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ANALYSED BIOLOGICAL ENVIRONMENT AND SOCIO-ECONOMIC IMPLICATIONS OF FISH

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ABSTRACT

Over the course of more than a century, scientists and fishermen have been aware of the fact that the current climate conditions might have a significant impact on the status of fish populations. The North Sea has been recognized as one of the twenty "hot spots" of climate change worldwide, and forecasts for the next one hundred years suggest that the region will continue to warm. This identification is based on historical data on sea surface temperatures. The effects of this rapid rise in temperature are already being observed, and these include changes in the distribution of species as well as variations in the recruitment of stock population. This chapter examines the present information about the effects of climate change on fisheries in the North Sea, which is considered to be one of the most important fishing grounds in the world. Additionally, this chapter discusses the available forecasts for the future of fisheries in the North Sea. Concerns over the biological, operational, and larger market factors, as well as potential economic repercussions, are the primary topics of discussion. Within the next fifty or one hundred years, it is abundantly obvious that fish communities and the fisheries that target them will be considerably different from what they are today, and that management and governance will need to adjust accordingly.

keywords: *biological environment, socio-economic implications.*

INTRODUCTION

Due to overfishing, damaging subsidies, and overcapacity, it is possible that global fisheries will not function as expected. The current state of affairs cannot be maintained on a global scale or on a regional scale (even in Europe). Institutions, organizations, and governments are all aware of the necessity of putting policies into place in order to guarantee the long-term viability of fisheries. In general, fishery policy has been centered on large-scale fishing, which has led to a dearth of understanding regarding many elements of small-scale fisheries, including those pertaining to biology, the environment, socioeconomics, management, and policy. The employment of fishers and other workers in small-scale fisheries and related activities, which provide vital supplements to livelihoods, is especially important during times of crisis. Small-scale fisheries have the potential to be an important source of income for certain regions, and they are essential for the provision of food and livelihoods.

One example of a potentially irreversible alteration to an ecosystem that can be attributed to current practices that are not sustainable is the depletion of fish stocks, as stated by the Millennium Ecosystem Assessment. A number of suggestions for mitigating the adverse effects that fishing activities have on marine ecosystems are included in the Code of Conduct for Responsible Fisheries, which was formulated by the Food and Agriculture Organization (FAO) of the United Nations in the year 1995. The Voluntary Guidelines for Securing Small-Scale Sustainable Fisheries (SSF) were developed in 2015 as a supplement to the FAO Code that was established in 1995. The SSF Guidelines are an essential instrument that promotes sustainable development within a strategic framework.

The "Green Paper" on a reform of the Common Fisheries Policy (CFP) was adopted in 2009 in Europe with the purpose of defining targets for several aspects of sustainability, including ecological, economic, and social sustainability. In the short term, the objective was to provide direction, and in the long term, the objective was to ensure that fisheries would continue to run smoothly. A feasible and environmentally sustainable option for the business is provided by the Common Fisheries Policy (CFP), which has been in effect since January 1, 2014. This policy offers the opportunity of eradicating overfishing while also giving an alternative that is viable. In order to repopulate fish stocks, reduce the capacity of fleets and overfishing, eradicate damaging fishing practices, and encourage access to resources for sustainable fishing, Member States are obligated to implement legislation between the years 2014 and 2024. As an additional point of interest, in a more general sense, a number of European countries "are encouraging the development of economic activity within the marine realm" or "Blue Growth," and "small-scale fisheries could become part of a blue economy."

OBJECTIVES

1. To study biological environment.
2. To study socio-economic implications.

Biological environment

Changes in the temperature of the saltwater and/or other types of ocean variables frequently correspond with changes in the distribution of fish that have been documented over time. There were fifty different species of fish that are commonly found in the seas of the Northeast Atlantic, and seventy percent of them had changed their distribution and abundance as a result of the warming. To be more specific, the abundance of warm-water species with smaller maximum body size had increased across the entirety of northwest Europe, whereas the prevalence of cold-water species with larger bodies had dropped.

Both distribution and abundance are characteristics that are the reactions that may be detected with the greatest ease. However, when fisheries and climate change are taken into consideration, there are a number of processes that interact with one another. These interactions are an expression of both biological and human processes. All of these components interact with one another, and many of them play a synergistic role. In most cases, the answers are not linear. There is evident evidence that climate has an effect on the physiology and behavior of fish. Migration, productivity (growth of populations minus decline in populations), susceptibility to disease, and interactions with other organisms are all influenced by the combination of these processes. The cumulative effects of these altered processes are reflected in shifts in distribution and abundance at the population level.

There are occasions when archeological evidence can provide valuable insights about historical shifts in the distribution and productivity of fish, as well as the responses of fisheries. During ancient digs carried out across northern Europe, the bones of warm-water species such as the red mullet, also known as Mullus surmuletus, have been discovered or retrieved. However, it appears that this species was common throughout the Roman period (AD 64–400), which occurred just recently when it returned to the North Sea in levels that are considered to be acceptable. listed a number of occurrences of warm-water species (e.g. red mullet, seabass Dicentrarchus labrax, anchovy Engraulis encrasicolus, and seabream Spondyliosoma cantharus) among bone assemblages, surrounding the North Sea, from the 1st to the 16th century AD. identified nine periods, each lasting several decades, during which large quantities of herring were caught close to the shore in the North Sea. Physical elements that are related with negative anomalies of the North Atlantic Oscillation (NAO) index were present throughout each of these events, which occurred at the same time as severe winters in western Europe. These winters were characterized by exceptionally cold air and water temperatures, as well as a decrease in westerly winds.

Methodology

An input-output (IO) analysis methodology was utilized in order to compute the impact of the sustainable fisheries model. The type of analysis that is being discussed here makes it possible to measure the influence that a change in demand for goods and services in a certain industry has on the economy as a whole. IO analysis is a tool that is widely utilized for the purpose of measuring the economic impact that particular industries have on other industries. A quantitative tool for conducting an analysis on the necessary measures for the implementation of a sustainable fisheries model has been offered by us through the linear model that is shown here. This analysis is contingent upon the availability of data.

measures that are required for the execution of a model for sustainable fishing, provided that data is available. The application of this methodology has been accomplished on a global scale. constructed Social Accounting Matrices (SAM) for the fishing grounds in the United States of America located in Westport (Washington) and Newport (Oregon) in order to evaluate the extent to which these areas are dependent on fish stock. This was accomplished by generating economic reliance indexes. These dependence indexes are generated through the use of SAM, and they indicate the proportion of GRP (Gross Regional Product) and total employment in the community that is a direct result of the exports of industries that are considered to be dependent on the community. The reliance indices are similar to the percentage of total economic activity (measured in terms of gross domestic product or employment) that is generated by the economic activity (in this case, exports) of a certain sector. By estimating the effect on the economic activity generated by the exports of the respective industries, as well as in terms of employment, the objective was to determine the degree to which the communities are dependent on marine resources, both economically (in terms of gross regional product) and in terms of employment. This was accomplished by estimating the effects on the economic activity generated by the exports.

used a general equilibrium model (GEM) to analyze the economic effects of three exogenous shocks on fishing with regard to the state of Alaska. These shocks included a decrease in the number of catches, an increase in price and fuel, and a decrease in demand for seafood products. The purpose of this analysis was to estimate the impact on production, employment, added value, and household income.

Seung used a Structural Path Analysis (SPA) to demonstrate how the variation in a sector of the fishing industry caused repercussions in a variety of ways on the economy of the region, as well as the degree to which these effects were magnified. This was done in accordance with the SAM framework for fisheries in the south-eastern part of Alaska. The SPA decomposes the regional multipliers and offers information on the ways or channels through which management action or an exogenous change causes impacts. This is done based on the total economic impact that is assessed by the multipliers that are produced from input-output models. The author develops models for two different scenarios that demonstrate, first, the impact that is brought about by a change in the amount of captures of particular species, and second, the influence that is brought about by a change in the demand for processed seafood products.

Dyck and Sumaila use an input-output model to evaluate the direct and indirect influence that marine fishing has on the economy of the entire world. This methodology is applied on a global scale. They are able to accomplish this by utilizing a sizable database of economic flows that was established by the Global Trade Analysis Project (GTAP). This database is comprised of a collection of input-output tables, and it contains economic flows for 57 different industries and 113 different locations all over the world. Additionally, they come to the conclusion that the indirect and induced impact of the fishing industry is nearly three times greater than its economic value. This is in addition to the estimation of the gross revenue that fishing generates.

Not only do these models offer significant information that assists in identifying the sectors and groups of stakeholders that are impacted by the fishing industry, but they also help to determine the extent to which the action that is affecting the sector has an impact on the sector whole. Information such as this can be of assistance to those who are responsible for formulating policies in order to ensure the biological sustainability of fishing resources.

In addition to the data on the economic impact on production and the number of jobs created by applying the measures, the objective of this study included two primary issues that are affecting the sector. These areas include a section that analyzes the characteristics of the new jobs that were created, as well as an environmental section that quantifies the increase and decrease in CO_2 levels.

Database

Based on the Input-Output Tables in Spain that were released by the National Institute of Statistics, the database was developed in accordance with those tables. This work made a number of significant advances, one of which was the division of fishing activity into two subsectors: traditional fishing and large-scale fishing. This differentiation was made possible by the utilization of the Galician Input-Output Framework, which was released by the Galician Institute of Statistics.

The only official data that is currently available, which pertains to the fishing industry in Galicia, have been utilized as a point of reference. Given that Galicia was the first fishing region in Spain and that the Galician fishing industry accounts for more than half of the Spanish fishing sector, this element is presumed to be true. In order to differentiate between traditional fishing and fishing on a huge scale, the following criteria are used:

Traditional fishing

- Coastal fishing is a type of fishing that is carried out by businesses that are involved in traditional everyday fishing. This type of fishing involves tactics such as gathering seafood at sea and using pots.

- In the seafood industry, units of production are groupings of seafood enterprises that are responsible for managing, controlling, and planning the production process, which includes pre-fattening, fattening, farming, and collection.

Large-scale fishing includes:

- Coastal fishing refers to businesses who conduct their fishing operations with the intention of selling fresh items that are comprised of catches from estuaries and along the coastline.
- Deep-sea fishing is an industrial practice that encompasses a significantly greater area of operation and occasionally reaches fishing areas such as the Gran Sol and the Canary Islands-Sahara bank.
- firms who have a significantly higher average that is greater than 500 GRT and are involved in deep-sea industrial fishing in waters such as the Falkland Islands, the South West Atlantic, and the Indian Ocean are considered to be deep-sea fishing firms.
- Aquaculture is a broad term that encompasses a variety of operations that involve the breeding of fish and mollusks, both on land establishments and via the utilization of metallic structures that are placed in the ocean.

The fishing industry is broken down into its several sectors, and Table 1 displays those sectors that are included in the calculation of impact. Specifically, Santero et al. present a comprehensive analysis of the distinctions that exist between sustainable fisheries in Spain (traditional, small-scale, or artisanal) and large-scale fisheries within the country.

Table 1. Areas **of** activity included in the impact analysis.

Agriculture and Forestry
Traditional fishing
Large-scale fishing
Extraction
Fuel and gas
Production and distribution of electrical energy
Collection, treatment, and distribution of water
Food products
Textiles, leather and wooden products
Chemical industry
Building materials

Metal industry and manufacture of metal products
Machinery
Manufacture of motor vehicles, trailers, and other transport material
Other manufactured goods
Construction
Trade, restaurants, and catering
Transport and communications
Other services (financial, insurance, research and development, . . .)
Services aimed at promoting sales
Services not aimed at promoting sales

Input-Output Methodology

An input-output table, often known as an IOT, is a statistical base that tracks the various industries that comprise the productive structure of a country or region. The data makes it possible to conduct an in-depth examination of the dimensions of the economic sectors, and it also makes it possible for us to divide the fishing sector into two subsectors: traditional fishing and large-scale fishing. It also made it possible for us to evaluate the effects of particular investment policies on various industries in terms of the amount of production and employment they generated. The primary benefit of the methodology that is based on input-output tables is that it enables the recording of the multiplier effect that the many inter-related industries have on a specific location.

The work of was the first to feature models that utilized IOTs. From a fundamental standpoint, they are made up of a set of linear equations, each of which explains the distribution of the products that are produced by a particular industry throughout the entire economy. At the moment, the European Commission is proposing the utilization of environmentally extended input-output tables and models as instruments for the purpose of determining priorities, evaluating impacts, and establishing strategic objectives, such as eco-efficiency or decoupling environmental impact from operational growth.

In these models, the productive sectors are depicted as linear functions of demand, and the models are multi-sectorial linear models. Therefore, the whole production of any sector might be described as the complete transaction with the other sectors as well as the transactions that were carried out through final demand. The matrix equation that results from this is as follows:

$$X = AX + D \qquad (1)$$

D is an order matrix with dimensions of n × 1, where n represents the number of producing sectors. It is constituted of the final demand, while X is an order matrix with dimensions of n × 1, which is composed of the total output of the sectors. An order matrix with dimensions of n × n, which is composed of the average tendency of the productive sectors or industries to spend.

Resolving the equation:

$$X = (I - A)^{-1} D \qquad (2)$$

The Leontief matrix, denoted by the equation (I − A) −1, is a matrix in which each element cij represents the change in the output of sector i when sector j gets an additional monetary unit from the final demand. The vector X that is produced as a result is the matrix that represents the extent to which an external injection into the system has an effect on the overall revenue of the sectors.

When there is a change in the final demand, the equation (I − A) −1 takes into account all of the significant impacts that occur on output. An increase in the final demand in a sector will result in an increase in that sector's production in order to meet the increased level of demand. This, in turn, will cause that sector to raise the amount of goods and services it purchases from other sectors, and so on.

Result analysis

For the purpose of determining the economic impact of the various strategic areas of action that have been presented, it is necessary to first identify a group of activities that fall under each action and then make an estimate of the budgetary requirements that are associated with those activities over a specific time period. After that, we determine the direct influence that the activity has on the production fabric, the sectors that are affected by the investment in each activity that has been identified, as well as the direct and indirect impact that the activity has on production and employment by utilizing the IO technique, which was explained earlier, in addition to the impact that the activity has on the environment.

The outcomes of the suggested model for sustainable fisheries are presented in Table 2, which displays the findings of the overall impact. An increase in total production of nearly 4000 million euros, the net creation of more than 60,100 jobs, and a decrease in greenhouse gas emissions equivalent to 412,297 tons of CO_2 are the specific economic impacts that are expected to occur over the course of a period of ten years.

Table 2. Principal figures representing the economic and environmental impact of the transition to a sustainable fisheries model.

	Production		Employment		CO2 Emissions	
	Millions of Euros	%	Jobs	%	Tons	%
Support for traditional fishing	1364	0.06	24137	0.12	66,061	0.03

Prohibition of trawling	−1179	−0.05	−9038	−0.04	−738,082	−0.28
Extension of the marine reserve network	1260	0.05	11,666	0.06	75,800	0.03
The advance of deep-sea fishing towards sustainability	78	0.003	544	0.003	3419	0.001
Prohibition of new aquaculture operations	0	0	0	0	0	0
Demand measures	21	0.001	143	0.001	892	0.0003
Compliance with biological optimums	53	0.002	384	0.002	2367	0.001
Control of marine coastline contamination	2368	0.10	32,325	0.16	172,196	0.07
Total	3965	0.16	60,162	0.30	−418,457	−0.16

One of the areas that has the most significant impact on the economy is the management of contaminants. The activities that require investment in this sector have an effect on the overall production of about 2400 million euros and the creation of 32,300 new jobs throughout the course of the ten-year period that is considered in the simulation. However, this would also be consistent with a negative outcome in terms of emissions, as it would result in an increase of more than 172,000 tons of carbon dioxide from the atmosphere. If, on the other hand, trawling were to be prohibited, there would be a reduction of over 740,000 tons of carbon dioxide emissions.

There are two more areas of action that have significantly favorable consequences in terms of overall production (1364 and 1260 million euros, respectively) and employment (24,137 and 11,666 jobs, respectively). These are the support for traditional fishing and the extension of marine reserves. Both of these areas of action are quite beneficial.

The prohibition of trawling would result in a loss of about 9000 jobs and 1179 million euros over the course of the decade that was investigated. This loss would occur not only in the fishing industry but also in other, connected industries.

Because they enable us to answer questions such as "what would be the cost in terms of employment of gradually eliminating trawling?" the results that were produced form a vital instrument for decision-making because they enable us to answer those questions. In the event that traditional fishing is supported, what kinds of employment opportunities would be created? What is the percentage of occupations that would be held by young people and women?

What percentage of the population would be considered to be rural residents? The building of the necessary infrastructure to improve the quality of coastal waters would result in a significant amount of carbon dioxide emissions. What would the extent of these emissions be? The utilization of an input-output model has made it possible to estimate the adverse effects that Spanish fisheries have on the economy, society, and the environment.

Throughout the course of ten years, the simulation has demonstrated the economic impact in terms of production and employment, as well as the environmental impact in terms of CO2 emissions. Both of these impacts have been proved to have occurred. An additional objective should be to lessen the impact on the environment by reducing the amount of carbon dioxide emissions.

The findings indicate that a relatively greater number of employment opportunities would be produced as a result of leisure and tourism; these chances would be available to young people, women, and individuals with medium and high requirements. Through this contribution, a clear guideline is provided for the development of the country's economic standing as well as for the management of fisheries in a sustainable manner.

The combined action would make the fishing sector in Spain completely sustainable, as well as contribute to an increase in economic production of four thousand million euros, the creation of more than sixty hundred jobs, and the facilitation of improved preservation of our oceans and coastlines, as well as the establishment of larger reserves. Based on the technical estimation that was performed for this project, the budget that is required to carry out the transition towards a model of sustainable fisheries is estimated to be 2,725 million euros over the course of the remaining decade. The annual effort that is being made to advance towards a sustainable fisheries model (approximately 135 million euros per year) is almost identical to the amount that has been allocated in the most recent Operating Program to action 1, which is titled "Measures for the adaptation of the Community fishing fleet" (133 million euros per year). This action has primarily been used to reduce the number of vessels, primarily in the traditional fishing sector.

Conclusions

There are a number of different ways in which climate change may have an effect on fisheries in the North Sea. The repercussions of rapid temperature rise are already being felt in terms of alterations in the distribution of species and variability in stock recruitment. There are still many knowledge gaps, particularly with regard to understanding how fishing fleets themselves might be impacted by underlying biological changes and what this might entail for regional economies. Despite the fact that there is now a growing amount of study on this subject, there are still significant knowledge gaps. It is clear that fish communities and the fisheries that target them will almost certainly be very different in fifty or one hundred years, and that management and governance will need to adapt accordingly. Historically, fisheries managers and fishermen have been required to adapt to the varying weather and climate conditions. However, the challenge that will be presented by future climate change should not be underestimated.

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