringing back native plants and building man-made environments for fish and other water animals. It's really important to understand how well these methods work in improving both the variety of species in water and the productivity of fish farming.

Water quality management involves the protection and improvement of water resources. It is the process of monitoring and controlling the various factors that affect water quality to ensure that it is safe and suitable for different uses, such as drinking, bathing, and irrigation. One important aspect of water quality management is identifying potential sources of pollution. These sources can include industrial facilities, sewage systems, and agricultural practices that release harmful substances into the water. By identifying these sources, steps can be taken to prevent or minimize pollution and protect the water from contamination. Another crucial component of water quality management is monitoring. This involves regularly testing water samples to assess its quality. Various parameters are measured during these tests, including temperature, pH levels, dissolved oxygen, and the presence of pollutants such as bacteria and chemicals. By monitoring these parameters, any changes or deviations from the desired water quality standards can be identified and appropriate actions can be taken to rectify the situation.

To ensure effective water quality management, regulations and standards have been developed by regulatory authorities. These regulations set limits for various pollutants and establish guidelines for water quality. Compliance with these regulations is crucial for industries, municipalities, and individuals to prevent pollution and maintain the quality of water resources. Water quality management also involves the use of treatment processes to improve water quality. Treatment processes may include physical, chemical, and biological methods to remove or reduce contaminants from the water. These processes can address a wide range of pollutants, including suspended solids, organic matter, nutrients, and pathogens. By treating the water, its quality is improved, making it safe for consumption or for discharge into the environment. Education and public awareness are essential elements of water quality management. By educating individuals about the importance of water quality and the actions they can take to protect it, a culture of responsible water use can be fostered. This can include promoting water conservation practices, proper waste disposal methods, and minimizing pollution sources. In conclusion, water quality management is vital for protecting and improving water resources. It involves identifying and controlling pollution sources, regularly monitoring water quality, adhering to regulations and standards, implementing treatment processes, and promoting education and awareness. By effectively managing water quality, we can ensure the availability of clean and safe water for various uses.

Managing the quality of water is important for the long-term success of wetland aquaculture. Research needs to find ways to keep the water in aquaculture healthy. This includes things like how to recycle nutrients, reduce pollution, and understand how wetland plants can help purify the water. We should create and test better ways to do aquaculture that do not harm the environment.Disease Prevention and Management refers to the practices and methods used to prevent and control diseases. The objective is to minimize the risk of getting sick and to

manage existing health conditions effectively. Prevention is a crucial aspect of disease management. It involves taking steps to avoid illnesses before they occur. This can be achieved by adopting healthy lifestyle choices such as eating a balanced diet, engaging in regular physical activity, getting enough sleep, and avoiding harmful habits like smoking and excessive drinking. Vaccinations are also a vital component of prevention, as they help protect against various infectious diseases. To effectively manage diseases, it is essential to diagnose them early. Regular check-ups and screenings can help identify potential health issues at an early stage.

Early diagnosis allows for prompt treatment, increasing the chances of successful management. It is also important to follow prescribed treatment plans diligently and take medications as directed. This helps control symptoms and prevent complications. Additionally, disease management involves adopting self-care practices. People with chronic conditions like diabetes or hypertension need to monitor their health regularly. This can involve checking blood sugar levels, blood pressure, or other indicators to ensure they are within the recommended ranges. By doing so, they can make necessary adjustments in their lifestyle and treatment plans to maintain optimal health. Maintaining a strong support system is also crucial in disease management. Having a network of family, friends, or healthcare professionals who can provide assistance and guidance can greatly contribute to effectively managing health conditions. Support groups and online communities can also be valuable resources for individuals facing similar challenges. Education plays a significant role in disease prevention and management. It is important to stay informed about the signs, symptoms, and risk factors associated with various diseases. Understanding how diseases spread and how to protect oneself can help in taking necessary precautions.

Overall, disease prevention and management involve a combination of healthy lifestyle choices, regular check-ups, early diagnosis, and diligent treatment adherence. By incorporating these practices into our daily lives, we can reduce the risk of developing diseases and effectively manage existing health conditions.Diseases can cause a lot of damage to fish farms. Research should focus on finding ways to prevent and manage diseases specifically in wetland fish farms. This means studying how tiny organisms in wetlands, along with disease-causing agents, can affect the fish and other animals that are raised in aquaculture. We should look for new and creative ways, like probiotics and vaccines, to make our bodies stronger against diseases.

Innovative technologies are new and creative tools or methods that help make our lives easier or solve problems. These technologies are developed by scientists, engineers, and other experts who look for ways to improve how we do things. They often think outside the box and come up with groundbreaking ideas that revolutionize our world. One example of an innovative technology is the smartphone. It has completely changed the way we communicate and access information. With a smartphone, you can make calls, send messages, take pictures, browse the internet, and so much more. It's like having a mini computer in your pocket. Another example is renewable energy technology. As we face climate change and the need to reduce our carbon footprint, scientists have developed innovative ways to harness energy from sources like the sun and wind. Solar panels and wind turbines are just some of the technologies being used to generate clean and sustainable energy. Innovative technologies also play a big role in healthcare. Medical advancements, like robotic surgery and 3D printing of organs, have improved patient outcomes and made treatments more efficient. These technologies help doctors diagnose diseases earlier and provide better care to patients. Transportation is another area where innovative technologies are making a difference. Electric cars are becoming more popular as an alternative to

traditional gasoline-powered vehicles. They are quieter, produce less pollution, and can be charged using renewable energy sources. Innovative technologies can also be found in everyday gadgets, like smart home devices and wearable technology. These devices make our lives more convenient and connected. For example, you can control your lights and appliances with your voice or track your fitness goals with a smartwatch. Despite the many benefits of innovative technologies, there are also challenges that come with their adoption. Some people may find it difficult to adapt to new technologies or afford them. Additionally, there are concerns about privacy and security when it comes to using advanced technologies. In conclusion, innovative technologies are constantly shaping and improving our lives. They bring new possibilities and opportunities, making our world more efficient, sustainable, and connected. As we move forward, it's important to embrace these technologies while addressing the challenges that come along with them.

New technologies in fish farming, like recirculating systems, can help make fish farming more effective and sustainable. The research should study whether it is possible to combine RAS with wetlands, taking into account the good things it can bring and its impact on the environment. Also, it is important to investigate new ways of making animal feed that use fewer resources and have less impact on the environment.This type of collaboration involves individuals with different knowledge, skills, and perspectives coming together to contribute their unique insights and abilities. The purpose of interdisciplinary collaboration is to combine the strengths and knowledge of different disciplines to address complex issues that cannot be adequately addressed by any one discipline alone. By bringing together various perspectives and expertise, interdisciplinary collaboration allows for a more comprehensive understanding and holistic approach to problem-solving. In interdisciplinary collaboration, individuals from different fields collaborate by sharing information, exchanging ideas, and working together to find innovative solutions. This collaboration often requires effective communication and a willingness to learn from others' perspectives. The diversity of disciplines involved in interdisciplinary collaboration ensures a broader range of ideas and approaches, leading to more creative and effective solutions.

There are various benefits to interdisciplinary collaboration. First, it allows for a more thorough exploration of a problem from multiple angles, leading to a better understanding of the issue at hand. Second, interdisciplinary collaboration can result in innovative and groundbreaking solutions that may not have been possible without the input of multiple disciplines. Third, it promotes learning and growth by exposing individuals to new perspectives and ideas outside of their own expertise. However, interdisciplinary collaboration also comes with its challenges. It can be difficult to navigate the different languages, methods, and cultural norms of other disciplines. Effective interdisciplinary collaboration requires patience, openness, and respect for others' expertise and viewpoints. Additionally, it may take time to establish trust and build effective working relationships among individuals from different disciplines. Overall, interdisciplinary collaboration is a valuable approach to problem-solving that harnesses the collective knowledge and expertise of individuals from various fields. By working together and embracing the diversity of perspectives, interdisciplinary collaboration has the potential to generate innovative solutions and address complex issues more effectively.

We need people from different fields (ecologists, aquaculturists, hydrologists, and policymakers) to work together in order to solve the many problems that wetland aquaculture faces. Research should encourage different areas of study, like ecology, society, and economics, to work together and understand each other better. Collaborative research can help find complete solutions that both protect nature and support aquaculture.Community

engagement is when people come together to work on projects and make decisions that benefit everyone in the community. It involves the participation and involvement of all community members. Indigenous knowledge refers to the knowledge and wisdom that has been passed down through generations in indigenous communities. It includes their understanding of the environment, traditional practices, and cultural beliefs. When communities engage, they work together to solve problems and make improvements. This can include things like creating community gardens, organizing events, or making decisions about resources and infrastructure. By involving everyone in the community, ideas and perspectives from different people are taken into account, leading to more inclusive and informed decision-making. Indigenous knowledge is valuable because it comes from a deep understanding of the natural world and the relationships between humans and nature. Indigenous communities have lived in harmony with the environment for centuries, relying on their knowledge to sustain their livelihoods. This knowledge is passed down through storytelling, observation, and lived experience, and it is often closely tied to cultural and spiritual beliefs.

When community engagement and indigenous knowledge come together, it creates a powerful combination of local expertise and traditional wisdom. Indigenous communities have a unique perspective on land and resource management, conservation, and sustainable development. By including indigenous knowledge in community engagement processes, we can benefit from their insights and learn from their practices. However, it is important to approach indigenous knowledge with respect and caution. Indigenous communities have faced colonization and exploitation throughout history, and their knowledge has often been marginalized and disregarded. When engaging with indigenous knowledge, it is important to seek consent, provide recognition, and give proper credit to the communities from which this knowledge originates. In conclusion, community engagement and indigenous knowledge are both important for creating inclusive and sustainable communities. By involving all community members and valuing the wisdom of indigenous communities, we can make better decisions and work towards a more equitable and respectful society.

It is important to involve local communities, including indigenous groups, for wetland aquaculture to be successful. Research should include communities in decision-making processes, use their traditional knowledge, and empower them as protectors of wetland resources. Working together can make research better, help people change their ways to fit new information, and make sure that everyone gets the same advantages.Policy and regulation refer to rules and guidelines set by governments or organizations to promote certain behaviors or control certain activities. These policies and regulations are put in place to ensure fairness, protect public safety, and achieve specific goals. For example, in the field of healthcare, policies and regulations may be established to ensure that patients receive high-quality care and that medical professionals adhere to certain standards. These rules might pertain to licensing and certification requirements for healthcare practitioners, guidelines for patient confidentiality, or regulations on the use of medical devices and drugs. Similarly, in the business world, policies and regulations are created to maintain fair competition, protect consumers, and ensure financial stability.

This may include laws governing pricing practices, regulations on product safety and labeling, or policies promoting transparency in financial reporting. Policy and regulation also play a crucial role in areas such as environmental protection, education, and transportation. For instance, environmental policies and regulations are enacted to prevent pollution, conserve natural resources, and promote sustainable practices. In the education sector, policies are established to ensure equal access to education, maintain curriculum standards,

and regulate the qualifications of teachers. In transportation, policies and regulations exist to improve safety standards, manage traffic flow, and regulate the use of public infrastructure. The development of policies and regulations involves a thorough process that often includes research, public consultation, and collaboration between various stakeholders. Governments, regulatory bodies, and expert organizations play important roles in crafting and implementing these rules. Policy and regulation are necessary for maintaining order, protecting individual rights, and achieving desired societal outcomes. However, they can also be subject to critique and debate.

Some may argue that regulations can impose burdens on businesses, stifle innovation, or limit personal freedoms. Balancing these concerns with the need for public welfare and orderly functioning of society is an ongoing challenge for policymakers. In summary, policy and regulation refer to rules and guidelines established by governments or organizations to promote specific behaviors, protect public safety, and achieve desired outcomes. They exist in various fields like healthcare, business, environment, education, and transportation. While they serve essential purposes, they also face criticism and require careful consideration to ensure a balance between conflicting interests.Having good rules and plans is important to make sure that fish farming in wetlands is done in a way that protects the environment and can continue for a long time. The research should help create and enforce rules that promote responsible actions, safeguard wetland environments, and give rewards for new ideas. Working together is important for governments, NGOs, and businesses to create helpful policies.In summary, the findings of this study suggest that the relationship between social media use and mental health is complex and influenced by various factors. While some studies have found a negative association between social media use and mental health outcomes such as depression and anxiety, others have found no significant association or even a positive association in some cases. One important factor that may influence this relationship is the way individuals use social media.

Excessive use, comparing oneself to others, and seeking validation through likes and comments have been linked to negative mental health outcomes. On the other hand, using social media for positive purposes such as staying connected with loved ones, seeking support, and engaging in hobbies or interests has been associated with positive mental health outcomes. Another factor that may influence the relationship between social media use and mental health is the individual's pre-existing mental health condition. People with pre-existing mental health conditions may be more vulnerable to the negative effects of social media use, while those with good mental health may be less affected. It is important to note that the research in this field is still emerging and there are many limitations to consider. Most studies rely on self-report measures, which can be subjective and prone to bias. Additionally, the majority of research is based on cross-sectional designs, making it difficult to establish causality.

Future research should employ more rigorous methods, such as longitudinal studies, to better understand the relationship between social media use and mental health. In conclusion, the relationship between social media use and mental health is not straightforward and is influenced by various factors. It is essential for individuals to be mindful of their social media use and to prioritize positive interactions and experiences. Additionally, more research is needed to further explore this relationship and provide evidence-based guidelines for healthy social media use.In short, the future of wetland aquaculture depends on using techniques that support both the economy and the environment. Research needs to focus on making sure that ecosystems and communities can withstand the impacts of climate change, making natural habitats better, improving how we manage water quality, preventing diseases, creating new

and useful technologies, working together with different fields of study, involving the community, and making new rules and guidelines. By focusing on sustainable and responsible practices, wetland aquaculture can grow and protect the environment for future generations.

Fisheries enhancement is a critical method for sustaining and boosting fisheries production while also addressing some of the other modern concerns confronting marine ecosystems. Stock augmentation, restocking, and marine ranching are all examples of aquaculture-based enhancement. Aquaculture methods, tagging, genetics, modelling, and ecological advancements have fueled expansion in this discipline in the twenty-first century, especially in the context of marine recreational fisheries. Marine enhancement practice has already advanced to the point where quantitative techniques are commonly used prior to the release of any fish or shellfish into the natural environment, and pilot-scale enhancement scenarios and release methods are assessed before full adoption. Social and economic research are also becoming more essential components of this evaluation. Several case studies from various geographic locations are presented here to demonstrate how aquaculture technology, quantitative modelling, social science, physiology, and ecology may be used to predict enhancement potential, develop enhancement tactics, assess enhancement results, and promote adaptive management. Integrating aquaculture-based enhancement with habitat enhancement represents a remarkable opportunity for future research and development, with the potential to significantly increase the opportunities and associated socioeconomic benefits available to a wide range of fisheries stakeholders.

Improving fish production in the ocean is a big goal for the future. It's important for making sure we have enough food to eat. There are chances to gain economic and social advantages from certain opportunities. we should help damaged natural systems that have been harmed by human activities like overfishing and destroying habitats. Fisheries enhancement means using extra methods to improve the productivity of fish populations beyond what can be done by just managing how many fish are caught. This can include taking care of the places where the fish live like their habitats and protecting them. and taking care of groups of organisms for example, controlling their numbers or ensuring their survival. These measures usually involve using technology to solve problems in nature caused by people or the environment. For example, they might focus on helping fish populations grow by using fish farms, fixing damaged habitats, or creating new homes for animals using man-made structures.

In simple terms, aquaculture-based enhancement means using hatchery-raised fish to help improve fish populations that are struggling or have been severely depleted. This can be done by releasing the hatchery-raised fish to help the natural populations grow or by restocking areas where fish populations are very low. It can also involve releasing hatchery-raised fish into designated areas where they can be caught by fishermen. Over the past 20 years, the science behind these strategies has changed a lot. During this time, there has been a discussion about how release programs should be created, carried out, and evaluated. Many authors have contributed to this dialogue. The International Symposia on Stock Enhancement and Sea Ranching (ISSESR) and their associated meetings have played a big role in advancing science in this field. These events have provided a place for experts to review and summarize research, identify new and important topics for further study, and help create basic principles in the field. The studies discussed at these Symposia and the resulting discussions have been printed in books.

Almost 20 years after the first ISSESR in Bergen, Norway in 1997, we still have three big problems: there are more and more people on Earth, the amount of fish we are catching is not increasing, and it is very important to have fish in our diet to be healthy. During this time, the

number of people in the world went up by nearly 30%, going from 5. 7 billion to 7. 3 billion The amount of fish caught every year stayed the same at about 90 million tonnes. However, the amount of fish farmed increased by 150% from 28 to 70 million tonnes. So, overall, the amount of seafood produced increased by 35%, just a little more than the growth of the human population. Despite the significant increase in fish farming, fishing in the sea is still very important for people living in poor coastal areas. It has also become more important for recreational fishing and the industries that rely on it, which are worth billions of dollars. Changes in the environment, both small and big, are expected to affect the ability of fisheries to catch fish and make money. With more people in the world and the need to keep producing lots of fish, different ways of managing fisheries are still important. These new approaches will help improve how many fish can be caught in the future. The 5th ISSESR, which took place in Sydney Australia in 2015, looked at the progress made in improving aquaculture in the past 5-10 years. It also discussed how these advancements could affect future research and management in this field.

CONCLUSION

In summary, chapter emphasizes the importance of studying the relationship between wetland ecosystems and the aquaculture industry. The chapter focuses on a few important ideas.The first summary highlights the changes happening in wetland environments because of climate change, changes to habitats, and differences in water quality.

These changes greatly affect how sustainable wetland-based fish farming is.The second summary talks about why it is important to do more research in the future. This text is saying that using new technologies, flexible management strategies, and working together with different fields of study can help solve the difficult problems faced by wetland fish farming.

The chapter focuses on how important it is to adapt and be sustainable in a world that is constantly changing. We need to do research to find ways for wetlands and aquaculture to work well together. This will help keep both of them healthy for a long time.In simple words, this chapter is urging the scientific community and industry stakeholders to prioritize research that focuses on making wetlands and aquaculture more resilient and sustainable. By using new ideas and working together in different areas of study, we can overcome the problems of a changing world and ensure that wetlands and fish farming can both flourish together in the future.

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