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The Impact of Jellyfish Population on Human Economy and Countermeasures

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Abstract. Global warming has brought huge changes to marine life. This essay analyses the direct and indirect factors that lead to changes in the number of jellyfish, and the impact of the increase in the number of jellyfish on humans. The direct cause of the impact on the jellyfish population is due to global warming, and human overfishing is an indirect factor leading to the increase in the jellyfish population. However, as a result of the development of coastal cities by humans, the living environment of some giant jellyfish has been destroyed which resulting in a decline in the number of giant jellyfish. The growth in the number of jellyfish has caused a huge expense on the human economy in beach recreation, fishing and aquaculture. Therefore, the government needs to take some targeted measures to prevent the increase in the number of jellyfish and planning to prevent ecosystem changes due to continued global warming. Global warming and human overfishing lead to imbalances in marine ecosystems. This essay hopes to find more solutions that to prevent jellyfish populations from continuing to increase which can protect marine ecosystems and sustain the human economy.

Keywords: economic loss, fisheries, overfishing, global warming

1. Introduction

Over the past few decades, the importance of jellyfish in marine ecosystems has become increasingly evident [1]. A jellyfish is an invertebrate without a brain, heart, bones or eyes, but the number of jellyfish rise has had a huge negative impact on the marine life and fisheries industries [1, 2]. The fisheries of many countries have suffered serious economic losses. This article knows the reasons that affect the number of jellyfish and the impact of the increase in the number of jellyfish on humans, also including some measures and management to prevent the continued increase in the number of jellyfish.

Many previous studies have shown signs of jellyfish growth in various sea areas. Previous literature by observed the annual growth of jellyfish in specific sea areas, and model and analyses what causes the growth of jellyfish. This article summarizes the factors affecting jellyfish, some specific cases and valid data, and the actual impact of the increase in the number of jellyfish on human beings, as well as some management measures that have been carried out. The reasons for the change in the number of jellyfish are climate change and human activities, so management measures cannot be simple. According to most of the literature, changes in jellyfish populations are related to global warming, overfishing, and eutrophication, but until now there is no awesome solution to solve the negative impact of increase population on jellyfish on the marine ecosystem and human economy, even if some measures have been taken. Because of the particularity of jellyfish, it is difficult to collect data on their population changes. This is a problem that needs to be further solved. How to

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analyses the population changes of jellyfish more accurately. In additionally, how to make effective measures and management to prevent jellyfish from continuing to grow.

The main purpose of this article is to analyses the causes of jellyfish growth and to make some management measures for these factors. Firstly, based on previous research, analyses and summarize all the known causes that affect the growth of jellyfish, and the results of the growth of jellyfish, and then how to solve the problem. Moreover, make some guesses about factors that might affect the number of jellyfish. However, further research and future management methods are needed to prevent the jellyfish from continuing to increase. This article hopes to pay more attention to the impact of global warming and human activities on jellyfish, as well as the impact of jellyfish population growth on marine ecology and human economy.2. Effects of global warming

2. Influencing factors of jellyfish population change

Over the past two decades, the population of jellyfish in the global wide have been growing, although the fact that global warming and destruction of ecological environment (ocean pollution, habitat loss) for a considerable number of animals have had a fatal impact, even leading to their extinction [3]. In the meantime, the population of jellyfish increase and decrease has also been accompanied by other causes

2.1. Global warming

Due to global warming in recent years, the climate change give rise to the level of oxygen to decline, while the temperature of ocean are also increasing. In additional, rainfall capacity is vital for the growing environment of jellyfish. In some sea area with limited rainfall represent the higher level salinity of sea water. The research shows, jellyfish can grow better in low oxygen content, high salinity components and warm water [4]. As the same time, because of global warming, carbon dioxide level has been rises, and then this carbon dioxide will enter the ocean and acidify the seawater. Seawater acidification may also be a factor affecting the number of jellyfish [4]. The research suggested PH value for number of jellyfish do not have significant effect, but higher PH may have potentially negative effects on jellyfish [5].

The European Arctic was the region with the most obvious global climate change, so that result in marine ecosystem range of Atlantic Ocean has expended to the poles, therefore the water temperature and salinity of Atlantic Ocean have reached the maximum value. Through 12 consecutive summers (2003-2014) survey the sea area between Atlantic Ocean and European Arctic. Interannual variability data analysis of the level of salinity, seawater temperature, depth of the sea and the latitude of the effects on the abundance and reproduction of jellyfish (Fig. 1) [6].

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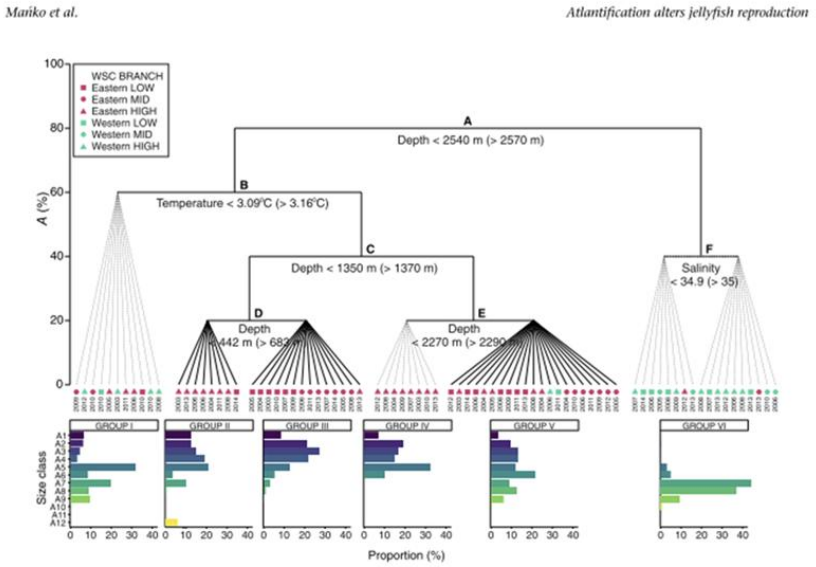

Figure 1. Atlantification Alters Jellyfish Reproduction [4].

In the Fig.1 the data of group I is about temperature (<3.09°C), and then contain both of temperature and depth is from Group II to Group V, those data Most of these are in the eastern of West Spitsbergen Current. Only the group II data that the depth (<442) have the A12 size jellyfish. It is obvious that in group V the reproduction of small jellyfish is decreasing, but the reproduction of large jellyfish is increasing. And between group I and group II to group V there was a clear contrast, the population of jellyfish from size of A1 to A5 of was increase [6].

It can be seen, under the influence of global warming, the production situation and population of jellyfish in the Atlantic Ocean was affected. This information (Fig.1) [6]. suggest that the temperature and depth as well as salinity all of these were factors to affect the number of jellyfish grow and decline. However, for the same species of jellyfish of different sizes, these factors had different effect on them (Fig.1) [6]. Also, according to the provide, different jellyfish sizes will grow in diverse living conditions.

2.2. Human activities

Human overfishing may also be responsible for the jellyfish bloom. Over the past twenty years, between 100 million and 120 million marine life disappear from the ocean every year [3]. Human hunt for invertebrates such as fish and squid which they are like jellyfish that the plankton as food. The number of jellyfish competitors reduce due to overfishing of jellyfish competitors that leading to more abundant food for them [7]. In addition to jellyfish competitors being heavily fished, jellyfish predators are also heavily fished. Grey triggerfish, ocean sunfish, seabirds, turtles, whale sharks, crabs, and whales all feed on jellyfish [8]. The larvae of sardine and anchovy are one of the food of jellyfish, the study shows that in the western Mediterranean, these two small pelagic fish are negatively affected by the increase in jellyfish [9]. Predicted declines the number of sardine and anchovy due to overfishing coupled with massive climate change which the food of the jellyfish also decease. But because tuna and large pelagic sharks are both predators of jellyfish, these fish are affected by climate and overfishing that can they result the jellyfish population growth. In general, the increase in the number of jellyfish has a certain impact on sardine and anchovy, but the impact of changes in the number of small pelagic fish on jellyfish needs further research [9].

After 16 years of research and observation in Ireland (1994-2009), the increase in jellyfish numbers is not directly related to human overfishing. Because of over-development of herring cause the number of herrings dropped rapidly. This situation has caused structural changes in the marine ecosystem, but this is not main the reason for the increase in the number of jellyfish. However, in 2000 the reduction

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in cod fishing it also further promoted the growth of the number of haddocks, for this changes in haddock numbers have no effect on jellyfish numbers. The change in figure of cod and herring and changes in jellyfish are interactions and do not indicate a direct or indirect effect between them [10]. Human overfishing can create the competitors of jellyfish down, or lead to a reduction in their food, but the change of numbers of these sea creatures that do not directly cause the explosion of jellyfish. But the climate change and global warming for all marine life have straightforward influence.

2.3. Eutrophication

In coastal areas, eutrophication enables phytoplankton blooms. The plankton is the main food for jellyfish, which means that the plankton massive growth the jellyfish had more food , which may also be responsible for the growth of jellyfish. Both sewage and fertilizer runoff contain large amounts of nutrients, and when these nutrients went into ocean that lead to rapid growth of phytoplankton [5]. Because jellyfish can live in low oxygen environment [4], These phytoplankton was sink to the seafloor and cause local hypoxia, so this results in fish not being able to survive in a low oxygen environment like jellyfish, which such a living environment reduces jellyfish competitors and predators [5]. This situation can provide a good habitat for jellyfish reproduction.

3. The impact of changes in the number of jellyfish

The increase in the number of jellyfish will have some negative effects on human activities, such as seaside recreation, fisheries and aquaculture productivity, biodiversity, etc., and bring economic losses to human beings [11]. Likewise, because of human exploitation of coastal areas, for example, Construction of marina and recreational facilities. This behavior destroy some growth environment of big jellyfish, which result the jellyfish number decline [12]. The impact of the increase of jellyfish on humans and the destruction of the marine ecological environment by humans are interactive.

3.1. The impact of the increase in the number of water trees on the beach

Because the increase in jellyfish negatively affects a range of activities at coastal sites, such as beach closed. Investigation found on Israel's Mediterranean coast, Seaside resorts here lose anywhere from 1.8 million to 6.2 million dollars a year. Including tourist travel from a decrease of 3% to 10.5% [11]. According to data collection, among the four main beaches of St. Ives, a famous British resort, there is 182 questionnaires that were collected, of which 151 were completely filled out, this questionnaire is based on each person's explicit preference and then used in the travel cost model (Table 1) [11].

Table 1. Income And Demographic Factor Consider For The Travel Costs Model [11] (continue).

Variable	Type	Category Code	Frequency		Percentage
Gender	Dichotomous	Male	0	70	46%
		Female	1	81	54%
Income	Categorical	0-30K	1	54	36%
		31-60K	2	58	38%
		61K	3	69	26%
Age	Dichotomous	18-44	0	79	52%
		45-75+	1	72	48%
Education	Dichotomous	Secondary or lower	0	53	35%
		Higher Education	1	98	65%
Employment	Dichotomous	Unemployed	0	31	21%
		Employed	1	120	79%
Children	Categorical	No children	1	29	26%
		1 child	2	28	19%
		2 or more children	3	84	56%
Reason for visit	Dichotomous	Beach holiday	0	127	84%
		Other holiday (cultural, family, etc)	1	24	16%

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It can be seen from Table 1 that 84% of the tourists came to the beach for vacation, and 79% of the tourists who came on vacation are employed, here it obviously that most of the economy of the beach comes from tourists. 56% of these tourists have three children, does this prove that their consumption levels were higher. According to the literature, 66% of tourists are on the beach for recreational activities [11].

There are four cases, the economic impact of increased jellyfish population on beaches Table 2 [11]. Situation 1, if a jellyfish outbreak occurs, the beach had been closed, leaving the beach without tourists. On the first day of the jellyfish outbreak, the beach loses £26,625 a day, and if the jellyfish outbreak continues for 14 days, the beach was lose 372,750. But according to the survey, only 42% of respondents would left this beach and went to somewhere else, and 58% of respondents chose to stay near St Ives Beach. in the light of this data, St Ives Beach was lose 42% of its visitors, this represents a 42% reduction in the total use value of the St Ives coast, so a jellyfish outbreak would cost the beach £11,118,250 for one day and £156,555 for 14 days [11].

Also in the second case, when the jellyfish erupts but the beach had been opening, but the data is clear that even if the beach had been opening, there was economic loss. In the survey, 85% of visitors chose to stay on the beach, but would choose recreational activities on the coast instead of underwater activities. The remaining 15% of the visitors chose to visit the beach in another way, and 2% of the visitors chose to wait for a safe time to enter the sea. But 13% of visitors still choose to leave the beach. In this case the beach was lose 3461.25 per day and £50977.50 in 14 days. In another condition, only 2%, of the visitors would choose to leave the beach and 18% would not change any choice. And then 27% would be more vigilant about stayed at the beach, while the remaining 40% would choose for other recreational activities and avoided underwater activities. In this case, the loss of the beach was the least, only 532.50 per day and 7455 in 14 days [11]. Furthermore, 90% of people who lived in the area avoided beaches during a jellyfish outbreak [11].

Table 2. Estimated Decrease In Aggregated Use Value Of The Beaches And Costal Area Under The Bloom Scenarios Per Day And Over The Assumed Typical Duration Of A Bloom (14 Days) [9].

	Per day	**14-day bloom**
Scenario 1: reduced coastal visits	£11,182.50	£156,555
Scenario 1: no beach visits	£26,625	£372,750
Scenario 2: reduced beach/coastal visits	£532.50	£7455
Scenario 2: no beach visits	£3461.25	£50,977,50

From this questionnaire, it can be seen that the increase in jellyfish numbers and beach recreation are interactive. During a jellyfish outbreak, there was an economic loss to the beach, but when this phase subside, beach entertainment was resume, but the economy still declines [11].

3.2. Impact of jellyfish population growth on fisheries and aquaculture

Outbreaks of jellyfish have a large negative impact on fisheries. A jellyfish bloom can lead to a large number of fish deaths in fish farms, as jellyfish can clog power plants, or cause the fishing net to break and fail to catch fish when people are fishing [12]. The most common report of an increase in jellyfish in the fishing fleet was a clogged fishing net that the harvest decline and lead to longer fishing time, which the boat consumes more fuel. Therefore, jellyfish indirectly affects the fishery economy [13]. Marine aquaculture has become a source of global fish production, but there has been an increase in reports of jellyfish bloom disturbances to finfish farming facilities or to the health of farmed fish. The jellyfish can be swept through the finfish cages by the current, where they can stab the fish in these farmed cages which causes damage to the gills and skin of the fish, which can lead to death, including some jellyfish, which are highly toxic [14]. Jellyfish boom has indirect and direct impacts on fisheries and aquaculture, and indirect effects are predation of juveniles by jellyfish that reducing competitors. The immediate effect is to disrupt the entire fishing process, such as hindering fishing, destroying fishing tools, or killing fish caught [14]. Jellyfish growth is causing serious economic losses to fisheries and aquaculture. Because jellyfish can not only affect the fish, but also directly affect the

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entire fishing process. It is possible that the loss to these two industries is not just the low number of fish caught, but the cost of the facility.

4. Measures

The massive growth of jellyfish has a negative impact on the marine ecological environment and the human fishery economy, so we need to take some measures and management. It is difficult to implement for management, so preventing jellyfish outbreaks is the best solution. It is necessary to take a series of targeted actions suitable for the local marine ecological environment in the early stage of jellyfish outbreaks to avoid large-scale changes in the ecological environment, and reduce economic losses to local fisheries [10]. Humans can reduce overfishing through regulations, such as avoiding the breeding season of fish and not catching fish of special size, which can increase the number of jellyfish competitors and predators. Keeping the marine ecological environment balanced can also maintain the economy of the fishery when the number of jellyfish decreases. Including the special reproduction of jellyfish and the influence of different growth environments, the diversified plans can be set according to data changes to make management more effective [14]. So far, jellyfish are eaten in many countries, but eating jellyfish is only a short-term control of the decline of a particular species of jellyfish. Of the 400 species of jellyfish, only about 20 are edible [13]. In line with research, jellyfish are extremely nutritious, and they can be used as a substitute for many foods. Jellyfish are low in calories and fat, but high in minerals and protein [15]. To control the number of jellyfish also depends on global warming and the impact of environmental changes.

5. Conclusion

There are two reasons that affect the growth of jellyfish, one is due to climate change, and the other is human activity. Since jellyfish are adapted to survive in warm water, low oxygen and high salinity, global warming has a negative impact on all marine life except jellyfish. Human activity, such as overfishing have reduced the number of jellyfish predators and competitors, as well as the discharge of sewage and fertilizer runoff into the sea to provide jellyfish with more nutrients. These provide a better living environment for jellyfish to increase their reproduction. The impact of the external on the jellyfish and the impact of the jellyfish on the external are both interactive. However, the negative impact of jellyfish on the marine ecosystem and the major losses to humans need to be highly valued. Planning fishing times to prevent overfishing so that marine ecosystems are not destroyed. This article wants to express that humans need to continue to pay attention to the changes in the number of jellyfish, and find better ways to control the water volume of jellyfish in the future.

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