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ISSN 2959-6157

The Impact of Environmental and Biological Factors on Orca Populations and Their Conservation

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Abstract:

As the top predator of the ocean, the orca's role in protecting the environment should not be underestimated. Although the protection of killer whales is not mature at this stage, with the deepening of research on killer whales, the protection measures will become more and more perfect. This paper introduces the biological characteristics of orca populations, analyzes the effects of these four factors on orcas from dietary habits, reproductive habits, migration and the environment, as well as the relationship between human beings and orcas, and the results of the research are those orcas are most affected by the marine environment, reproductive habits are the second, and the dietary habits are mainly affected by the marine environment, so the best way to protect the orcas is to reduce the effects of marine pollution on their food sources, such as salmon's heavy metal overload. This paper mainly give attention and protection to the neglected marine predator populations to monitor the development of the marine ecosystem better. There are still questions about the nutritional value of orca food and orca hunger tolerance that still need to be addressed, and future research could focus on the nutritional value that orcas receive and the direction of how to balance the relationship between humans and orcas.

Keywords: Orca conservation; Marine ecosystem; Environmental impact.

1. Introduction

Killer whales are unique in the ocean for their "black and white" coloration, and although they are called "whales", they belong to the mammal family Delphinidae and are close relatives of the dolphin family. The orca has a streamlined body with smooth skin, but underneath the skin is a thick layer of blubber that helps it adapt to the cold water, while its dorsal fin looks similar to the ancient weapon "halberd" when it is upside down, hence the name "orca". Like all cetaceans, it has nostrils at the top of its head,

making it easy to surface and exhale. Adult male orcas are about 10 meters long and weigh 7-8 tons, while females are slightly smaller, 8 meters long, and weigh 5-6 tons [1]. Although they are close relatives of dolphins, killer whales have much more aggressive habits than dolphins and are killers of most fish in the oceans, choosing to feed on seals and some other large fish. Killer whale clans are matrilineal, usually headed by a female, who follows the group for life after birth, and males who remain bonded to the group as adults. Killer whales in hunting also play a full role in the characteristics of the animals as a group. According to observation found that the killer whale group in the hunt will have "tactics," just like the land lions, encountered in the blue whale such as the massive size of the prey, 2-3 males will go up to launch an attack and wait for the prey to be killed, the rest of the members will go up to share and eat! The rest of the group will go up and share the prey. When hunting seabirds or other marine life, killer whales will adopt the strategy of "playing dead," lying on their backs in the sea, waiting for their prey to approach, and then turning over to kill them. However, in recent years, the population of killer whales has been drastically reduced due to environmental changes and human activities, which have indirectly affected the marine ecosystem [2].

At the top of the food chain, killer whales maintain the integrity of the food chain, control the number of invasive alien groups, and help human fisheries and aquaculture industries through their habits, such as using their voices to help humans catch squid. This paper will analyze the existing measures to protect killer whales based on their habits and influencing factors and make practical suggestions.

2. Killer Whale Population Introduction

2.1 Biological Characteristics

As mentioned in the introduction, killer whales, as top predators, play a role in controlling the population size of each food chain level, such as controlling invasive species and the balance of the ecosystem. The killer whale's diet includes sea otters, seals, and other fish at the higher end of the marine food chain, such as great white sharks and sperm whales. What establishes killer whales as top predators is their speed (30 miles per hour), teeth, and intelligence. According to research, the orca's brain is five times the size of a human brain but structurally similar to that of a human [3]. For example, orcas have fully developed insula and cingulate sulcus in the brain, giving them a "self-awareness" system and the ability to socialize and "empathize" with other family members, which allows their hunting skills to be more sophisticated than their marine counterparts, as well as their ability to hunt for food. This ability makes their hunting skills more sophisticated than their marine counterparts and gives them an unrivaled position in the food chain. The paralimbic system in the killer whale's brain has more grooves than the human paralimbic system. Research has not been able to determine what advantage this piece of the brain gives to killer whales in terms of their hunting skills. Still, according to hypotheses provided by scientists, the paralimbic system gives them the ability to process and retrieve information from the brain, helping them to better utilize the information in their brain [4]. The paralimbic system allows whales to process and retrieve information in their brains, helping them to perceive better "emotions.

In the ocean, orcas not only have a brain like that of humans but also a brain structure that differs from that of humans: the ability to recognize sound. As we all know, sound travels four times faster in the water than on land, and orcas rely on bat-like echolocation to pinpoint the location of their clansmen or prey and distinguish the size of their prey through the echoes to facilitate the selection of food.

Killer whales are the only species other than humans that work so closely as a team. This is mainly because the orca's brain also violates the conventional laws of biology to a certain extent. The larger the brain volume of the animal's brain, the more significant the amount of white space on the brain, but the orca's brain, although significant, folds more extensive than the general brain volume of large animals, which also creates the orca's high IQ and the ability to work as a team [5]. The ability to work as a team is one of the things that makes killer whales the top predator in the ocean. Killer whales often gather in groups of 6-8, and it is this close teamwork that they rely on for strategic planning when hunting. For example, when hunting Antarctic seals, the killer whales will create waves around the seals so that they will fall off the ice floes and then kill them as they lie on their backs [6]. The benefits of being in a group go beyond just the benefits of grouping, which include a sense of teamwork when hunting prey and the ability to repel competitors of their own class, such as hammerhead sharks and sperm whales.

In conclusion, killer whales are qualified to represent the top predators in the ocean based on their physiology and habits.

2.2 Role of Killer Whales in the Ocean

As the top of the marine food chain, the killer whale has a quantitative impact on its prey populations, such as harp seals, sea snails, and even sharks. Killer whales play an

ISSN 2959-6157

important role in controlling the numbers of these populations, and if these populations were to reproduce without killer whales, the entire marine food chain would be in danger of collapsing. As for parasites, killer whales are the hosts for their survival. The main parasites on killer whales are Cyamus orcini, Fasciola skiranini, Trigonocotyle spasskyi and nematodes. Although these parasites are benign, they can sometimes cause fatal damage to killer whales. By hunting some of the most abundant populations in the oceans, killer whales help maintain the ocean's biodiversity by making room for other, less abundant populations.

Killer whales also exist as "umbrella species" and "indicator species," and their population size and habitat often indicate the health of the marine environment. As umbrella species, many other aquatic organisms depend on killer whales to protect their habitats and calving grounds from competitors at the same food chain level. As orcas swim through the ocean, their tails stir up and down the water, aiding in the exchange of nutrients between shallow and deeper waters. The carcasses of killer whales can also be recycled by nature as food for marine scavengers and fertilizer for the seabed, which is an indispensable part of the marine environment and plays a vital role in protecting the ecology and balance of the aquatic environment.

3. Factors Affecting the Killer Whale Population

Many factors affect orca populations, mainly dietary habits, environment, reproductive habits, and migration.

Killer whales have a diverse diet and mainly hunt mammals and large fish such as sharks. Killer whales mainly hunt monodontids such as beluga and narwhal in Canadian waters, followed by bowhead whales. The hunting of bowhead whales is primarily concentrated from mid-July to September, and the targets are mostly bowhead whales. The hunt for bowhead whales is concentrated from mid-July to September, and the targets are often the calves of bowhead whales. The impact of killer whales on their prey is difficult to observe, but there are some clues. For example, bowhead whales in Canadian waters will stay in areas with more ice floes after the whales arrive, avoiding the waters where the whales are often found. There is also a tendency for prey to stay in shallow water and avoid areas where orcas have hunted, which can be particularly noticeable in beluga whales in Hudson Bay and narwhals on Northern Baffin Island. More interestingly, prey selection varies between killer whale populations; for example, the prey of killer whales living off the northern Antarctic Peninsula would be minke whales, and after hunting minke whales, the carcasses of the minke whales remaining are also given to nearby seabirds, such as southern giant petrels (Macronectes giganteus) (2) - including one white morph individual, Snow Petrels (Pagodrama nivea) (1-2), Wilson's Storm Petrels (Oceanites oceanicus) (1-3) and Cape Petrels (Daption capense) (3-5) provide the food on which they (1-3) and Daption capense (3-5) provided the food on which the whales depended. The effects of dietary habits on killer whales are more related to individual energy consumption and the maintenance of basic vital signs.

The drastic reduction in food availability and water pollution emphasizes the impacts of the marine environment on killer whales. The Antarctic killer whale population, for example, feeds primarily on chinook salmon, but over the past 50 years, territorial erosion and fisheries have decimated the wild salmon population, which has had a significant impact on their predator, the killer whale. The orcas need to change some of their behavioral patterns to get more food and nutrients to survive the winter. Pollution of the water means that toxins can change geometrically as they climb up the food chain, and orcas, at the top of the food chain, are the most susceptible to toxins. In testing stranded orcas, inspectors often detect high levels of lead, mercury, and compounds in their bodies primarily derived from human marine waste discharges, threatening orca populations to a great extent.

Regarding reproductive habits, female orcas are mature enough to conceive by the time they are ten years old. According to previous statistics, each female orca gives birth to a calf in an average of 5.3 years, with most calves being born in the fall and winter and first monitored in the summer. 1987 statistics on mature females showed a trend of lower fertility at younger ages due to human intervention, gender imbalance in the population, and compressed living space, and Dr. Eric Ward's study showed a significant increase in fertility at age ten years in a population that was threatened by marine debris discharge. In Dr. Eric Ward's analysis, it was noted that the reproductive habits of killer whales are closely related to the number of prey. In his study, Ward compared chinook salmon fecundity with orca fecundity and found that in years of high chinook salmon fecundity, orca productivity was 50% higher and that if chinook salmon populations had remained at the 1980-2006 average, 50% of female orca fecundity would have increased. However, there was a 15% reduction in fecundity. However, there is a risk of 15% lower fecundity. During periods of lower-than-average prey abundance, orcas expand their summer range and form smaller groups than before [7].

Migration is also an instinct of orca populations. For example, in the Northern Atlantic orcas population, during the winter, large groups of orcas follow their food, the NSS herring, into the Norwegian Straits, and when the

NSS herring leaves the Norwegian Straits to continue its migration, the group determines, based on the number of other prey available in the Norwegian Straits, whether to continue to follow the NSS herring or to stay in the Norwegian Straits. Remain in the Norwegian Straits. While the killer whales are migrating, many marine organisms that feed on the NSS-hering, like the killer whales, are also a source of food for the killer whales. While migrating, killer whales follow the biological clock of NSS-herring, e.g., during the day, they follow NSS-herring to deeper waters, while at night, they stay close to shallower waters. Migratory habits vary between killer whale populations, so it is difficult to define how migration would specifically affect killer whales, but more as a means for them to survive and find food.

4. Killer Whales and People: Summary of Conservation Measures and their Optimization

Killer whales are essential to the economic development of human societies and to the development of the marine economy. “Whale watching is a major contributor to the tourism industry, generating up to US$290 million annually. The human fishing industry sometimes uses killer whales’ sounds to help drive away fish. However, the harm brought to the killer whales by the pollution of the marine environment is also substantial; in addition to the heavy metals mentioned above, there are often killer whales and fishing boat collision accidents, and the residue left by the engines of the fishing boats on the sea surface will seriously affect the respiratory system of the killer whales, which may cause some respiratory injuries, as well as the sound of the engines of the fishing boats will be the bottom of the sea caused by “noise pollution The sound of the engines of the fishing vessels will cause “noise pollution” on the seabed, which will interfere with the echoes of the killer whales and their communication system [8].

Most of the current conservation measures for killer whales focus on protecting their food sources, reducing marine pollution, and controlling undersea noise. Although these programs have begun to spread in Washington State and some coastal areas in the United States, and some achievements have been made, the programs still need to be optimized. As Dr. Ward mentioned in his study, two issues should be clarified in the protection of food sources: how long the killer whales can withstand the absence of food sources and the specific nutritional value of the killer whales’ food, which need to be monitored and studied more precisely. As for reducing marine pollution, there is a need to popularize the method and the relevant laws in more areas, focusing on those countries that rely on fisheries to survive, and there is a need to collaborate with the local government through the orca conservation organizations. To control undersea noise, it is essential to understand how much noise can disrupt orca communication and the navigation system during migration and to set sound limits and regulations accordingly.

5. Conclusion

In summary, orcas are a team player and as top predators in the oceans, they serve as “indicator species” and maintain the balance of the marine food chain. The main factors affecting orca populations are the amount of pollutants in the sea and the sharp decrease in the amount of food available, which in turn determines the amount of food available to the orcas. Currently, the main conservation measures for orcas are the enactment of legislation related to marine pollution discharges, such as in the state of Washington, as well as the control of fisheries organizations and the dissemination of relevant information.

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