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The Vulnerable Olive Ridley Turtle: Global Threats And The Path To Conservation

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Abstract

Sea turtles, especially the olive ridley (*Lepidochelys olivacea*), are integral to marine ecosystems, contributing significantly as predators, prey, and hosts within diverse marine environments. Despite their ecological importance, all sea turtle species, including olive ridleys, face severe population declines, with the olive ridley classified as vulnerable on the IUCN Red List. This review focuses on the species' distribution, habitat, feeding habits, ecological roles, and threats, particularly those faced by olive ridleys in the western Pacific. Key threats include illegal egg harvesting, bycatch, marine pollution, and climate change. Conservation efforts, such as community-based programs and the use of Turtle Exclusion Devices (TEDs), have shown some success in stabilizing populations in certain regions, particularly in the Americas. However, the rapid decline in other areas underscores the need for enhanced global conservation strategies. Addressing emerging challenges such as rising temperatures and plastic pollution is critical for ensuring the long-term survival of olive ridleys and the ecosystems they support.

Keywords: Olive ridley, marine environment, vulnerability, conservation.

INTRODUCTION:

Sea turtles are crucial to maintaining healthy ocean ecosystems, contributing significantly to the evolution, structure, and dynamics of multiple marine environments. They play various roles as prey, consumers, hunters, competitors, and hosts for other organisms, making them key participants in interspecific interactions [1]. Given their influence on marine ecosystems, sea turtles are considered potential bioindicators of ecosystem health. Despite their importance, sea turtle populations have been declining worldwide, with all species now classified as vulnerable, endangered, critically endangered, or near threatened. The olive ridley (*Lepidochelys olivacea*), one of the smallest and most abundant sea turtles, faces significant threats, particularly in the western Pacific where populations have drastically declined. Once considered resilient to exploitation, industrial extraction between the 1960s and 1980s caused severe population crashes, leading to the species' endangered status on the IUCN Red List [2]. Olive ridleys, named for their olive-green heart-shaped shells, are known for their mass nesting events, or "arribadas," in select locations like Costa Rica, India, and Mexico. However, less is known about populations in other, lower-density nesting sites around the world, particularly in Southeast Asia and the western Pacific, where egg harvesting has severely depleted numbers [3]. Olive ridleys exhibit great behavioural plasticity, migrating through oceanic waters to feed on surface fauna or staying in shallow coastal waters to hunt invertebrates. Their nomadic behaviour enables them to adapt to dynamic ecosystems, which has helped them remain the most abundant sea turtle species. Nonetheless, slow growth rates and increasing human activities—such as coastal development, fishing, and habitat destruction—continue to threaten the long-term survival of olive ridley populations. Beach erosion, artificial lighting, and predation further degrade their nesting habitats, endangering many rookeries worldwide [4].

In oceanic waters, olive ridley turtles face numerous threats, including harmful algal blooms, climate change, bycatch, directed fishing net capture, marine litter, and contamination, all of which can be fatal. Assessing their risk of extinction is challenging, as it requires a deep understanding of global trends over generations. Population size fluctuations are central to determining their conservation status [5]. Although monitoring the size of arribadas has been difficult, local conservation initiatives have provided valuable data for status assessments. Decades of efforts, such as nesting beach protection and bans on sea turtle commerce and direct capture, particularly in the Americas, have shown promising trends. In the last two decades, most arribada rookeries in the Americas have exhibited positive or stable population trends, while those in Asia continue to decline rapidly [6]. Despite global efforts to protect olive ridleys, the species is still experiencing a fast population decline compared to the past. This underscores the need for continued and enhanced conservation strategies to safeguard the future of olive ridley turtles [7]. The present review focuses on distribution, habitat, food behaviour, ecology, food resource, threats and vulnerabilities to the olive ridley turtles.

Distribution:

The olive ridley turtle (*Lepidochelys olivacea*), often referred to as the Pacific ridley, is a small sea turtle species belonging to the Cheloniidae family. Its name comes from the olive green color of its heart-shaped shell, or carapace. As the world's second-smallest sea turtle species, the olive ridley is closely related to the Kemp's ridley, a species endemic to the Gulf of Mexico. A distinctive behavioral trait of olive ridleys is their synchronized mass nesting, known as arribadas, where thousands of females gather on the same beach to lay eggs. This species is considered the most prolific sea turtle globally, with an estimated population of at least 800,000 nesting females each year [8]. Olive ridley turtles are widely distributed across tropical and subtropical waters of the Pacific, Atlantic, and Indian Oceans, particularly in the Indo-Pacific region. They exhibit a flexible migratory lifestyle, adapting to a variety of habitats. In the Pacific, they are mostly found in oceanic zones, while in the Atlantic, they tend to occupy neritic areas near coastlines.

The species can travel vast distances between feeding and breeding grounds, sometimes covering thousands of kilometers. The most significant arribada nesting sites are located on the Pacific coasts of Mexico, Costa Rica, and northeast India, with some nesting sites also found along the Atlantic coasts of South America, the west coast of Africa, and various islands across the tropics [9]. Historically, Mexico has hosted the largest arribada sites, with Playa La Escobilla being the most prominent. However, between the 1960s and 1990s, overexploitation due to the sea turtle and shrimp fisheries caused a dramatic decline in olive ridley populations. After the Mexican government enacted a permanent ban on turtle exploitation in 1990, populations rebounded significantly. In addition to Mexico, Central American countries like Panama, Nicaragua, and Costa Rica also host major arribada events, with Ostional in Costa Rica being the largest site in the region. In India, mass nesting occurs along the east coast in Odisha, with arribada numbers fluctuating in response to environmental changes. Although human activity has historically been blamed for the decline of some arribada populations, environmental factors such as organic debris buildup and beach topography also play a significant role in the success or failure of these mass nesting events [10].

Feeding habits:

Olive ridleys inhabit coastal bays, estuaries, and occasionally oceanic waters, often within 15 km of coastlines in shallow marine waters. They travel long distances to participate in mass nesting events, or arribadas, returning to their birth beaches to lay eggs. Outside of reproductive periods, they forage in diverse habitats, including coastal and continental shelves, feeding on pelagic and benthic prey. As generalist feeders with strong jaws, olive ridleys consume jellyfish, crustaceans, sea urchins, fish, and algae. However, their omnivorous diet makes them vulnerable to ingesting marine litter like plastic bags, which poses significant risks [11].

Ecological roles:

Sea turtles, including olive ridley turtles, are integral to the planets food web and play a crucial role in maintaining the health of the world's oceans. As predators of invertebrates, olive ridleys help regulate populations and maintain ecological balance in both coastal and marine ecosystems. Additionally, they contribute to nutrient transport, moving essential nutrients from feeding areas to nutrient-depleted coastal environments near nesting beaches [12]. The unhatched eggs and eggshells left on beaches act as natural fertilizers, promoting vegetation growth and stabilizing coastlines while providing nourishment for various animals, invertebrates, and microorganisms. By supporting diversity across reefs, seagrass meadows, and open ocean ecosystems, sea turtles are essential for sustaining healthy marine environments, underscoring the need to protect and rebuild their populations [13].

Current status:

The global population of olive ridley turtles has experienced a significant decline over the past few decades, with only 1 to 8% of eggs laid during arribadas successfully hatching due to illegal egg poaching, turtle hunting, and nest destruction. Between 1988 and 2008, the population decreased by 28 to 32%, and by 2013, their numbers had dropped by more than 30% globally. Once estimated to be at least 10 million in Pacific Mexico, mass exploitation drastically reduced their population, leading to their classification as vulnerable by the IUCN. By 2008, the global population of annual nesting females had fallen to approximately 852,550, signaling a sharp decline within just one generation [14].

Vulnerabilities and Threats for the Olive Ridley Turtle

Despite laws prohibiting turtle killing and egg collection, illegal trade and consumption of sea turtle eggs and meat continue, driven by cultural beliefs and demand for exotic dishes. Olive ridley turtles are particularly vulnerable due to their arribada nesting behavior, which makes mass egg harvesting easier on beaches near dense human populations. This long-term exploitation has significantly contributed to the species' global decline [15]. Sea turtle bycatch, particularly in shrimp trawl nets, longlines, and gill nets, is a significant global concern. Bycatch, the unintentional capture of non-target species, can lead to drowning or fatal injuries. Olive ridleys are particularly affected, with over 100,000 turtles estimated to have died in Odisha, India, between 1993 and 2003 due to fishing practices. Similarly, nearly 700,000 olive ridley turtles were trapped by longline fisheries in Costa Rica between 1999 and 2010, contributing to the decline of nesting populations on arribada beaches [16]. Entanglement in abandoned fishing nets and debris can quickly kill sea turtles by drowning or preventing them from escaping predators or hunting. Sea turtles, including olive ridleys, frequently ingest plastic debris from fishing gear and are prone to becoming tangled in ghost gear. Foraging areas often overlap with trawl fishery zones, increasing the risk of entanglement in longlines and shrimp nets. In the Maldives, 131 sea turtles were reported entangled in trawl or gill nets over five years, with olive ridleys accounting for 97% of incidents. The accumulation of plastic debris at nesting sites also endangers adult females and hatchlings, preventing them from reaching the sea [17].

Olive ridley sea turtles face frequent attacks from wild animals like raccoons, coyotes, jaguars, and semi-domesticated animals such as dogs and cats, especially when they approach beaches to lay eggs. Predators like sharks, killer whales, and saltwater crocodiles target adult turtles, while opportunistic predation by animals like feral pigs, birds, and crabs threatens eggs and hatchlings. Additionally, ants, sapro-necrophagous beetles, and bacterial or fungal infestations on beaches can severely impact hatching success, contributing to the population decline of olive ridleys in areas like Nancite, Costa Rica [18]. Fibropapillomatosis (FP), a transmissible disease associated with Chelonid alphaherpesvirus 5 (ChHV5), poses a significant health concern for sea turtles, including olive ridleys. First observed in olive ridleys at Ostional National Wildlife Refuge, Costa Rica, in 1982, FP was confirmed through histopathology and later detected in both diseased and healthy tissues. The disease has since been reported in various regions, including Mexico, Nicaragua, India, and the U.S., with sightings becoming increasingly frequent. While no conclusive epidemiological data exist on its population impact, FP remains a potential threat to olive ridley populations, influenced by genetic and environmental factors [19]. Olive ridley turtles may consume marine waste, such as fishing lines, plastic bags, and oil, mistaking them for food. A plastic bag, for instance, can resemble jellyfish or algae, which turtles often consume. Marine debris has been found in dead olive ridleys and in the nostrils of live ones in Costa Rica. Ingested plastic disrupts metabolism, introduces toxins, and can cause intestinal blockages or buoyancy issues, stunting growth and reproduction. Pesticides, heavy metals, and PCBs have been detected in turtles and their eggs, potentially causing stress and health issues, with concerns about the consumption of contaminated eggs by humans [20].

Oil pollution in nearshore and offshore marine environments has posed a threat to sea turtles for decades, impacting eggs and hatchlings as well. Oil spills can severely affect the lungs, skin, blood, and salt glands of marine animals, including sea turtles. Furthermore, feeding areas often overlap with regions of mining and oil or gas exploration, presenting an additional risk to the health of these turtles [21]. Sea turtles face significant threats from vessel collisions, especially in busy ports, waterways, and during their oceanic migrations. When near the surface, they are vulnerable to being struck by various types of watercraft, leading to injury or death. This risk is particularly high for adult sea turtles, especially nesting females, during reproductive migrations and the nesting season near shorelines [22]. Climate change is posing significant threats to the habitat and biology of olive ridley turtles, particularly through rising temperatures and changes in beach morphology. Warmer sand temperatures on nesting beaches can be fatal to turtle eggs and disrupt the sex ratio of hatchlings, as sea turtle sex is determined by incubation temperature. Higher temperatures lead to predominantly female hatchlings, with temperatures over 31°C producing mostly females, and temperatures above 35°C being lethal to embryos. This imbalance could reduce genetic diversity and hinder the long-term survival of sea turtle populations. In addition, storms and rising sea levels contribute to beach erosion, flooding nests, and washing them away. Changes in food supply and habitat availability in the marine environment may further alter the turtles migratory patterns and nesting seasons. The situation is compounded by factors like coral bleaching, which threatens key habitats, especially for species like the hawksbill turtle [23]. The rise in sea levels driven by global warming is anticipated to cause a substantial loss of nesting habitats along tropical coastlines. As turtles typically lay their eggs between the mid-beach slope and the vegetation line, increased moisture from wave action could expose nests to predators and sunlight, endangering hatchlings. Efforts to combat sea level rise, such as the construction of sea walls in tourist areas, could further reduce available nesting spaces and exacerbate beach erosion [24]. Additionally, coastal development and light pollution are major threats to sea turtle hatchlings, which rely on natural light cues to find the ocean. Disoriented by artificial lights, hatchlings may head inland, where they face dehydration, exhaustion, or death on roadways. In India, coastal erosion and inundation have already led to a decline in nesting females due to shrinking beach areas, demonstrating the urgent need for conservation strategies that address these multifaceted challenges [25].

Olive ridley turtles are particularly vulnerable to climatic and oceanographic events such as the El Niño Southern Oscillation (ENSO), which affects sea surface temperatures and atmospheric pressure in the equatorial Pacific Ocean. Occurring every two to seven years, El Niño leads to increased oceanic temperatures and decreased marine productivity, both of which impact the foraging behavior of olive ridley turtles. These conditions often result in fewer female turtles nesting, as well as shifts in migration patterns and a reduction in the number of eggs laid. Despite these challenges, olive ridley turtles have demonstrated resilience to ENSO events, with populations showing an ability to recover. However, the long-term effects of ENSO on turtle abundance remain uncertain, and continued monitoring is essential [26]. In addition to ENSO, harmful algal blooms (HABs) pose a significant threat to sea turtles, including olive ridleys. These blooms, often resulting from ecosystem imbalances, involve the excessive growth of toxin-producing microorganisms such as dinoflagellates. Species like Gymnodinium catenatum, Pyrodinium bahamense, and *Karenia brevis* release neurotoxins such as saxitoxins and brevetoxins, which can lead to a range of detrimental effects on sea turtles, including altered immune function, neurological impairment, and increased mortality. In some cases, these toxins may even act as tumor promoters. Olive ridley turtles along the Mexican Pacific have exhibited symptoms of Paralytic Shellfish Syndrome (PSS) due to saxitoxin exposure, with cases reported in Bahía Banderas and Oaxaca. Affected turtles display symptoms like lethargy, motor impairment, and difficulty in breathing, and in severe cases, death. Chronic exposure to these biotoxins is believed to cause muscle weakness in the posterior flippers of nesting turtles, particularly in La Escobilla, limiting their ability to construct nests [27].

Conservation Efforts and Management Status

Although the olive ridley turtle is considered the most abundant of the seven sea turtle species, it remains under serious threat due to historical over-exploitation and habitat destruction. In the past century, widespread harvesting of eggs, along with hunting for the females' skin and flesh at nesting sites, drastically reduced their population numbers. Despite international treaties, national laws, and protective measures, olive ridleys are currently listed as vulnerable on the IUCN Red List and are included in Appendix I of the Convention on International Trade in Endangered Species (CITES) [28]. In the U.S., olive ridley conservation efforts fall under the joint jurisdiction of NOAA Fisheries and the U.S. Fish and Wildlife Service, which focus on protecting turtles both at sea and on nesting beaches. Regular monitoring of populations is conducted by

NOAA and other agencies, and various countries, including Costa Rica, Mexico, and Brazil, have implemented community-based conservation projects aimed at protecting nesting beaches and promoting ecotourism as a sustainable source of revenue for local communities [29].

Ecotourism, such as turtle watching and diving, has proven beneficial both economically and for conservation, especially when regulated to minimize the impact on sea turtles. Several countries have developed initiatives where sea turtles serve as flagship species for conservation, education, and research. Some programs, such as the communal egg collection at Costa Rica’s Ostional National Wildlife Refuge, have successfully provided sustainable income for locals while stabilizing turtle populations [30]. Additionally, fishing gear improvements, like the use of Turtle Exclusion Devices (TEDs), have helped reduce bycatch of olive ridleys, with countries like the U.S. mandating TED use in shrimp fisheries. Despite these efforts, challenges remain, as poaching of eggs and the killing of nesting females continue, along with the unintended capture of turtles in fishing nets. To prevent further decline of olive ridley populations, stronger enforcement of poaching laws and the universal implementation of TEDs are necessary, particularly in key feeding and breeding areas [31].

Conclusion and Future perspectives:

The olive ridley turtle (*Lepidochelys olivacea*) plays an integral role in maintaining the health of marine ecosystems, yet its global population has suffered significant declines due to a combination of overexploitation, habitat destruction, and human-induced threats. Although olive ridleys remain the most abundant sea turtle species, their status as vulnerable on the IUCN Red List underscores the urgency for comprehensive conservation measures. While certain populations, particularly in the Americas, have shown signs of recovery thanks to decades of protective efforts, many regions, particularly in Asia, continue to face rapid declines. Key threats, such as illegal egg harvesting, bycatch in fisheries, marine pollution, and climate change, persist as significant challenges for olive ridley conservation. Ongoing initiatives, such as the use of Turtle Exclusion Devices (TEDs) and community-based conservation programs, have yielded positive results, but global coordination and enforcement remain critical. The vulnerability of olive ridleys to emerging threats like climate change and harmful algal blooms highlights the need for adaptive strategies that address both present and future risks.

Moving forward, a combination of robust international cooperation, stricter enforcement of protective laws, and the expansion of sustainable practices, such as ecotourism, will be essential in safeguarding olive ridley populations. Enhancing monitoring efforts to track population trends, improving habitat restoration, and investing in public education will help protect nesting sites and reduce threats across their migratory routes. Addressing climate change's impact on nesting habitats and gender ratios will also be pivotal for ensuring the long-term survival of this species. With continued commitment and innovative approaches, there is hope that olive ridley populations can stabilize and contribute to the resilience of ocean ecosystems for generations to come.

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The authors declare no competing interest

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