Communication Between Marine Mammals: Understanding their Social Structure

Morgan Harrison

BIOL 405W

Dr. Christopher Osgood

November 17, 2024

Abstract

Marine mammals present a very interesting tapestry of both vocal and non-vocal communication strategies, crucially relating to their social structures and interactions. This essay discusses the intricacies of marine mammals in communicating, especially in the diversity and complexity of their interactions. Within species, communication can range from the melodic songs of humpback whales to the intricate whistles and clicks of dolphins, serving not only for navigation and foraging but also to reinforce social bonds and hierarchies. Non-vocal communication, like body movements, bubble emissions, and tactile interactions, further enriches these social interactions, allowing for a nuanced and multi-faceted dialogue within their communities. Cross-species communication is also discussed, giving evidence of how different species of marine mammals, such as dolphins and pilot whales or even humans, cooperate with each other and understand one another. These interactions point out the adaptability and intelligence of marine mammals, which can establish complex social networks even beyond their own species.

The essay also touches on the effect of human activities on these fragile communication systems. Noise pollution from ships and industrial activities intrudes into the acoustic environment, causing stress, changes in behavior, and impaired communication among marine mammals. Technology, while helpful in certain research and conservation aspects, is also a challenge as it sometimes interferes with natural communication channels. Exploration hereby completes with an elaboration of the state-of-the-science attempt in mitigating our impact on this and educating us more in marine mammal communication by using up-and-coming technology. Ultimately, only then-perceived appreciation for knowledge of the amazing creature itself will continue trying to secure complex social life and perhaps assure their continuity for survival with no end into this highly loaded noisy and cramped oceanic atmosphere. This essay seeks to provide a comprehensive overview of the complex communication strategies of marine mammals, the importance of these interactions within and across species, and the urgent need to balance human progress with the conservation of our oceanic neighbors' natural habitats and social systems.

Introduction

Marine mammals are one group of animals that include dolphins, whales, seals, and manatees. The animals have developed a wide variety of communication methods and complex social structures that are important in the continuity of life and interactions. Their intelligence makes them rely mostly on vocal and non-vocal communications to cope with the environment, form social ties, and coordinate activities. These ways of communication and the social structure further the understanding of their behaviors and functioning ecosystems. Marine mammals communicate in various ways, depending on their species, environmental necessities, and social contexts. For example, dolphins whistle and click, whales are famous for their songs, and seals bark or growl to convey messages. These variations in communication can be likened to the different languages spoken by human societies, where each species has developed its unique "language" adapted to its surroundings and lifestyle. Interesting, most species of marine mammals tend to display the ability to understand the body language of other species much as humans understand when a person is angry or happy without actually being told. This helps in cooperative behaviors such as hunting or navigation and increases their survival chances.

The social structures of marine mammals range from solitary lifestyles to highly social groups. Species like the blue whale tend to lead solitary lives, while others, such as orcas and dolphins, form tight-knit pods or families. The preference for solitude or group living is often influenced by factors such as predation risk, food availability, and reproductive strategies. In such cases, different species often come to understand the social structures of these other species when they communicate with them. For instance, a pod of dolphins will recognize the hierarchical orca pod structure and look at mitigating behavior. These social dynamics are really important to the understanding of marine mammal coexistence and interaction in their ecosystems.

The study of communication and social structures in marine mammals is important for a number of reasons. In addition to learning how different species interact and coexist, it provides a better understanding of their migration patterns, reproductive behaviors, and responses to environmental changes. This knowledge can also be used to aid in the conservation of these species, helping protect them from human activities that may harm them. The threefold objectives of this paper are to show how the marine mammals communicate, their interactions with each other species, and relate these communicating methods to the social structure. By examining these elements, the paper will reveal some of the complex and captivating aspects relating to the behavior of marine mammals, as well as the importance of preservation of the natural habitats for these organisms.

Types of Marine Mammals

Marine mammals are a fascinating and diverse group of species that have uniquely adapted to life in aquatic environments. These adaptations are not only physical but also behavioral, influencing how these animals communicate, socialize, and interact with their surroundings. Knowledge of the different types of marine mammals and their particular

characteristics gives insight into their evolutionary success and ecological roles. Cetaceans, an order encompassing whales, dolphins, and porpoises, are among the most well-known marine mammals. Their streamlined, spine-like body shape allows them to glide effortlessly through water. Adaptations such as vestigial hind limbs and clawless front flippers contribute to their aquatic efficiency. Cetaceans are also marked by not having sweat glands, hairless bodies, and insulating them in water with thick layers of blubber to keep them warm. These mammals are fully aquatic and cannot survive on land. Two types of cetaceans are whales and dolphins. The whales are the giants of the sea that are well-known for their remarkable size and complex vocalizations, which are also well-known as whale songs. They form part of the vital mode of communication and social interaction. Dolphins represent a class of marine animals noted by their intelligence and jolliness and are very social living in a group known as a pod. Whistles and clicks produce this mammal's various use of echolocation and intra-society communication.

Pinnipeds are seals, sea lions, and walruses. Their bodies are torpedo-shaped, with wide torsos and narrow hindquarters, adapted for swimming. Unlike cetaceans, pinnipeds have short, stout flippers with claws on their fore flippers, which they use to crawl on land. Although pinnipeds are aquatic animals, they can spend a considerable amount of time on land, resting or raising their young, but their small front flippers limit their mobility on land compared to terrestrial animals. Seals adapted more to aquatic life, seals make various calls, especially during the breeding season. Their bodies are well-streamlined for swimming but not as agile on land. Sea Lions are recognized by their loud barks and social nature. Sea lions are more agile on land than seals because of their larger front flippers, which enable them to "walk" on land. Sirenians are commonly referred to as sea cows. The manatees and dugongs belong to this group. These marine mammals are herbivorous, with two flipper limbs at the front and a big paddle-like flipper at the rear. They have some characteristics in common with cetaceans, like having thick skin with little hair to insulate them in their aquatic environments. Sirenians are slow-moving and generally found in shallow coastal areas and rivers, where they feed on aquatic vegetation. Manatees are referred to as gentle giants, and they have been described as slow-moving animals. Manatees are docile and are considered important browsers that maintain aquatic ecosystems.

The differences among cetaceans, pinnipeds, and sirenians further illustrate the divergent evolutionary paths of marine mammals. Cetaceans have evolved to be highly specialized for life in deep and open waters, developing sophisticated echolocation abilities and streamlined bodies. Pinnipeds, having adapted to life both on land and in water, have physical features that enable them to excel in both environments. Sirenians, though fully aquatic like cetaceans, have evolved to eat only aquatic vegetation, which affects their slower pace and habitat preferences. Understanding such differences underlines the adaptability and ecological significance of marine mammals. Their various methods of communication, social structures, and physical adaptations show the complexity of life in the marine environment and, when studied, can yield valuable insights into the functioning of oceanic ecosystems.

The Types of Communication

Marine mammals have a very rich diversity in their methods of communication, which are important for their survival and social interactions. These can be broadly categorized into vocal and non-vocal communications. Understanding these various types of communication provides insight into the complex behaviors and social structures of these fascinating creatures. Marine mammals heavily utilize vocal communication in interacting with each other. This includes whistles, clicks, songs, calls, and other forms of vocalizations. Dolphins are well-known for their distinctive whistles and clicks used for echolocation and social interaction. Whales, especially humpback whales, produce elaborate songs that can travel great distances underwater. These vocalizations are often used during mating seasons and have been shown to vary significantly among populations, suggesting a form of cultural transmission. Seals, sea lions, and other marine mammals use a variety of calls and vocalizations to communicate. These can include barks, growls, and grunts, which are used for a range of purposes such as mating calls, territorial signals, and alerts to the presence of predators. Vocal communications also vary greatly between different species due to differences in their anatomy, habitat, and social structures. Whale songs are different in frequency and pattern from dolphin whistles and clicks. Although some evidence does exist that species utilizing similar clicks can understand each other, the degree of this communication across species remains a subject of study.

Non-vocal communication is also used among the marine mammals. These can also be as complex and pertinent in their social interactions. Marine mammals primarily depend on body language for communication. It ranges from breaching to slapping the tail and spy-hopping. The mentioned different postures express a message. Such postures may tell something about their status in a society, warning call, or inviting signal for playful activities. Tactile communication is vital in terms of bonding, and in the case of mothers and their young. Touching, rubbing, and other ways of physical contact reinforce social ties and soothe feelings. Dolphins, above all, use bubbles as a means of communication. This goes to form bubble rings and other shapes with the ability to denote playfulness, curiosity, or even aggression. It's very common for other species to notice other species' body language: for example, a shark or a sea lion. Dolphins, on the other hand, might understand an aggressive or playing shark and sea lion. This is essential to interpret non-vocal cues, that actually enhance their survival and interactions with their environment.

Social Structures in Marine Mammals

Marine mammals span a wide range of social structures, from highly organized groups to solitary lifestyles. “Predictable patterns of organization have been found which provide insights into the adaptive significance of the social systems. Until recently, available information for cetaceans has been inadequate to allow construction of comparable models” (Wells 1987). Such social structures are closely related to the methods of communication and environmental needs, hence shaping their interactions and behaviors. Dolphins are one of the marine mammals that have an advanced social structure and always live in large groups called pods. These pods can range in size from just a few individuals to hundreds of animals, depending on the species and

the particular environmental conditions. The behavioral patterns of dolphins are very coordinated, such as hunting in groups herding fish, or in social playing to maintain social bonds and facilitate communication within the pod. The social structures of dolphins can be quite dynamic, and the individuals have very strong and long-lasting relations, somewhat like friendships in humans. Humpback whales are usually solitary animals that come together only during the feeding and mating seasons. In such cases, they create temporary groups called feeding aggregations or mating pods. It is thought that their solitary lifestyle decreases competition for food and mates. “The male or bull whales seem to separate from the cows and calves when about the size of 35 barrels” (Best 1979). However, songs in humpback whales, which may be projected over considerable distances, have become an essential method of communication in such social interactions and play a vital role in territorial establishment and attraction of mates. Seals are social animals that live in colonies. During the mating period, seals show a division in their social status. Dominant males set up territories and advertise them through vocalizations, threatening postures, and battles. Territories are crucial in the attraction of females, hence ensuring the continuity of genes. The social organization of seals is visibly based on a dominance hierarchy that helps in maintaining order and minimizing conflicts within a colony. Like seals, walruses have a social system based on dominance and competition. Male walruses compete for territories and access to females, especially during the breeding season. These social interactions are often marked by vocalizations, physical displays, and sometimes aggressive encounters. The social bonds among walruses are strengthened by their shared haul-out sites on land or ice, where they rest and socialize.

Social relationships among marine mammals are an essential ingredient to their survival and lifestyle. In most species, considerable bonds exist between mothers and offspring. A baby whale will have no problem in recognizing its mother's call. “Molecular typing revealed that pod members form a single extended family. Mature males neither disperse from nor mate within their natal pods, a situation unusual for mammals. Such behavior could be explained in terms of inclusive fitness benefits gained by adult males helping the large number of female relatives with which they swim” (Amos 1993). For that, this has very essential implications to keep in touch within an immense ocean. The pups of sea lions rely on the sound their mothers make to identify them from hundreds of individuals in busy rookeries. While manatees are rather solitary and basically only communicate with their own species through vocalizations and physical contact that is essential at the time of copulation or mother-calf interactions.

The interactions between different species of marine mammals are proof of their adaptability and how complex their social structures are. “Like the elephants and most primates, many odontocetes lead rich social lives. A few long-term field studies, in which individual whales and dolphins are identifiable and sometimes genetically typed, allow us to make more detailed comparisons with terrestrial species than was previously possible” (Connor 1998). Dolphins and pilot whales have been observed communicating and sometimes cooperating in hunting. These interspecies interactions will reveal the capability for marine mammals to comprehend and respond to the behaviors and signals of other species for mutual benefits. In similar manners, orcas and humpback whales do interact, with orcas sometimes assisting the humpbacks in driving away predators.

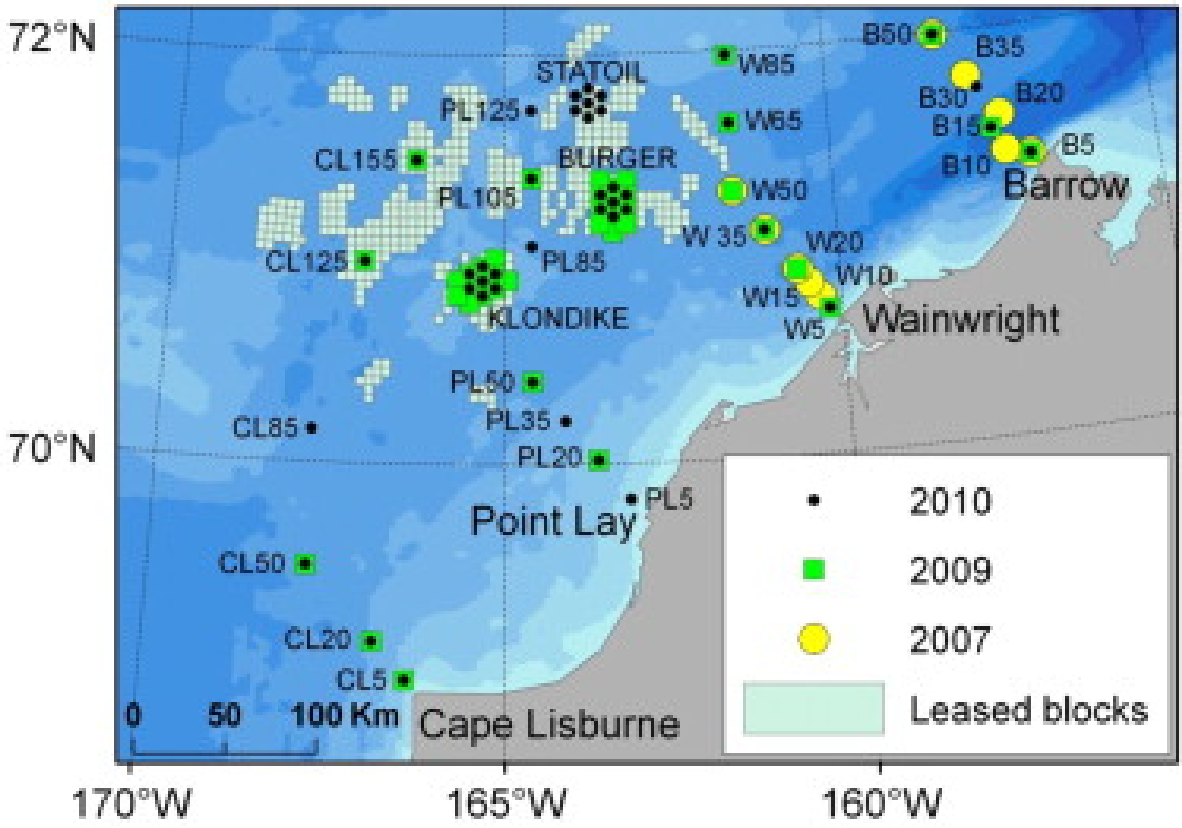

Figure 1Acoustic recorder locations for the 2007, 2009, and 2010 summer deployments in the northeastern Chukchi Sea (Hannay 2013)

This intensive monitoring program, as described in Figure 1, consisted of deployments of recording stations in each of the three main study areas: Burger, Klondike, and Statoil. “Arrays of autonomous acoustic recorders were deployed in the northeastern Chukchi Sea to monitor nearly continuously from July 2007 to August 2011” (Hannay 2013). In this figure, the station names were succeeded by numbers that reflected how many statute miles the station was from shore; different water depths were represented by the range of blues. These deployments captured a rich set of information on the acoustic environment of marine mammals in the area, helping the research team to discern patterns of communication and social structure. The deployment of acoustic recorders was very important in enhancing our understanding of the communication of marine mammals. This can be done by continuously monitoring the soundscape to know the species present and their calling patterns throughout the year. The resultant data is very important in understanding how changes in environmental factors, like seasonal changes and human activities, affect the behavior of marine mammals. The case study illustrated the facilitation of technology in studying marine mammal communication and their social structures. Acoustic recorders can capture from very low-frequency calls to very high-frequency songs and even echolocation clicks; these sounds are important for the social behavior, orientation, and hunting of animals. It is also from these records that mapping of

communication networks and social hierarchies within and between species by scientists is possible.

The results of this case study have important implications for conservation. Knowledge of the acoustic environment and communication patterns of marine mammals helps in identifying critical habitats and periods of high activity. This information forms the backbone of effective conservation, by establishing marine protected areas and regulating human activities that generate underwater noise. In addition, the continuous monitoring data can feed into the formulation of noise mitigation strategies that human activities, such as shipping and industrial operations, do not interfere with the communication channels that marine mammals naturally use. Preserving the acoustic environment can support the social structures and overall well-being of these species. The application of autonomous acoustic recorders in the Chukchi Sea becomes, in effect, a specific case that vividly illustrates the possible use of technologies in studies related to marine mammal communication and social structures. These findings point out the great significance of continuing acoustic monitoring to study and perform the conservation of marine mammals.

Climate Effect on Marine Mammal Communication

Climate change has resulted in significant reductions in sea ice, most particularly in the Arctic and Antarctic regions. The loss of sea ice to species such as polar bears, seals, and walruses is not only destruction to their home but also affects their social structures and ways of communication. These animals depend on sea ice for breeding, resting, and hunting. The melting ice compels them to shift their ranges to other locations, where they may face increasing competition and shifts in their social structures. Marine mammals, such as whales and dolphins, migrate over long distances. These migrations usually occur simultaneously with seasonal water temperature changes and the availability of food. With climate change, ocean currents and water temperatures are altered, thus disrupting the normal course of these migrations. The consequence could be a lack of communication because groups may be separated, or this may involve having to adopt new ways of communicating in unfamiliar environments. Altered migration can also affect mating and feeding behaviors, further influencing social structures. In most marine mammals, acidification of the ocean, resulting from the increase in carbon dioxide levels in the atmosphere, may also degrade their sensory capabilities. As it may affect the echolocation ability of dolphins and whales, it might be difficult for them to navigate, hunt, and communicate in the ocean. Changes like these can disrupt social structures since these animals rely heavily on their acoustic environment to maintain social relationships and organize group behaviors.

With the melting of sea ice, areas previously inaccessible to shipping and industrial activities are opening up, which increases noise pollution. This interferes with marine mammals' vocalizations and hampers their communication over long distances. For cetaceans dependent on sound for social cohesion, this may have serious repercussions for their social structures and general welfare. Climate change alters the distribution and abundance of prey species, forcing marine mammals to alter their foraging strategies and social behaviors. For example, changes in krill populations can impact baleen whales that depend on these small crustaceans for food. As prey availability becomes more unpredictable, marine mammals may need to travel further and expend more energy to find food, affecting their health and social interactions.

Understanding and Mitigation of Impacts: It is important to study the impacts of climate change on marine mammal communication and social structures in order to develop effective conservation strategies. By understanding how environmental changes affect these animals, scientists can propose measures to protect critical habitats, regulate human activities that exacerbate these issues, and enhance international cooperation on climate action. Other mitigations include marine protected areas, the development of quieter technologies for ships, and the reduction of greenhouse gas emissions. Continuous monitoring and research are also necessary to follow up on the changes in a timely manner and adapt conservation strategies accordingly.

Human Impact on Marine Mammal Communications

The interaction between humans and marine mammals has had significant implications for how these animals communicate and interact with their environment. Human activities have disrupted the natural communication channels of marine mammals, posing both challenges and opportunities for their conservation and well-being. Human activities such as fishing, shipping, and industrial operations have created tremendous noise pollution in marine ecosystems. For example, the presence of constant fishing boats produces enough underwater noise to mask the vocalizations of marine mammals, making communication, navigation, and foraging problematic. These disturbances, resulting from such activities, may increase stress levels and modify behaviors in ways that have the potential to affect the health and survival of marine mammal populations.

Many conservation programs with a pure heart and the right mindset still end up harming marine mammals unwittingly. Marine protected areas can displace long-established migration or feeding habits of marine mammals, affecting changes in their communicative behaviors and social constructions. Past research into marine mammals sometimes used invasive techniques and even approaches considered unethical today, which has taken its toll on the populations of these creatures. In addition to causing physical injury, this has disrupted normal behavior and communication within social groups. Notwithstanding the challenges, positive outcomes have resulted from the interaction between humans and marine mammals. Humans have, in some instances, created avenues for interaction between different species, hence enhancing interspecies communication and cooperation. For example, studies and conservation programs have put dolphins and whales together; such interactions have led to observations of interspecies communication and interaction. These interactions have shown much about the adaptability and intelligence of marine mammals through their ability to understand and respond to the behaviors of other species.

Moreover, the knowledge of advanced technology has also enhanced the ability of researchers to study marine mammal communication, thus improving conservation strategies. Non-invasive techniques, such as passive acoustic monitoring, enable scientists to monitor vocalizations and behaviors without disturbing the animals. This has led to a greater

understanding of the communication and social structures of marine mammals, thus informing more effective conservation efforts.

Technological Impact

The impact of technology on marine mammal communication is a highly significant and sensitive topic. Human activities, especially those with the involvement of advanced technologies, can either interfere with or improve the communication systems of marine mammals. This section looks at the dual nature of technology's influence: disruption caused by military and naval operations and the potential of technological advancement to foster new forms of communication between species. Submarines and naval ships are huge sources of underwater noise pollution that may seriously disturb the communication of marine mammals. These vessels produce different kinds of sounds, from low frequency to high frequency, which may interfere with various clicks, whistles, and calls that marine mammals use. The noise generated from submarines, especially when conducting sonar, may overlap with the frequencies marine mammals use for echolocation and communication. This can create confusion whereby important sounds to these animals for navigation, hunting, and social interaction are masked. Such sudden, loud noise from sonar may cause physical damage like hearing loss or disorientation that further disrupts natural behavior. The naval vessels produce a background noise continuously, sometimes incomprehensible to human ears. It interferes with the marine mammals' acoustic environment. This constant kind of noise reduces the effective communication ranges of vocalizations, and as such, marine mammals find it difficult to get a mate, coordinate group activities, or alert others about dangers. Such disruptions can lead to increased stress levels and changes in social dynamics, affecting the overall health and survival of marine mammal populations.

Although some technologies have interfered with marine mammal communication, the evolution of technology also promises to improve our understanding of and possibly assist marine mammal communication in new ways. Bridging inter-species communication: Advanced technology can facilitate communication between different marine mammal species. For example, underwater communications devices that mimic the sounds of different species can enable interactions that are otherwise not possible. This could foster better cooperation among species and improve their survival chances within the same habitat. Research and Conservation: Passive acoustic monitoring and AUVs are some of the technologies that let researchers study marine mammal communication in ways they never could before. These non-invasive tools can record and analyze vocalizations without disturbing the animals, providing valuable data on their social structures, behaviors, and responses to environmental changes. These patterns should, in turn, be useful in the elaboration of better conservation strategies for these animals and their habitats. There are efforts to reduce human-generated noise and its impact on marine environments. Quieter ship engines, modifications in propellers, and alternative sonar techniques have all been developed to minimize noise pollution so that the disruption of communication among marine mammals can be reduced.

Concluding Statements

In the vast, underwater expanse of our oceans, marine mammals show remarkable diversity and complexity in their method of communication and social structure. These creatures, from the jovial dolphins to the solitary humpback whales, have an incredibly rich array of vocal and non-vocal communicative abilities, which are central to their survival and social interactions. These methods of communication will fall under a study for further insights into these elaborate lives of amazing animals. These various orders of marine mammals have distinctively developed some very particular physical and behavioral specializations that enable them to communicate and establish social patterns. Cetaceans are aquatic mammals with streamlined bodies, possessing complex vocalizations that enable communication through whistles, clicks, and songs that can travel over long distances underwater. Pinnipeds use a series of vocal calls and visual displays to establish hierarchical relationships and to interact with each other in their colonies. Sirenians, on the other hand, are more low-key in their communications, using soft vocalizations and tactile behaviors, which mirror their slow-paced, more solitary lifestyles.

Social structures among marine mammals reflect the great deal of importance attached to maintaining communication for their social bonds. For example, dolphins live in highly structured groups, or pods, and hunt and play together as a coordinated unit. Humpback whales are typically solitary animals, but they gather during feeding and mating seasons, using their songs to communicate. Seals and walruses can be found in social hierarchies, with dominant males that control territories and access to females, and manatees are loners, only interacting for the purpose of mating. Human activities have impacted the communication of marine mammals significantly, both positively and negatively. The addition of noise pollution from fishing boats, naval ships, and submarines has disrupted the natural acoustic environment, making it difficult for marine mammals to communicate effectively. While often beneficial, conservation efforts sometimes unintentionally interfere with natural behaviors and communication patterns. Conversely, technological advancements have provided tools for better understanding and mitigating these impacts, and have even facilitated interspecies communication in some cases.

The study of marine mammal communication and social structures is not only fascinating but also important for conservation. By understanding how these animals interact with each other and their environment, scientists can come up with strategies to protect them from the adverse effects caused by human activities. It also helps in preserving the rich biodiversity of our oceans, thereby enabling future generations to continue marveling at the wonders of marine life. Thus, it is the balance between communication and social structure-and human impact to these-which all compose the sensitive status that exists in an effort to maintain healthy, sustainable marine mammal populations. The growth of interest in these animals and their societies serves to perpetuate a better understanding necessary in creating a balance in which humans and marine mammals coexist together within an environment they share. This holistic approach to conservation emphasizes the need for protecting their natural habitats and corridors of communication, which are essential for the survival of these remarkable animals.

References

Best, P. B. (1979). Social organization in sperm whales, Physeter macrocephalus. In *Behavior of marine animals: Current perspectives in research* (pp. 227-289). Boston, MA: Springer US.

Bill Amos et al., Social Structure of Pilot Whales Revealed by Analytical DNA Profiling.Science260,670-672(1993). https://doi.org/10.1126/science.8480176

Connor, R. C., Mann, J., Tyack, P. L., & Whitehead, H. (1998). Social evolution in toothed whales. Trends in ecology & evolution, 13(6), 228-232. https://doi.org/10.1016/S0169-5347(98)01326-3

Hannay, D. E., Delarue, J., Mouy, X., Martin, B. S., Leary, D., Oswald, J. N., & Vallarta, J. (2013). Marine mammal acoustic detections in the northeastern Chukchi Sea, September 2007–July 2011. *Continental Shelf Research*, *67*, 127-146.

Wells, R.S., Scott, M.D., Irvine, A.B. (1987). The Social Structure of Free-Ranging Bottlenose Dolphins. In: Genoways, H.H. (eds) Current Mammalogy. Springer, Boston, MA. https://doi.org/10.1007/978-1-4757-9909-5_7