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Study On The Impact Of Gulls And Terns On The Local Fish Population In Cochin Fisheries Harbour, Ernakulam District, Kerala, South India

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Abstract

Gulls are opportunistic feeders and can affect local fish populations, potentially impacting fisheries. This should highlight the study on the gulls and terns of the study area, Cochin fisheries harbour, Ernakulam district, Kerala. The work focused on their ecological role and relationship with the fish catch density also highlight the field surveys and data analysis. The aim of the study was to understand the abundance, distribution and behavior of these avian species, along with their impact on the local fish population. These findings shed light on the intricate ecological dynamics between these birds and the fishing activities in the region. Seagulls play a significant role in the life of a fisherman, both positively and negatively. On the other hand seagulls are bioindicators that help fisherman to locate schools of fish. Common Terns eat mostly small fish, usually no more than 7 inches long. They also steal fishfrom other tern species, gulls, and themselves, as well as fish that are near the surface or that are caught on the wing. Sea gulls eat fish, insects, reptiles, rodents, and a variety of other items. These omnivorous birds hunt and scavenge with great efficiency. The impact of Gulls and Terns on local fish populations can vary. While these birds plays important roles in ecosystems, they may cause challenges in certain situations. Increased population of gulls and terns can lead to higher predation pressure on local populations. This could result in reduced fish abundance. Changes in fish populations due to seabird fluctuations may have cascading effects on other species within the ecosystem.

Keywords: Cochin harbour, catch density, gulls, turns,

1.Introduction

Shore birds can be found on every continent, except Antartica, having more than 214 species in the world. Although they can be found in many different environments, including tundra, grasslands, woodlands, and open oceans, shorebirds are typically found close to bodies of water. They travel on migration routes and wintering grounds for two-thirds to three-quarters of the

year, mostly in tidal habitats where they graze on marine life. The extensive network of wetlands in the interior and coast that is abundant in invertebrates is crucial to their capacity to finish the year (Thurston, 1996). There are many different types of feeding niches for shorebirds due to their variable bill morphology. When regard to the tide line and other birds, a species of shorebird that is likely to be observed feeding is ascertained by its bill length and, to some extent, its leg length. The shorebird breeds in groups. A few individuals to hundreds of thousands of birds gather in flocks at their migratory stopping spots and wintering grounds. But they scatter during the mating season. These species exhibit a wide variety of mating behaviours that appear to discuss how to make the greatest use of the resources at hand, such as polyandry, polygyny, and Polyandry in sequence (Thurston 1996).

Gulls and Terns are belongs to the order Charadriiformes. Gulls and terns are colonial breeders, building their nests on the ground near beaches, marshes and other wet areas and closed salt mines. While some gull species may nest on rocky cliffs, others may not at the rooftops of man-made buildings in numerous coastal cities, including hotels, apartments, and office buildings. A shallow trench or building covered in grass, twigs, pebbles and other detritus can serve as a nesting site. Embryology usually lasts, depending on the species, 21-27 days. Chicks of terns and gulls are semi-precocial. They stay at or close to the nest for the first two or three weeks after hatching, but they have open eyes, down coverings, and the ability to walk. While terns and gulls have waterproof plumage and webbed feet, only gulls are able to swim (Meryl Faulkner,2007).

The weight of gulls and terns varies, with the 40 g Least Tern and larger gulls weighing over a kilogram. The parents feed the young terns and gulls mostly fish that are the right size on the day after hatching. Fish is fed to the young by Least Terns about every two hours. Male Western Gulls eat chicks every 2-4 hours, and by the time they are fledging, females are feeding every 3-5 hours. During the mating season, when they are restricted to feeding sites relatively close to the colony and may operate near their capacity limitations, seabirds are especially vulnerable to fluctuations in the supply of food. They have developed a number of life techniques that could aid in overcoming challenges related to foraging. Seabirds are longer-lived, lay fewer clutches, and mature later than other bird. Additionally, they frequently reproduce in dense colonies, which may increase their chances of finding enough food for their progeny in the event that food is dispersed erratically. Despite having originated late in the geologic past, man has had a significant impact on geomorphology during his brief existence on Earth (Jesse walker.H,1984).

Releasing terns and gulls raised in captivity into a suitable habitat with other members of their species is imperative. The IUCN Red List currently classifies it as Least Concern. However, a number of European nations have observed a decrease in the quantity of breeding pairs. The principal disturbances include competition, flooding, habitat damage, and human disturbances and exploitation. One genetic marker that is frequently utilised in population genetic research. The control region, which is rapidly developing, is an excellent instrument for evaluating within-species interactions. Because disturbances interfere with nesting behaviour, they can lower output. By analysing how breeding Common Terns (*Sterna hirundo*) and Laughing Gulls (*Lams atricilh)* responded to Herring *(L. argentutus)* and Great Black-backed (*L. murinus*) gulls' frequent overhead flights to see if these flyovers would have led to productivity losses(Paul M Chavanagh,1993).The feeding habits of the globally distributed Gull-billed Tern have been researched in certain areas of its breeding range (Cramp, 1895). Viruses, bacteria, micro fungi, and protozoa that are harmful to humans and other homeotherm vertebrates that are linked to birds in the Laridae family, also known as larids. The mobility and capacity for migration of gulls and terns is another important factor in the spread of various pathogens (Zdenek Hubalek,2021). The advantages of conservation efforts (like habitat protection) aimed at an endangered

community will be felt by all species. However, intricate relationships between species, including interference competition, can drive weaker, subordinate species extinct. Communities are acknowledged as one of the levels of ecological structure to which conservation should focus the majority of its research efforts, along with simpler and more complex systems (i.e., species and ecosystems, respectively). Competition between species within a guild partially determines the organisation of communities . This competition has several ecological and evolutionary implications, including competitive exclusion when resources are few. The patterns of community structure vary greatly in terms of both space and time (Daniel Oro et al.,2009).

The migratory seabirds known as terns (Sternidae, Charadriiformes) are found all over the world and contain a number of species that are under threat. Despite this, many species lack sufficient knowledge to allow for the implementation of effective conservation strategies, and numerous crucial biological questions pertaining to their dispersion behaviour remain unanswered. Molecular markers have proven helpful in answering a variety of conservation and population biology-related queries. Only three of the 44 tern species that are currently in existence have undergone population-level genetic study (*S. fuscata, S. dougalli,* and *S. albifrons*). It is crucial to get markers that offer appropriate amounts of variation for the scope of the suggested queries, which are unknown for terns at this time, in order to conduct such genetic investigations. The management of avian predators has resulted in increases in seabird population sizes on islands, either through decreased mortality or greater reproductively, where predation was found to be the primary cause of seabird decline. A significant contradiction in conservation management occurs when a control operation goes after a predator that is protected. When a prey species is highly conserved, tensions and disagreements between regulators and conservation managers may worsen (Alfarwi and Ibrahim,2021). Climate change is anticipated to increasingly affect migratory birds in Arctic and Antarctic marine areas, both through ecological changes and through changes in human activity patterns. Climate change thus adds on to the already substantial threats faced by some species in these regions, including pollution and fisheries impacts. Currently, it is widely acknowledged that biodiversity worldwide is significantly impacted by climate change, and that immediate action is needed to help species and ecosystems adapt to the changing environment with the least amount of loss possible (Arie Trouwborst,2009). Most taxa or locations lack controlled or replicated data, managers are concerned about the ethics of controlling wildlife using lethal means. In order to safeguard terns (Sterna spp.) from overpopulation of predatory gulls, particularly herring (*Larus argentatus*) and great black- backed gulls (*L. marinus*; huge gulls), the Gulf of Maine (GOM) has historically implemented extensive lethal and nonlethal predator management measures (Lauren.C.Scopel and Antony.W. Diamond,2017). Understanding the cues utilised to choose colony and nest sites is essential to habitat management and breeding colony site restoration. For instance, habitat alteration is frequently employed to enhance the availability of acceptable nest sites, and conspecific attraction with playback and decoys is frequently used to bring terns to suitable colony locations. Because tern colonies disperse, managing them effectively requires a met population strategy (Brian.G.Palestis,2014).

Both terns and gulls use ritual feeding as a key component of their communication systems. Unlike gulls, terns are distinguished by their airborne stereotypical ritual interactions. They employ rhythmic vocal constructions in some crucial circumstances; nevertheless, the efficacy of these signals as far away cues depends on the high frequency of the acoustic signals as well as the number of repetitions of the same note (Panov, 2002). One major aspect affecting the direction of incubating birds is wind. Over a wide range of wind speeds, the connection was linear and accurately predicted the orientation behaviour of birds who were incubating during a wind storm (Michael Gochfeld,1978).

Concerns regarding the effects of humans on fish communities have grown in the last few years. Growth and Development, pollution, eutrophication, and fisheries are just a few of the human activities that can have an impact on fish populations. For instance, it is challenging to assess the population stability and abundance of a target species without an empirical estimate of species abundance, which necessitates in-depth understanding of fish population dynamics. In any scientific investigation, fish stock assessment is used to determine the productivity of a fishery resource, the effects of fishing on that resource, and the impacts of changing fishing patterns, such as those resulting from the implementation of development or management policies, on the resource and Fisheries (Feoder & Matthew. J. Hoffman,2014). Fishermen make decisions which affect the success of their foraging operations and, like natural predators, they react with varying effectiveness to the conditions of the prey populations. Fish catch density describes the number of fish that are caught per area or volume of water. It is a metric frequently used in fisheries management to evaluate the amount of fish in a specific area. A healthy and sustainable fish population may be indicated by a high fish catch density, whereas overfishing or environmental issues may be indicated by a low density (David B sampson,1991). The present study aims at to find the impact of gulls and terns on the local fish population in cochin fisheries harbour, Ernakulam District, Kerala, South India

2. Materials and methods

2.1 Assessment of gulls and terns

2.1.1 Monthly count method

The monthly count method involves conducting regular surveys of shorebirds within a specific study area over a set period, usually on a monthly basis. This approach provides a temporal perspective on shorebird populations, tracking their presence, abundance and seasonal variations throughout the year. There several steps in monthly count method.

a) **Site selection** : Select Cochin fisheries harbour and surroundings that represent various fish and shorebird populations.
b) **Sampling frequency** : The gulls and terns are counted once a month and surveys conducted from fisherman for knows the abundance of these birds.
c) **Counting technique**: Recording the number of individuals of both gulls and terns seen or heard during each survey.
d) **Data recording**: Maintain a standardized data sheet. Monthly count, recording the data, time, location and gulls &terns observed.
e) **Data analysis**: Collate and analyse the data collected over 8 months to identify seasonal trends and changes in shorebird populations. This method is particularly useful for understanding long term population dynamics.

2.2 Analysis of fish catch density

2.2.1 Direct counting:

a) **Site selection**: Select the fish landing spot inside the Cochin fisheries harbour daily catch several tons of marine fishes.
b) **Sampling frequency**: The quantity of fishes recorded twice a month and surveys conducted from fisherman for knows about the local name and abundance.
c) **Data recording** : Maintain a standardised data sheet for recording each fish species
d) **Data analysis** : Collage the data collected over 8 months to identify seasonal trends and abundance.

2.2.2 Fish landing surveys

a) Select the site for survey that was inside the Cochin fisheries harbour. The sitesgathered by fishermen are preferred for survey.

b) The information regarding the fish catch density, population abundance and interaction with birds are recorded.

c) Maintain a standardised data sheet for recording each species diversity andabundance.

d) Collage the data collected over 8 Months survey to identify the fish catch density and population abundance.

2.3 Study area

The study will be conducted in Cochin fisheries harbour situated at Thoppumpadi, Kerala, India lying between the North latitude 9°56'7" and east longitude 76°15'33" E. The harbour was established and managed by the Cochin port trust. The Cochin fisheries harbour complex built on land area of 27.863 acres. The harbour is the livelihood of more than 10,000 fishermen and fish related workers. It is is occupied by a wide variety of avian species. The Catch of fishes are also at a higher level inside the Cochin fisheries harbour.

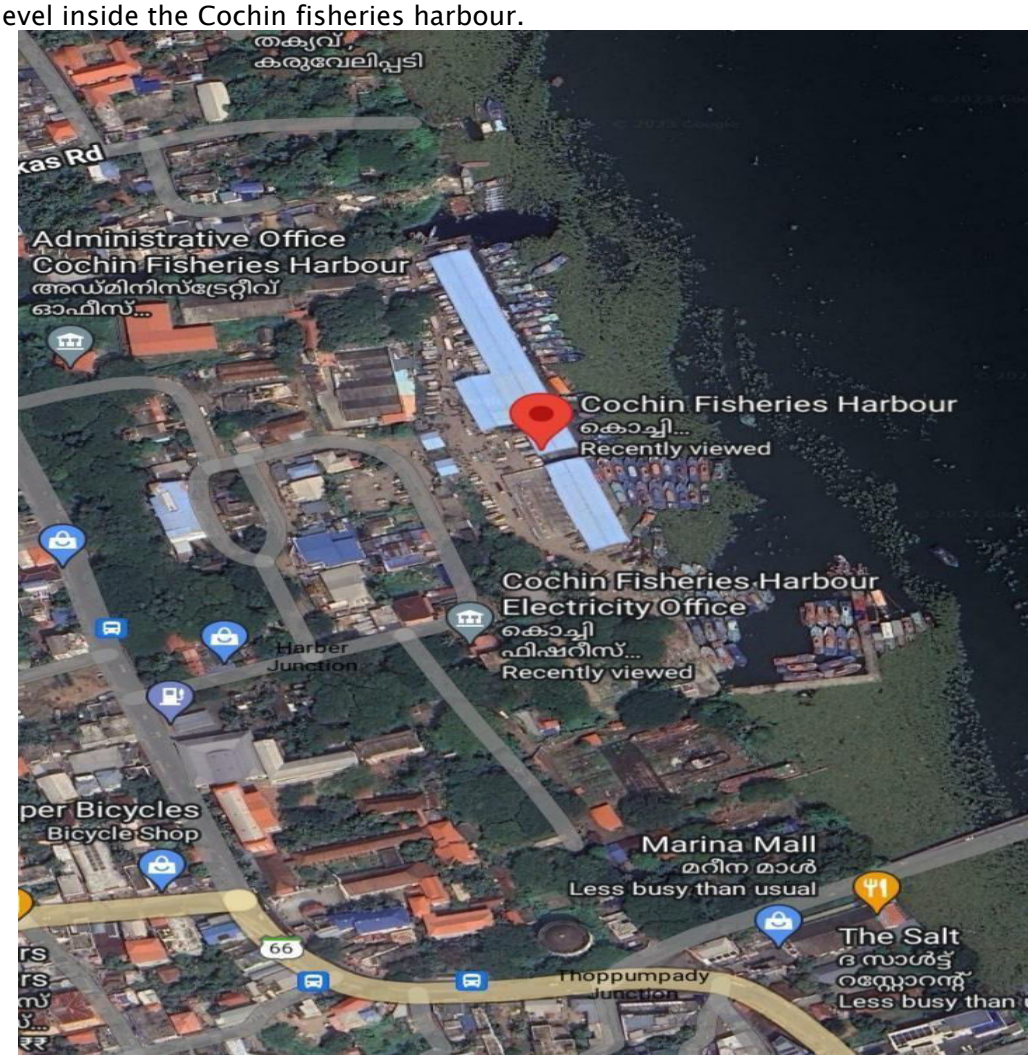

Figure : 2.1 Google map of study area

3. Observation and Results

The catch density of fishes in Cochin fisheries harbour situated in the Ernakulam district, Kerala is assessed from January 2023 to June 2023. A total of 47 species of fishes are identified and recorded during the study. The 6 month study revealed that the Cochin fisheries harbour is dominated by a wide variety of fishes and it also helps to identify the habitat and abundance of

fishes. The fishes are collected twice a month and fish landing surveys are help full for studying the diversity of fishes.

Table 3.1.The species composition of Fishes

Sl no	Common name	Scientific name	Family
1	Sword fish	*Xiphius gladius* (Linnaeus,1758)	Xiphiidae
2	Skipjack tuna	*Katsuwonus pelamis* (Linnaeus,1758)	Scombridae
3	Largehead hairtail	*Trichiurus lepturus* (Linnaeus,1758)	Trichiuridae
4	Oceanic whitetip shark	*Carcharhinus longimanus* (Poey,1861)	Carcharhinidae
5	Yellowfin tuna	*Thunnus albacares* (Bonnaterre,1788)	Scombridae
6	Indian oil sardine	*Sardinella longiceps* (Valenciennes,1847))	Dorosomatidae
8	Indian mackerel	*Rastrelliger kanagurta* (Cuvier,1816)	Scombridae
9	Short mackerel	*Rastrelliger brachysoma* (Bleeker,1851)	Scombridae
10	Green jobfish	*Aprion virescens* (Valenciennes,1830)	Lutjanidae
11	Longfin mako shark	*Isurus paucus* (Guitart-Manday,1966)	Lamnidae
12	Mackerel tuna	*Euthynnus affinis* (Cantor,1849)	Scombridae
13	Rosy snapper	*Pristipomoides filamentosus* (Valenciennes,1830)	Lutjanidae
14	Starry triggerfish	*Abalistes stellatus* (Bloch&J.G Schneider,1801)	Balistidae
15	Spinycheek grouper	*Epinephelus diacanthus* (Valenciennes,1828)	Serranidae
16	Tang's snapper	*Lipocheilus carnolabrum* (W.L.Y Chan,1970)	Lutjanidae
17	Diamond trevally	*Alectis indicus* (Ruppell,1830)	Carangidae
18	Shrimp scad	*Alepes djedaba* (Forsskal,1775)	Carangidae
19	Cobia	*Rachycentron canadum* (Linnaeus,1766)	Rachycentridae
20	Greater lizardfish	*Saurida tumbil* (Bloch,1795)	synodontidae
21	Black marlin	*Makaira indica* (G.Cuvier,1832)	Istiophoridae
22	Indo pacific sailfish	*Istiophorus platypterus* (Shaw,1792)	Istiophoridae

23	Indian anchovy	*Stolephorus indicus* (Van Husselt,1823)	Engraulidae
24	Spadenose shark	*Scoliodon laticausus* (J.P Muller&Henle,1838)	Carcharhinidae
25	Giant trevally	*Caranx ignobilis* (Forsskal,1775)	Carangidae
26	Scrawled filefish	*Aluterus scriptus* (Osbeck,1765)	Monocanthidae
27	Areolate grouper	*Epinephelus areolatus* (Forsskal,1775)	Serranidae
28	Illishi	*Tenualosa ilisha* (Hamilton,1822)	Dorosomatidae
29	Indo pacific blue marlin	*Makaira mazara* (Jordan&Snyder,1901)	Istiophoridae
30	Devil fish	*Mobula mobular* (Bonnaterre,1788)	Mobulidae
31	Lunar tailed bigeye	*Priacanthus hamrur* (Forsskal,1775)	Priacanthidae
32	Rainbow runner	*Elagatis bipinnulata* (Quoy&Gaimard,1825)	Carangidae
33	Pelagic thresher	*Alopias pelagicus* (H.Nakamura,1935)	Alopiidae
34	Kelee shad	*Hilsa kelee* (Cuvier,1829)	Dorosomatidae
35	False trevally	*Lactarius lactarius* (Bloch&J.G Schneider)	Lactariidae
36	Bigeye thresher	*Alopias superciliosus* (R.T Lowe,1840)	Alopiidae
37	Houndfish	*Tylosurus crocodilus* (Peron&Lesueur,1821)	Belonidae
38	Talang queenfish	*Scomberoides commersonnianus* (Lacepede,1801)	Carangidae
39	Blubberlip snapper	*Lutjanus rivulatus* (Cuvier,1828)	Lutjanidae
40	Hamilton's thryssa	*Thryssa hamiltoni* (Gray,1835)	Engraulidae
41	Common dolphin fish	*Coryphaena hippurus* (Linnaeus,1758)	Coryphaenidae
42	Black pomret	*Parastromateus niger* (Bloch,1795)	Carangidae
43	Blackfringe bigeye	*Pristigenys refulgens* (Valenciennes,1862)	Priacanthidae
44	Butterfish	*Drepane punctata* (Linnaeus,1758)	Drepaneidae
45	Randall's threadfin bream	*Nemipterus japonicas* (Russell,1986)	Nemipteridae
46	Great barracuda	*Sphyraena barracuda* (Edwards in Catesby,1771)	Sphyraenidae

47	Bignose unicorn fish	*Naso vlamingii* (Valenciennes,1835)	Acanthuridae
48	Atlantic tripletail	*Lobote surinamensis* (Bloch,1790)	Lobotidae

Fig.3.1 *Thunnus albacares*

Fig.3.2 *Sardinella longiceps*

Fig.3.3 *Carcharhinus longimanus*

Fig.3.4 *Rastrelliger kanagurta*

Fig.3.5 *Rastrelliger Brachysoma*

Fig.3.6 *Isurus paucus*

Fig.3.7 *Aprion virescens*

Fig.3.8 *Euthynnus affinis*

Fig.3.9 *Abalistes stellatus*

Fig.3.10 *Makaira indica*

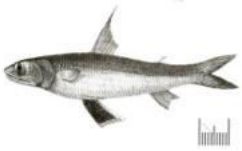

Fig.3.11 *Saurida tumbil*

Fig.3.12 *Alepes djedaba*

Fig.3.13 *Caranx ignobilis*

Fig.3.14 *Aluterus scriptus*

Fig.3.15 *Makaira mazara*

Fig.3.16 *Elagatis bipinnulata*

Fig.3.17 *Priacanthus hamrur*

Fig.3.18 *Stolephorus indicus*

Fig.3.19*Lobotes surinamensis*

Fig.3.20 *Rachycentron canadum*

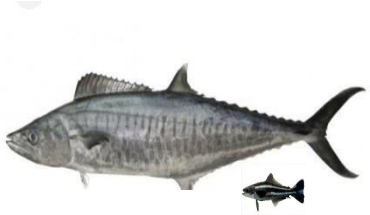

Fig.3.21 *Scomberoides coersonnianus*

Species composition of Gulls and Terns

Scientific name	Common name	January	February	March
Chroicocephalus ridibundus	Black headed gull	7	3	8
Chroicocephalus brunnicephalus	Brown headed gull	9	5	12
Chlidonias hybrida	Whiskered tern	0	0	3
Sternula albifrones	Little tern	0	0	1

Table 3.2.The species composition of gulls and terns

Fig. 3.22 .Black headed Gull

Fig. 3. 23 Brown headed Gull

Fig. 3.24 Little Tern

Fig.3.25 Whiskered Tern

3.1 Species composition of fishes

The study was carried out in the Cochin fisheries harbour and 48 species of fishes recorded during the study. These species belongs to 26 families and 6 species belongs to the family Carangidae,they support important commercial and recreational fisheries. The ray finned fishes such as *Naso vlamingi and Lobote surinamensis* are the characteristic feature of this harbour. Fish species have different special distributions according to their preferred habitats. For instance ,pelagic fish like tuna prefer open water, while demersal species like flounder prefer the vicinity of the ocean floor. The most abundant fishes in the Cochin fisheries harbour includes *Xiphius*

gladius,Katsuwonus pelamis,Istiophorus platypterus,Isurus paucus ,Thunnus albacores and *Trichiurus lepturus.*More than 20 ton of fishes exported to Karnataka, Tamil Nadu and other states from this harbour everyday. The mostly exported fishes are *Xiphius gladius* and *Katsuwonus pelamis.* More than 3 species of fishes are recorded belongs to the families Scombridae, Lujanidae and Carangidae. Many fish species exhibit seasonal migrations for spawning or seeking optimal conditions. Warmer seasons may lead to increased feeding and activity, while colder seasons may promt some species to move to deeper, warmer waters. An understanding of these patterns is essential for effective fisheries management and conservation efforts. Temperature, water clarity and food availability are some of the factors that can affect fish seasonal variations and trends.

The recorded fishes are categorized based on the density of catch. Mainly the categorization is into 3. The fishes catched between 2 to 5 ton is grouped in the high catch density category,1 to 2 ton is categorized into medium catch density category and less than 1 ton is categorized into low density category. As the environmental factors including water temperature, pH, salinity and food availability changes with the seasons, which in turn influence the amino acid and fatty acid profile of fish in different season. Moisture content known to vary in some fishes for maintaining osmoregulation during migration. *Xiphius gladius* commonly called sword fish ,a large and high migratory fish known for its long, pointed bill resembling a sword. They are known for their speed and agility in the water, making them formidable predators. Conservation efforts are important to ensure

sustainable swordfish populations, as they are susceptible to overfishing due to their desirability in the seafood industry. The catch of swordfish in the Cochin fisheries harbour is about 150 ton in a month .A trawler is a fishing vessel designed to catch large volumes of fish. This vessels are used to store large fishes like swordfish, Skipjack tuna, Largehead hairtail etc. The *Katsuwonus pelamis* commonly called skipjack tuna widely distributed in tropical and subtropical oceans. This is an important commercial fish, commonly used for canned tuna production. Sustainable fishing practices are crucial to maintain healthy skipjack tuna populations and to preserve the balance of marine ecosystems. The presence large amount of skipjack tuna is also a characteristic feature of this harbour.

3.2 Species composition of Gulls and terns

Due to the modernisation of the Cochin fisheries harbour the diversity of shorebird species are relatively low inside the harbour. The gulls and terns are mainly found in the seashore. The harbour is situated away from the shore and that is another reason for the lesser presence of gulls and terns inside the harbour. There are two species of gulls and two species of terns are recognised from the harbour. The assessment of gulls and terns from January to June helps to identify the diversity, behaviour and migration pattern of these shorebirds

The observed gulls includes *Chroicocephalus ridibundus* and *Chroicocephalus brunnicephalus* and the terns includes *Chlidonias hybrida* and *Sternula albifrones.* When perched the nonbreeding brown-headed Gull resembles the Black-headed Gull, but its bill and legs are frequently a brighter red colour. It also has a slightly heavier bill and darker gray upperparts and light iris. The Whiskered terns are typically stockier-built. Their dagger- shaped bill is most noticeable in males, and their grey rump is a distinguishing feature thatsets them apart from common, Arctic and White winged Terns.Breeding plumage of the Whiskered Tern includes a black crown with white cheeks and neck sides; medium grey upperparts, upper wings and tail; dark grey to slate grey underparts; White under tail with predominantly White underwings. They have brown eye, red bill, legs and red underparts. The Little Tern is silvery grey above and white below. It has a black cap,a black eyestripe and a white forehead. The Little Tern pocess yellowy-orange legs and yellow

bill with a black tip. This coastal seabird is highly migratory and feed on typically fishes in shallow water. Most Gulls and Terns are migratory birds they undertaking long-distance journeys between breeding and wintering groups. Migration typically occurs in response to changes in food availability, temperature and daylight. The Gulls and Terns leaves the Cochin fisheries harbour after the month March. So the population of Gulls and terns during April, May and June remains zero.

3.3 Correlation between fish and birds

From the study it was clear that the majority of fish species occurred at the months January and February. Comparatively higher number of Gulls and terns are also noticed at these months. There for it is clear that there is a correlation exist in between the fishes and birds. The Gulls and Terns collect their food from the harbour. They typically feed on a variety of fish species and their diet can vary based on their habitat and geographic locations. Common fish species consumed by the Gulls and Terns during the study include small fish species like Anchovies, Sardines and Tuna are often part of the diet of Gulls and Terns. In addition to fish, Gulls and Terns may also feed on Crustaceans like shrimp and small crabs.

4.Discussion and conclusion

The result obtained from the study specified that an increase in gull and tern populations could indicate a higher availability of fish as these birds are often attracted to areas with abundant food sources. However it's essential to consider other ecological factors, such as habitat changes, competition among bird species and human activities impacting fish stocks. A rise in gull and tern populations might lead to increased competition for fish resources, potentially impacting fish catch density. The similar result also been reported by (Gabriela Soares & Carolus Maria,2010) during a scientific fishing survey with bottom trawl of the coastal waters in February 2005. They explained the presence and behaviour of the seabird species that fed on fishery discards from the trawl catches. The 11 species of seabird species that came into feed on the discards were. The increase in the seabird diversity indicates the higher availability of fish. Conversely, a decline in bird populations could suggest a decrease in available prey or changes in the ecosystem. Monitoring and understanding these interactions require a comprehensive ecological analysis that considers multiple variables to draw meaningful conclusions about the relationship between bird population and fish catch density in a specific region.

Herbert(1991) observed the foraging ecology of migratory shorebird in marine communities and the effects of episodic predation on prey populations. The present study also explains that the foraging ecology of migratory birds are higher in marine communities like fishes. (Stephen C Votier et al.,2023) studied about the impacts of fishing on seabirds. According to them knowledge of fisheries impacts, past and present, is essential for understanding the ecology and conservation of seabirds. The fishing negatively impact seabirds via the effects bycatch, competition and discards. Bycatch continues to kill hundreds of thousands of seabirds annually, with negative population level consequences. Fisheries for forage fish negatively impact seabirds by competing for the same stocks. The present study shows the increase in catch density leads to the competition and it makes negative impact on seabird community. Laura Koehn et al (2021) investigated the relationship between forage fish control and survival of seabirds. The study clearly said that the fisheries for forage fish may affect the survival and reproduction of piscivorous predators, especially seabirds. However seabirds have evolved life history strategies to cope with natural fluctuations prey and it is difficult to separate effects of fishing on seabirds from impacts of natural variability.

The result of present study clearly says that forage fish control leads to the reproduction and survival of seabirds.

Total 4 species of Gulls and Terns belongs to 3 genus are identified from Cochin fisheries harbour.

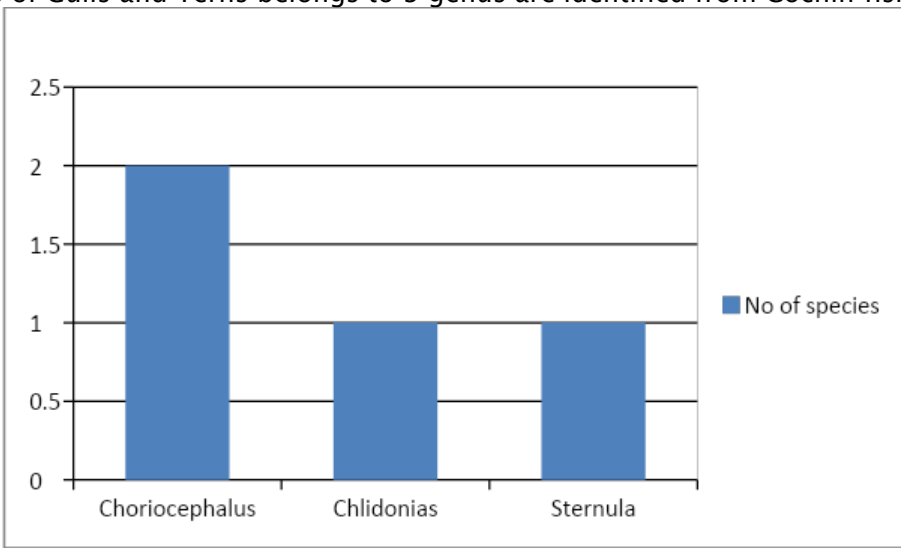

Figure : 3.26 .Bar graph showing the number of species respective to their genus

Fluctuations in Gull and Tern populations have several ecological consequences that will impact the sustainability of the fishing industry. Increased population of Gulls and Terns can lead to higher predation pressure on local populations. This could result in reduced fish abundance and altered size structures affecting the overall health of targeted fish stocks and potentially impacting the fishing industry's yield. Here the decreased population of Gulls and Terns in the Cochin fisheries harbour leads to lower predation pressure on local fish populations. This could result in increased fish abundance. Similarly large populations of sea birds may compete with commercial fishing operations for the same food sources. This competition could lead to reduced catch sizes for fishermen, potentially affecting their economic viability and the sustainability of fishing practices. Here the low population of Gulls and Terns reduces the competitive interactions. Seabirds contribute to nutrient cycling through their guano, which can enhance primary productivity in ecosystems Fluctuations in Gull and Tern populations may present challenges for fisheries management. Rapid increases in seabird numbers could necessitate adaptive management strategies to maintain a balance between conservation efforts for the birds and sustainable fishing practices. The Cochin fisheries harbour have a large density and variety of fishes and within the study period about 47 species belongs to 26 families are recorded.

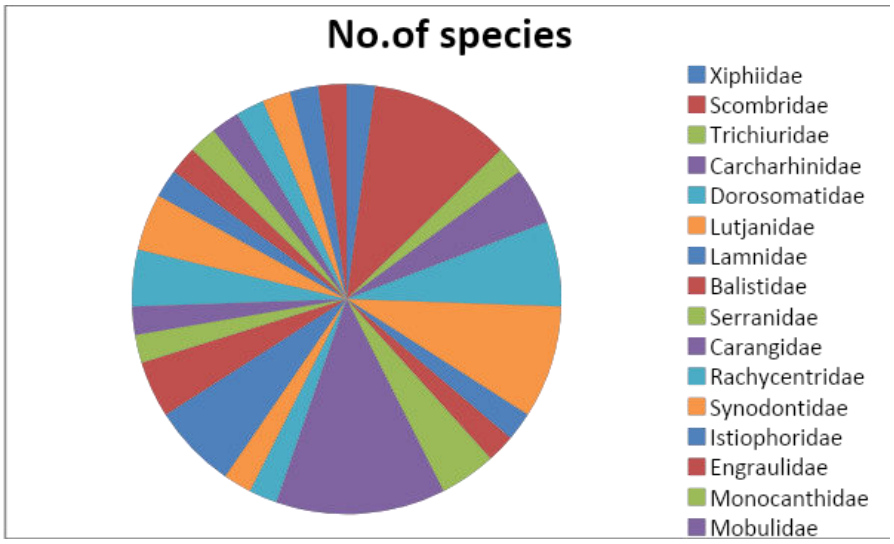

Figure 3.27 Pie chart showing number of species respective to their families.

Changes in fish populations due to seabird fluctuations may have cascading effects on other species within the ecosystem. This could impact the abundance and distribution of non- target species, affecting the overall biodiversity and ecosystem resilience. Understanding the intricate relationships between seabird populations and the fishing industry is essential for developing effective conservation and management strategies that ensure the sustainability of both ecosystems and human activities. Biodiversity indices are measures that express the variety and abundance of different species in an ecosystem. They help assess and compare biodiversity levels in different habitats or over time. The Shannon-Weiner index takes into account both species richness and evenness and the higher values indicate greater diversity. The Simpson diversity index focusing on the concentration of species in a community. The evenness index provides a measure of how evenly individuals are distributed among different species in a community and the dominance index refers to the relative abundance or prevalence of certain species in a community.

Sl no	Month	Dominance	Simpson's index	Shannon-Weiner index	Evennes
1	January	0.69	0.5	0.69	1
2	February	0.5	0.22	0.38	0.73
3	March	0.5313	0.69	1.28	0.89

Table 3.4 Diversity indices of Gulls and Terns

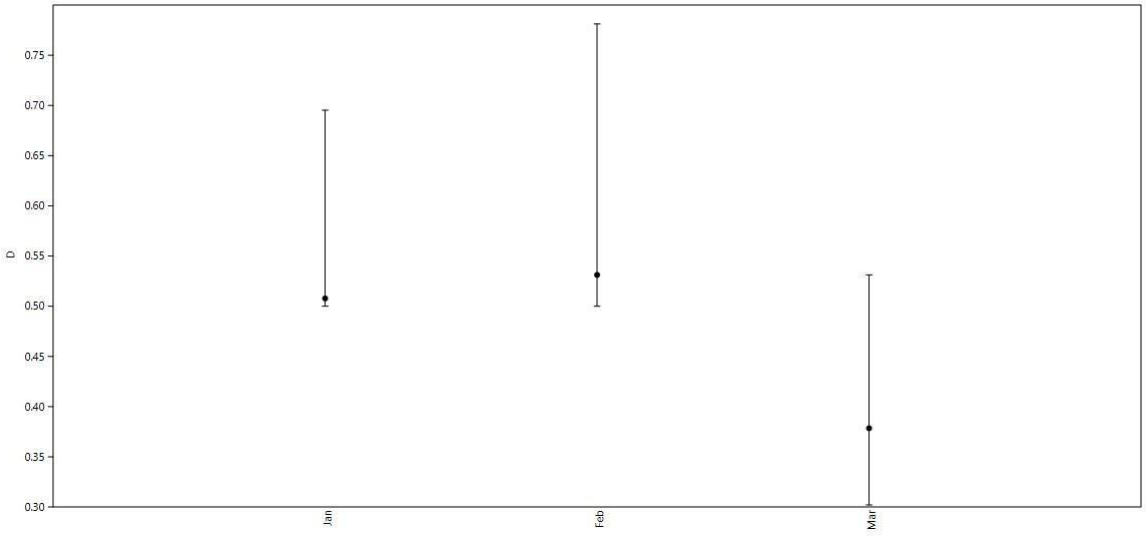

Figure 3.28 Line graph showing diversity indices of Gulls and Terns

Gulls and Terns are shorebirds commonly found along coastlines. These are typically larger birds with sturdy builds, webbed feet and distinctive bills. They often scavenge for food and can be seen near water bodies, Urban areas and landfills. Terns are more slender, agile birds with long, pointed wings and pointed bills. They are skilled fliers and are known for dividing into the water to catch fish. Terns are usually found near coastal areas and estuaries. Both Gulls and Terns are important components of coastal ecosystems, contributing to the balance of marine environments through their feeding habits and roles in nutrient cycling. Many bird species that inhabit damp coastal areas are collectively referred to as shorebirds. The diversity of Gulls and Terns is significant, with various species found around the world. The present study focused on the diversity of Black headed gull, Brown headed gull, Whiskered tern and little tern. Gulls and Terns play crucial roles in coastal ecosystems contributing to their ecological balance. Gulls and terns help to control the populations of smaller species like fishes and also helps in nutrient cycling. Their presence or absence can serve as indicators of environmental health. Monitoring gull and tern populations can provide insights into changes in the health of coastal ecosystems and the availability of prey species. Understanding and conserving these seabird populations is essential for preserving the health and resilience of coastal environments worldwide.

The relationship between gull and tern populations and fish catch density is complex and can vary depending on various factors. Fish is a vital food source for shorebirds, including Gulls and Terns which affects their migration patterns and general survival. By controlling the quantity of prey, shorebirds' feeding habits can also affect fish populations. Study of shorebird foraging behaviour to learn about the diets of these birds require and how it affects the local fish populations. Gulls and terns are both predators and prey ,participating in intricate food web dynamics. Their interactions with other species helps to maintain the overall balance of ecosystem. Understanding the behaviour of shorebirds is essential for conserving gull and tern populations and managing their interactions with human activities along coastlines.

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Statement Of Conflict Of Interest

The authors did not receive support from any organization for the submitted work. No funding was received for conducting this study or to assist with the preparation of this manuscript. No funds, grants, or other support was received. On behalf of all authors, the corresponding author states that there is no conflict of interest (Financial and non -financial)

References

1. Alfarwi, I. (2021). *The balance between predators and prey in a mixed seabird colony: managing biodiversity and the conservation of rare species* (Doctoral dissertation, Newcastle University).
2. Palestis, B. G. (2014). The role of behavior in tern conservation. *Current Zoology*, *60*(4), 500-514.
3. Cramp, S. (1977). Handbook of the birds of Europe the Middle East and North Africa: the birds of the Western Palearctic.

4. Oro, D., Pérez-Rodríguez, A., Martínez-Vilalta, A., Bertolero, A., Vidal, F., & Genovart, M. (2009). Interference competition in a threatened seabird community: a paradox for a successful conservation. *Biological conservation*, *142*(8), 1830-1835.
5. Sampson, D. B. (1991). Fishing tactics and fish abundance, and their influence on catch rates. *ICES Journal of Marine Science*, *48*(3), 291-301.
6. Lobyrev, F., & Hoffman, M. J. (2023). A method for estimating fish density through the catches of gillnets. *Fisheries Management and Ecology*, *30*(1), 24-35.
7. Wilson Jr, W. H. (1991). The foraging ecology of migratory shorebirds in marine soft-sediment communities: the effects of episodic predation on prey populations. *American Zoologist*, *31*(6), 840-848.
8. Walker, H. (1997). Man's impact on shorelines and nearshore environments. *The Human Impact Reader. Blackwell, Oxford, UK*, 4-19.
9. Koehn, L. E., Siple, M. C., & Essington, T. E. (2021). A structured seabird population model reveals how alternative forage fish control rules benefit seabirds and fisheries. *Ecological Applications*, *31*(7), e02401.
10. Scopel, L. C., & Diamond, A. W. (2017). The case for lethal control of gulls on seabird colonies. *The Journal of Wildlife Management*, *81*(4), 572-580.
11. Meryl Faulkner(2007). Gulls and terns-Hand rearing birds,https://doi.org/10.1002/9780470376393.ch1o.
12. Gochfeld, M. (1978). Incubation behaviour in common terns: influence of wind speed and direction on orientation of incubating adults. *Animal Behaviour*, *26*, 848-851.
13. Panov, E. N., & Zykova, L. Y. (2002). Comparative analysis of communication systems in two large taxa of the order Charadriiformes: Gulls and Terns. *Зоологический журнал*, *81*(1).
14. Cavanagh, P. M., & Griffin, C. R. (1993). Responses of nesting common terns and laughing gulls to flyovers by large gulls. *The Wilson Bulletin*, 333-338.
15. Votier, S. C., Sherley, R. B., Scales, K. L., Camphuysen, K., & Phillips, R. A. (2023). An overview of the impacts of fishing on seabirds, including identifying future research directions. *ICES Journal of Marine Science*, *80*(9), 2380-2392.
16. Thurston.H. (1996). The World of the Shorebirds, 117 pp. San Francisco: Sierra Club Book.
17. Hubálek, Z. (2021). Pathogenic microorganisms associated with gulls and terns (Laridae). *Journal of Vertebrate Biology*, *70*(3), 21009-1.