Brief Communication

Inferences on distribution and movement of some pelagic seabirds in western India

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India, with its extensive coastline, is home to a diverse array of seabirds. The Arabian Sea, Lakshadweep Sea, Bay of Bengal, and the island groups of Lakshadweep and Andaman-Nicobar offer varied habitats for these birds. The estuaries and mangrove ecosystems along the coastlines, and the neritic and pelagic zones of the country's vast EEZ combine to form unhindered foraging grounds for a significant number of coastal and oceanic birds. India's tropical location attracts seabirds from both the Northern and Southern Hemispheres, as they migrate away from their breeding grounds in search of more favourable wintering conditions. The inferences presented are based on personal observations and other published records, including those available in the online global database eBird. The personal observations span a period of six years from 2018-2024 on south western coasts of India (Kerala) and the islands of Lakshadweep. Observations were made along the shorelines and shelf waters off Kerala at seasons of seabird activities and off seasons. On board surveys were conducted up to a distance of 40 nautical miles off Kochi and Ambalappuzha. On a few occasions, seabird occurrences were documented enroute Lakshadweep islands from Kochi in ships. Monitoring at Lakshadweep consisted of shoreline and onboard surveys

Red-footed booby off Kochi

around the immediate waters of the islands as well as oceanic zones. Whether due to increased, regular, and synchronized seabird monitoring efforts and increased cyclonic events in the Arabian Sea and Bay of Bengal, or a combination of these factors, the records and diversity of seabirds encountered in India, is steadily increasing. The monitoring efforts carried out primarily and largely by the general public include individual as well as well-organised group endeavours. Such citizen-led monitoring programs, often organized in conjunction with migratory patterns and key times annually, have significantly contributed to these findings. An example is the regular 'Sea watching' events, of which the first author is a participant, organised by a community of birdwatchers in Kerala at strategic observation points across Kerala coasts and similar initiatives in other coastal states. An analysis of such observational data points that the addition of new records as well as the sightings of irregular occurrences of many species along Kerala resulted from these attempts. For instance, the recent discovery of Arctic tern on India's west coast by a hobbyist ornithologist highlights the importance of citizen science contributions. Similarly, the sightings of Christmas Island frigatebirds and a lone Red-footed booby in locations along the west coast and near the Kochi estuary, respectively, are direct results of dedicated individual or group efforts. The occurrence and distribution of regular migrants from both the northern and southern high latitudes follow the general physical and biological oceanography of the region. Observations from onshore areas, oceanic waters, and the Lakshadweep Islands show that birds tend to converge in areas with high pelagic productivity. This pattern is evident during the monsoon period (mid-May to October), when major species in groups congregate on the coastal waters of western India. This oceanic province, known for its annual monsoon-induced coastal upwelling, can sustain a vast number of seabirds. They primarily forage in inshore waters, even near shorelines, specifically targeting anchovies, sardines, mackerel, and shrimps with minimal interaction with the local fishery. The two-month annual trawl ban in western Indian waters also provides favourable conditions for wintering birds.

Seabird movements along the west coast

Seabirds are drawn to Indian waters primarily by four factors. First, they migrate from breeding grounds in both hemispheres to escape colder climates. During austral and boreal winters, various species seek warmer temperatures and better feeding opportunities in subtropical and tropical latitudes. Second, some species move from nearby breeding grounds, such as from islands and continental margins in the Indian Ocean. These post-breeding dispersals are often species-specific and independent of seasonal climatic changes. Third, species might move intentionally or unintentionally to western Indian waters in the prevailing winds. This can be advantageous due to increased oceanic productivity, especially during

Flesh-footed shearwaters off Ambalapuzha

Wilson's Storm Petrel foraging at Kochi estuary

the annual monsoon season. Finally, occasional vagrant or nomadic species may arrive without a clear connection to climatic or oceanic processes. These individual behaviors are primarily driven by intrinsic factors.

High latitude migrants

The waters surrounding India see year-round regular occurrence of migratory species from both the Northern and Southern high latitudes. Southern high latitude migrants, such as Wilson's storm petrels and Flesh-footed shearwaters, arrive in Indian waters from April to May and remain until September. Conversely, the arrival of Arctic breeding species, like three species of jaegers, coincides with the autumn migration of northern hemisphere birds to tropical regions. Observation records demonstrate an increasing frequency of occurrence These species appear in Indian waters during the mid-summer monsoon and return to their breeding grounds by April or May. Observation records demonstrate an increasing frequency of occurrence of these species in Indian coastal waters which are crucial feeding and staging areas for these migratory populations.

However, many other species have been recorded only a few times or even just once, by way of nomadism, vagrancy or consequent to cyclonic storms. This includes the Tropical shearwater, Sooty shearwater, Cory's shearwater, Black-bellied storm petrel and Light-Mantled Albatross. These isolated and erratic records often occur during the exceptionally windy monsoon seasons. For instance, the single exceptional records of Light-Mantled and Grey-headed albatrosses from the Palk Bay region happened during the summer monsoon. Similarly, the Lesser frigatebird and Christmas Island frigatebird occasionally appear along Indian coastlines and sometimes venture inland due to prevailing winds. Masked boobies were occasionally observed along the western Indian coast, particularly during the monsoon season. Both adults and juveniles were documented, often in exhausted or stranded conditions due to stormy weather. These seabirds are widely distributed across the major oceans and have breeding colonies in the northern Indian Ocean islands, including a small number of pairs in the Chagos archipelago. As mentioned earlier, the highly productive waters off India's western coast, encompassing the eastern Arabian Sea and Lakshadweep Sea, experience regular movements or passage of migrants from both hemispheres. Several observations conducted along the coasts of Sri Lanka have revealed a consistent pattern of seasonal species movement in this oceanic region. Among these, Pomarine, Long-tailed, and, less frequently, Parasitic jaegers are observed migrating eastward across the southern tip of Sri Lanka and into the Bay of Bengal. The immediate origin of these passing flocks is the western waters of India where they have been reported annually. These Holarctic breeding birds are known for their continental habits during the breeding season. However, during the non-breeding period, they disperse widely across the major oceans, sometimes even traversing land. Typically, they follow coastal routes during migration. While Sri Lankan observations suggest a return journey to their breeding grounds via the Bay of Bengal, Malacca Strait, and the northern Pacific in the spring, their autumn migration route to southern wintering areas, including India's western coast, remains uncertain. Observation data from the northern Indian Ocean is insufficient to clarify whether these jaegers enter the Red Sea from the Mediterranean and then migrate south-eastward to India. Although there are records of them in southern African waters, no evidence exists for a migration path from the Atlantic to the western Indian Ocean, encompassing the

Parasitic jaegers in coastal waters off Ambalappuzha

entire eastern African coast and continuing into the eastern Indian Ocean region. The notable absence of any species of jaegers in the Lakshadweep waters also implies that they migrate along a more coastal route than crossing the oceanic waters. One of the primary factors contributing to India's higher oceanic productivity, particularly along the western coast, is the prevailing wind patterns that significantly influence the movement and distribution of seabirds. During the summer monsoon (May-September), trade winds blowing from the southeast equator turn towards the Indian subcontinent, creating extensive coastal upwelling zones. These conditions are ideal for seabirds, as they can conserve flight energy by riding the prevailing winds to areas with higher productivity. As a result, the western Indian coast witnesses numerous sightings of various tern species, including Saunders tern, Lesser and Great crested terns, Bridled tern, Sooty tern, Common tern, Lesser noddy, Brown noddy, Little tern, Caspian tern and others. The abundance of certain species suggests that they are driven to Indian shores by these trade winds. Many of these terns, which are primarily oceanic and have breeding grounds in the region such as Lakshadweep Islands (Sooty & Brown noddy terns), Maldives (Sooty tern, Great crested tern), Chagos (Lesser noddy, Brown noddy & Sooty terns), and Sri Lanka (Bridled tern, Common tern, Greater crested tern), are observed passing the Indian coast annually.

Sooty tern *Onychoprion fuscata* & Brown noddy *Anous stolidus*: Certain islets or small sandbars in some atolls of Lakshadweep historically host the breeding colonies of some oceanic terns, including Sooty and Brown noddy terns, etc. Over the last century, many of such known breeding locations have been lost or abandoned by the birds. This can be linked to the increased human inhabitation on many of the atolls as well as to the gradual rise of sea level, though with more pronounced seasonal effects, that has made some of them vulnerable to flooding. Their breeding has been studied by many over the last 150 years, including ourselves, yet a clear picture is not available regarding the exact seasonality of the breeding events. As highly oceanic, these two terns has generally been not observed across the mainland coast of India. However, on rare occasions, both of them had been observed in the western coastal waters. It is not clear whether they are intentional migrants or wind-blown individuals. The record of a few Brown noddies along the west coast in healthy condition during

the current monsoon suggests an intentional movement from the nearby breeding colonies across the atoll system of Laccadive-Maldives-Chagos ridge. But in the case of Sooty tern, they are almost completely absent in the records along the coastal waters during any season. Even in the conditions of powerful trade winds blowing across their breeding colonies in Lakshadweep their general absence in the mainland coasts points to an ongoing breeding event in the Lakshadweep islands during the monsoon months as observed in some previous studies. Another inference that could explain this absence is that they complete their breeding by the time of the initial spell of monsoon and leave their breeding range to more southern or western oceanic regions. This could be substantiated if we consider the occurrence of a few wind-blown juveniles of sooty terns, though irregular, from various locations along the western coasts of India. Our observations made between 2016 and 2020 of the breeding colonies of Sooty terns and Brown noddies at Pitti Islet suggest that they may not have the same breeding time there. Instead, the Sooty terns breed earlier in the summer monsoon while the fledglings of Brown noddies were observed to be more numerous towards the end of the same season. However, there is also the possibility of a continuous breeding event of these species in the islet as suggested by some previous observations, or a synchronicity in breeding. Year-round monitoring of the islet is necessary to ascertain the same.

Lesser noddy *Anous tenuirostris:* In the summer monsoon, it is noticeable that a considerable number of Lesser noddies were sighted along the entire west coast of India during the months of July and August. This species is known to spend non-breeding time (December to April) in large numbers in Maldives and having large breeding colonies in Chagos and Seychelles. The occurrence of Lesser Noddy in India suggests the movement/dispersal of a population, probably a post-breeding one, along the prevailing monsoon wind regime from the above-mentioned breeding localities.

Saunders tern *Sternula saundersi:* The distribution of this species is mostly confined to the western Indian Ocean with widely scattered breeding localities. Sighting records during the summer monsoon show that non-breeding birds, including a few juveniles, frequent the western inshore waters of India and are generally absent during the remaining periods of a year. Since different populations in the western part of Arabian Sea (including Red Sea) are known as either resident breeders or migrants to southern Africa, those individuals moving to India could originate from the breeding colonies of Chagos or Seychelles along the monsoon winds.

Lesser-crested tern flock on Pallana coast, Alappuzha

Bridled tern *Onychoprion anaethetus:* This circumtropical species is one among the most common terns that visit western India during the mid-monsoon periods. The southward movement of Bridled terns (hereafter BTs) along the western coast of the Indian subcontinent (which also includes Sri Lanka) during the southwest monsoon season has been well documented by several observers from western India and Sri Lanka. Such observations of population movement towards the south along the inshore waters of India have been made from Mumbai to Kerala coasts during the August-September period. If we consider the timing at the known breeding locations of BTs in the Indian Ocean, it is highly probable that those that reach India originate from the eastern Indian Ocean breeding sites post breeding, by following the trade winds. Observers recorded the arrival of BTs at numerous breeding sites across the western Australian coasts by mid-October. Given the timing of mass movements of Bridled Terns (BTs) along the western coast of India and off southern Sri Lanka, it is plausible to infer that these birds undertake an annual round-trip migration primarily influenced by trade winds. After breeding in western Australia, they migrate to the productive upwelling waters of the western Indian shelf.

Great (*Thalasseus bergii*) and Lesser crested (*Thalasseus bengalensis*) tern: These are the two common species that can be seen regularly along the western waters of India irrespective of seasons, though large groups are seen towards the post monsoon periods. There are breeding sites of Great crested terns in Maldives and the population seen in India might emerge from there. In the case of Lesser crested terns there is no known breeding activity in Maldives and Chagos, but they are observed to move along western Indian waters from the Arabian regions during the end of summer monsoon. Large flocks of this species, sometimes mixed with the other conspecific, are recorded from various shorelines and estuarine regions of Kerala towards the second half of the boreal migratory period. Both the species forage across a wide area from the continental shelf to estuaries, backwaters as well as other coastal wetlands like paddy fields and marshes.

Seabird interactions with fishery

One of the finest interactions between fishery and seabirds can be seen in the Lakshadweep islands. As mentioned earlier, two species of oceanic tern breeds in this region and thus have a regular presence and movement in the sea surrounding the islands. The people of these islands are following a sustainable method of tuna fishing. Their efforts in finding a tuna shoal would be largely scaled down if they could find a few birds in surface feeding. We noticed such occasions where the fishers would follow the birds to their point of aggregation where shoals of skipjack or kawakawa would be detected. They could detect shoals of skipjacks or kawakawas. Usually, the birds feed on small fishes chased to the surface by large pelagic fishes such as the tunas and species like needle fishes, dolphin fishes, seer fish, barracudas, and billfishes. Thus, in a small-scale island fishery where subsistence-level pole and line fishing is prevalent by using small to medium-sized boats, minimizing fishing efforts through the use of a reliable biotic cue can significantly enhance both economic efficiency and time-saving. This cue, which directly indicates the presence of target resources, allows fishermen to concentrate their efforts on areas with higher potential yields, thereby optimizing their livelihood activities. Seabird bycatch and competition for the same resources by both humans and seabirds remains the primary fishery related impact on seabird populations in the ocean. In general, most species of migrant seabirds target the same fishery resource as humans as their food. These include seabirds which primarily target plankton feeders and the smaller pelagics such as sardines, flying fishes, anchovies, and the shrimps. Thus the interaction of seabirds with fishery becomes more evident during the productive summer monsoon period. However, the extent of bycatch mortality or injuries remains to be conclusively assessed. Current global estimates indicate about 700000 annual seabird mortalities occur through two major fishing gears, gill net and longline, with the former surpassing the later. Trawl and purse seine fisheries contribute to bycatch to much lesser extents. Mortality through gillnetting and longlining is not documented in India. No mortality of seabirds has been reported from the tuna fishery in India. Fishery discards can have both positive and negative effects on seabird populations, serving as a supplementary food source while also increasing the risk of bycatch.

While the lack of reports suggests that seabird bycatch in Indian seas might not be substantial, only dedicated monitoring through extensive surveys employing advanced technologies like electronic monitoring, remote sensing, big data, and artificial intelligence can provide an accurate assessment. As interest in and monitoring of seabirds grows, comprehensive information on these vital components of the marine ecosystem will become increasingly accessible.