

Possible economic effects of musilage on Sea of Marmara fisheries

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Abstract

Today, with global warming, problems occur arising from the deterioration of ecological balances in all seas of the world. These unexpected events affect the fishing industry quite negatively. As a matter of fact, the emergence of jelly organisms that covered the sea surface by about 80% during the fishing season in the Sea of Marmara in 2007, damaged both fishing equipment and caused a significant product loss. That's why many fishermen could not go fishing, lost their nets, waste their fuel, labor, food, etc. Musilage was partially reappeared on the shores of Balıkesir in 2020 and caused great discomfort in the related circles. This study, which was carried out in order to estimate the economic losses that may occur in the event that the musilage re-occurs in 2007, has been carried out in the light of real data. The main material of the research consists of the data obtained from the Ministry of Food, Agriculture and Livestock and General Directorate of Agricultural Research and Policies. In the study, the economic losses that may occur in the event that these organisms reappear in the future are calculated by using proportional calculations of the losses caused by the jelly organisms that occurred in the past in the Sea of Marmara. As a result of the research; it was determined that the fishermen who went fishing during the musilage lost an average of 14123 Euros due to the loss of the product as well as the various expenses they made due to sailing throughout the season. In the study, it was calculated that the decrease in fishing income was 27459 Euros / year on average, and the effect on fishing income was -61.41%.

Keywords: Sea of Marmara, fishery economics, mucilage, possible economic effect.

Introduction

Sea of Marmara; is an inland sea in Marmara Region which the most advanced region of Turkey respectively and include the cities Istanbul, Izmit, Balıkesir, Bursa, Canakkale and Tekirdag. Since the Sea of Marmara is known as the spawning and feeding area of pelagic fishes, it is a sea where benthic/demersal species and with largely seasonal migratory fishes are fished by purse seine fishing generally (Anonymous (a), 2017).

Species such as bonito, bluefish, ceramop, mackerel, horse mackerel, sardines, and anchovies are heavily fished in the Sea

of Marmara, which pelagic fish migrate seasonally from the Aegean to the Black Sea and from the Black Sea to the Aegean in our country. The most important fish species are regarded as bluefish and redfish in terms of the economic contribution. It is reported by Erazi (1942) 181, Slastenenko (1955) 135 and Geldiay (1969) 175 different species exist in the Sea of Marmara, while another product with high economic returns is deep water pink shrimp.

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The number, technological equipment, capacity, fishing equipment and operations capabilities of fishing vessels had increased significantly after 2000s in Turkey. However, with these developments, in the 2000 and 2007 fishing seasons, the jellyfish organisms were seen especially in the Sea of Marmara of our country, and had a negative impact on fishing, as well as a decrease in the amount of fishing, loss of fishing supplies, time, labor and money. For this reason, most of the fishermen could not go out to sea in this period, lost their nets, or such as fuel and crew expenses. As a matter of fact, in 2000, when jelly organisms appeared, the amount of fishes caught was 50 thousand tons and in 2008 it was 57 thousand tons. The average fishing quantity caught and landed in the last 30 years has increased by 10 tons in every decade (Güngör et al., 2019). It is reported that these organisms were partially observed in the southern coasts of the Marmara region, especially around Balıkesir in 2020, and caused various economic losses (Anonymous (b), 2020). Apparently; Unless the problems are resolved, the jelly-like organisms will continue to affect the Sea of Marmara fisheries adversely.

The most severe algae eruption caused by these organisms in our country took place in 2007 and covered almost 80% of the Sea of Marmara (Artüz, 2007, Tüfekçi et al., 2010, Altuğ et al., 2010, İsinibilir, 2010, İsinibilir et al., 2010). For this reason, in this study, 2007 was taken as the basis year for calculations to reveal the size of the economic losses caused by the jellyfish organisms where a significant fishing income was obtained and draw attention to the negativities which emerged from time to time in the Sea of Marmara that this problem may cause in the coming years.

Materials and Methods

The main material of the research consists of the data obtained from the Ministry of Food, Agriculture and Livestock and General Directorate of Agricultural Research and Policies. In the study, by using proportional calculations of the losses caused by the jelly organisms that occurred in the past in the Sea of Marmara, the economic losses that may occur in the event that these organisms reappear in the future were calculated. Since the study was aimed to be simple and understandable, the boat sizes have been neglected and a concrete result has been reached on average figures.

First of all; the normal fish season in the past and the two fishing seasons in which jelly organisms appeared were compared and proportional calculations of product losses were made. The average total fishing income calculated for the normal year and the calculations of the share of the fish species in the income were taken as the basis. Using these two starting points, first the normal year income according to the fish species calculated using the "Proportional Decrease" and then the income of the year when the musilage occurred. Finally, the total decrease in income with mucilage was proportioned to the average total income obtained in the normal year, and the effect of the musilage on fishing income was calculated.

In addition, as musilage not only reduces income as a result of the decrease in the amount of fishes caught, but also causes great damage to the fishing equipment, especially the nets, fuel, workmanship, food, etc. Expenses were made a table and added

to the study as a negative effect of the musilage. Other literatures were also widely used in the study related to the subject.

Discussions

While Turkey vary according to sea and inland waters, catching and 600-700 thousand tons per year from aquaculture together it is realized in aquaculture production. However, as in the whole world, studies are carried out in our country to ensure sustainability rather than increasing production due to reaching the limit in catching. In order to ensure sustainability, a series of protection measures are introduced and tried to be implemented effectively.

In this study, the effects of mucilage occurring in the Sea of Marmara and the possible problems in case of recurrence of this situation were discussed. At the same time, solutions were tried to be offered for the problems that occurred.

The phenomenon called as "musilage" and "white liquid layer seen on the sea surface" occurred throughout the Sea of Marmara was described actually a mixed algae explosion. Indeed, in a study conducted by Artüz in 2007 when the algae explosion was the highest, these types of algae were named; *Rhizosolenia calcar-avis*, *Dinophysis caudata* and *Dinophysis tripos*. In addition, in the study, it was observed that the jelly-like organisms occurred close to the surface, especially in the areas where the sea traffic is intense throughout the Sea of Marmara, trapped the microscopic air bubbles in the mixture formed by the effect of the rudder waters thanks to the viscous structure, and as a result, they caused trace-formations on the water surface along the rudder water.

In many studies, it has been pointed out that this kind of abnormalities threatens species diversity with the pollution that exceeds the load that the Sea of Marmara can handle. Because the living things in question died due to insufficient oxygen dissolution and density in water, and they caused a slimy structure by breaking down. In the studies carried out, this type of anomalies are a significant indicator of the delicate balance due to the diversity of species in the Sea of Marmara, this situation causes mass deaths in other living creatures living in the sea and can cause consequences such as health problems in humans through the food chain, due to the damage caused to the fishing gears. It has been determined that it may cause a decrease in the income of fishery products (Aktan et al., 2008; Altuğ et al., 2010; İsinibilir, 2010; İsinibilir et al., 2010; Tüfekçi et al., 2010; Eyuboğlu et al., 2013; Altın et al., 2015).

In the research, firstly the distribution of the product losses caused by the jelly-like organisms in terms of the main fish species were investigated. Table 1 was prepared in this context and calculations related to product losses caused by jelly-like organisms were shown in terms of fish species. As can be seen from the table, in the fishing season 2007-2008, when the musilage occurred, there was a significant decrease in the amount of fishing. Although the fish species that were caught were affected by the abnormality of mucilage at different rates, it was determined that the 99.4% of the amount of anchovy, 63.3% of the amount of horse mackerel, 90.5% of the sardine amount and 82.6% of the acorn amount and 93.4% of the sledgehammer were decreased. It has been determined that bluefish which was the most income-generating species, was fished 55.2% less.

Table 1. Distribution of Product Losses Caused by Jelly Organisms According to Fish Species

Fish Species	Regular Season (Kg/Year) 2006/07	Musilage Season (Kg/Year) 2007/08	Difference	Proportional Decrease (%)
Anchovy	141124	787	140337	99,4
Mackerel	83598	30670	52928	63,3
Sardine	180048	17115	162933	90,5
Acom	20814	3616	17198	82,6
Bluefish	24549	10988	13561	55,2
Mackerel	24449	1613	22836	93,4
Berlam	1297	905	392	30,2
Mullet	335	260	75	22,4
Shrimp	5825	4495	1330	22,8

Search: Anonymous, 2017. Socio-Economic Structure of Marmara Sea Fisheries and Determination of Management Strategies Project, TAGEM/HAYSÜD/2008/09/04/01.

* In this table, the amount of small bluefish is evaluated together with Bluefish.

In the study, the distribution of average fishing income obtained in a normal fishing season by fish species was also examined. As can be seen in Table 2, the average annual income of a fisherman who hunts in the Marmara region, which is the average annual income earned in a normal season, was distributed according to the share of fish species in income. In this context, it is observed

that the highest share in income belongs to bluefish with 28.79% and then to bonito fish with 20.63%. The fact that the market prices of bluefish and bonito fish are relatively higher and high amount of demand were reflected in the research results. On the other hand, horse mackerel was also emerged as an important source of income for fishermen with a share of 16.67%.

Table 2. Distribution of Average Income of Fishermen Obtained in a Normal Catching

Fish Species	Share In Total Revenue (%)	Regular Year Income Calculated According To Fish Species (€/Year)
Anchovy	6,60	2951
Mackerel	16,67	7454
Sardine	1,50	671
Acom	20,63	9224
Bluefish	28,79	12873
Small Bluefish	15,31	6846
Berlam	0,84	376
Mullet	1,40	626
Shrimp	3,25	1453
Sub Total	94,99	42474
Others	5,01	2240
Total	100,00	44714

Search: Anonymous, 2017. Socio-Economic Structure of Marmara Sea Fisheries and Determination of Management Strategies Project, TAGEM/HAYSÜD/2008/09/04/01,142-146

Losses in fishing income due to the jelly-like organisms identified in the study were shown in Table 3. The proportional decrease caused by the musilage in the table compared to the normal year was multiplied by the normal year revenues and the revenues in the musilage year were calculated by fish species. As a result of the calculations; It was concluded that the jelly

organisms that appeared in the 2007 fishing season and covered 80% of the Sea of Marmara reduced the income of fishermen by an average of 1.41% when the sum of the decrease in income due to musilage was compared to the average total income obtained in the normal year.

Table 3. Losses in Fishing Income Due to Jelly Organisms

Fish Species	By Fish Species Regular Year Income (€ / Year) *	Proportional Decrease Due To Mucilage (%)	Decrease In Income Due To Mucilage (€/Year)	In The Year Of Musilage Average Income (€/Year)
Anchovy	2951	99,4	2933	18
Mackerel	7454	63,3	4718	2736
Sardine	671	90,5	607	64
Acom	9224	82,6	7619	1605
Bluefish	12873	55,2	7106	5767
Small Bluefish	6846	55,2	3779	3067
Berlam	376	30,2	114	262
Mullet	626	22,4	140	486
Shrimp	1453	22,8	331	1122
Others	2240	5,01	112	2128
Total	44714	-	27460	17254
Proportional Loss In Revenue (%)		(27459/44714)		61,41

In the research, it was determined that musilage did not only reduce the hunting rate but also caused great damages to fishing equipment, especially networks. For this reason, besides the networks, fuel, workmanship, food and so on expenses were

compiled to give an idea and are given in Table 4. As can be seen from the table, it is understood that the fishermen lost at least 14123 Euros on average during the season due to their expenses.

Table 4. Losses of Some Cost Elements Due to Musilage

Inputs of cost	Avarage (€/Year)
Fuel Oil	8540
Victual	797
Ship Maintenance And Repair	1228
Fishnet Maintenance And Supply	1202
Labor	377
Insurance (Annual)	114
Cleaning	20
Contact	58
Fuel Book	29
Taxes, Permissions	196
Others	1562
Total	14123

Search: Anonymous, 2017. Socio-Economic Structure of Marmara Sea Fisheries and Determination of Management Strategies Project, TAGEM/HAYSÜD/2008/09/04/01.

Results

Today, with global warming, problems arising from the deterioration of ecological balances occur in all seas of the world. These unexpected events affect the fishing industry quite negatively. As a matter of fact, the emergence of jelly-like organisms in the Sea of Marmara that affected the fishing season by about 80%, especially in 2007, caused damage to the fishing equipment and significant product loss. So, many fishermen were not be able go to catching in this reason, lost their net, gasoline wasted and some expenses like wage of craftsmanship, food, etc. could not cover.

This study was carried out in the light of real data in order to shed some light on the economic losses that may occur with the musilage, which was partially reappeared in Balikesir coasts in 2020 and caused great discomfort in the related environment.

Considering the difficulties in calculating the economic dimensions of environmental problems, in this study, which is important in terms of presenting a concrete result, the following results have been reached.

In the fishing season 2007-2008, there was a considerable reduction in the amount of fishing, compared to the normal fishing season. The decrease in fish amounts were at different rates according to the fish species. In this context; It was determined that there was a 99.4% decrease in the amount of anchovy, 63.3% in the amount of perch, 90.5% in the amount of sardines and 82.6% in the amount of bonito. A decrease of 55.2% in the amount of bluefish and ceramics, and 93.4% in the sledgehammer was determined.

The highest share in income was in bluefish with 28.79%, followed by bonito fish with 20.63%. In the study, it was

observed that bluefish and bonito fish were the most important commercial species due to their relatively higher market prices and higher demand. In addition, horse mackerel has been found to be an important source of income for fishermen with a share of 16.67%.

Fishermen who went fishing during the musilage period lost an average of 14123 Euros due to the loss of the product as well as the various expenses they made due to sailing throughout the season.

It was found that the decrease in fishing income in the period of 2007-2008, when musilage was the most common, was on average 27459 Euro/year, and its effect on fishing income was 61.41%.

As a result; in the Sea of Marmara, which has a special importance for the fisheries sector, as well as the strategic importance, the lack of oxygen dissolved in water due to pollution, excessive sea traffic, overfishing and excessive construction along the coastline disrupts ecological balances with the formation of jelly organisms. While this situation causes mass deaths in other living creatures in the sea, it can also create health problems in humans through the food chain. When the subject was considered in terms of fisheries sector, it was observed that these organisms caused damage to fishing gears, increase their costs and cause significant reductions in fishing income. It is understood that jelly-like organisms will continue to adversely affect the Sea of Marmara fisheries unless the problems are solved. As a matter of fact, the reappearance of jelly-like organisms in 2020 around Balıkesir supports taking measures in this regard. In order to avoid a problem as in the fishing season of 2007-2008, it is necessary to take necessary measures.

Author Contributions

Günay Keleş contributed to the analysis of the results and drafted the manuscript. Serpil Yılmaz carried out the experiment and helped to draft the manuscript. Mustafa Zengin carried out the experiment and helped to draft the manuscript.

Conflict of interest

The authors declare that they have no competing interests.

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