Chapter 4

Seabirds as Bioindicators of Marine Ecosystems

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.75458

Abstract

Seabirds are those waterbirds that directly or indirectly depend on the marine environment over the waters, i.e., they foraged at sea either near shore or offshore and inhabit in coastal areas, islands, estuaries, wetlands, and ocean islands. They are mostly aerial waterbirds sailing above sea spending much of their time (weeks, months, and even years) in marine environments or floating on the water surface or diving in deep sea in search of food. Seabirds encompass of 65 genera, 222 marine, and 72 partially marine bird species. Seabirds have been used as good indicators (i.e., bioindicators) of marine ecosystems due to cause-effect association with different microclimate and habitats. They exploit broad scale of habitat, quickly respond to environmental changes, they can be detected easily (i.e., they showed their presence through vocalization), easy to identify, can be surveyed efficiently over large spatial scale, e.g., presence, abundance, and influenced by surrounding habitats as compared to other animals. Employing seabird as bioindicators is a cost-effective and informative tool (well defined matrix) to determine the effects of disturbances, contamination, i.e., effects of pollutants, organic substances, and oil-spills of the marine environment. Seabirds are top predators in the marine food chain and key component of the food web. Seabirds may indicate the status of habitat, reduction in food occurrence and abundance, rate of the predation, an effect of weather (climate change), and threats. The other reason could be that, seabirds often closely associate with inter-site more distinctly than other animals and may breed in the same site each year, easy to catch while incubating and during rearing chicks. Hence, it is crucially important to use seabirds as bioindicators within the context of ecological and spatial parameters to determine the effects of disturbances in the marine environment and for effective conservation and better management of seabirds in the future.

Keywords: seabirds, bioindicators, marine, habitat, threats, ecology

1. Introduction

Marine is the largest and highly productive aquatic ecosystem of the world which covers 70% earth surface and encompasses of salt marshes, intertidal zones, estuaries, lagoons, mangroves, coral reefs, and deep sea. They are suitable home, (i.e., living place, food, shelter, and breeding grounds) for a wide array (i.e., millions of species) of invertebrate, e.g., corals, crustaceans, molluscs, etc., and vertebrate animal species, e.g., birds, reptiles, mammals, and fishes. Despite being a highly productive ecosystem, it faces significant threats due to human interaction. Marine ecosystem has substantial linkages with coastal and inland waters which are important habitats for numerous species. For example: sandy beaches, estuaries, and mangroves are nurseries and breeding grounds for a diversity of birds, reptiles, and fishes [1]. In addition, marine ecosystem is a major source of economic wealth for human being, i.e., it provides a wide range of active ingredient resources such as raw material for medicine, staple food for human as well as wildlife, and gene bank for basic as well as applied research [2].

1.1. Current status of marine areas

Presently, only 1.2% marine areas of the world within exclusive economic zones, 4.3% areas of the continental shelf, and 0.9% areas of offshore waters have been protected [3, 4]. Marine areas are the most productive ecosystem for seabird species, i.e., they provide a wide array of habitat rich in food resources that had attracted a diversity of seabird species to be utilized year around. Identifying the ideal foraging and breeding sites of the seabird is highly crucial to declare marine protected areas and manage them on the sustainable basis to ensure the breeding success and to enhance population of seabirds.

The coastal and island areas offer heterogeneous habitat and highly productive foraging sites that had attracted a wide array of seabirds to forage year-round in these areas to fulfill their requirements (**Figures 1–3**). These areas attracted congregate numbers of loons, gulls,

Figure 1. Least tern—*Sternula antillarum.* Source: This picture was taken from short natural film "A Puffin Paradise: The Seabirds of the Farne Island".

http://dx.doi.org/10.5772/intechopen.75458

and cormorants during winter season to forage in rich up dwelling areas. In addition, an island within the proximity to rich foraging sites also provide ideal nesting sites for Gulls, Guillemots, Cormorants, and Oystercatchers (**Figures 4–10**).

Figure 2. Whiskered tern—*Childonias hybrid*. Photo by Rajpar in Marudu Bay coastal area Malaysia.

Figure 3. Greater flamingo—*Phoenicopterus ruber*. Photo by Rajpar in the coastal area of Sindh, Pakistan.

Figure 4. Atlantic puffin—*Fratercula arctica.* Source: This picture was taken from short natural film "A Puffin Paradise: The Seabirds of the Farne Island".

Figure 5. Common Murres—*Uria aalge.* Source: This picture was taken from short natural film "A Puffin Paradise: The Seabirds of the Farne Island".

Figure 6. Great black-backed Gull—*Larus marinus.* Source: This picture was taken from short natural film "A Puffin Paradise: The Seabirds of the Farne Island".

Figure 7. Red-footed Booby—*Sula sula.* Source: This picture was taken from short natural film "A Puffin Paradise: The Seabirds of the Farne Island".

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Figure 8. Artic tern—*Sterna paradisaea.* Source: This picture was taken from short natural film "A Puffin Paradise: The Seabirds of the Farne Island".

Figure 9. Ringed-billed Gul—*Larus dilawarensis.* Source: This picture was taken from short natural film "A Puffin Paradise: The Seabirds of the Farne Island".

Figure 10. White tern—*Gygis alba.* Source: This picture was taken from short natural film "A Puffin Paradise: The Seabirds of the Farne Island".

2. Seabirds

The term "seabirds" has been applied to waterbirds that directly or indirectly depend on the marine environment over the waters [5]. Seabirds comprised of five orders, namely; Sphenisciformes (i.e., Penguins), Procellariiformes (i.e., Albatrosses, Petrels, Storm-Petrels, Fulmars, Shearwaters), Ciconiiformes (i.e., Herons, Egrets, Storks, Ibis, Spoonbills), Pelecaniformes (i.e., Pelicans, Frigatebirds, Gannets, Boobies, Cormorants, Anhingas), and Charadriiformes (i.e., Shorebirds, Skuas, Jaegers, Skimmers, Auks, Guillemots and Puffins) are a major component of the marine environment and often exhibit distinct association with the sea environment (**Table 1**).

Family	Scientific name	Common name	Reference
Alcidae	*Alca torda*	Razorbill	[6]
Laridae	*Anous minutus*	Black noddy	[7]
Procellariidae	*Ardenna bulleri*	Buller's shearwater	[8]
Procellariidae	*Ardenna creatopus*	Pink-footed shearwater	[9]
Procellariidae	*Ardenna gravis*	Great shearwater	[8]
Procellariidae	*Calonectris leucomelas*	Streaked shearwater	[10]
Stercorariidae	*Catharacta antarctica*	Brown skua	[10]
Stercorariidae	*Catharacta chilensis*	Chilean Skua	[10]
Stercorariidae	*Catharacta maccormicki*	South polar skua	[10]
Stercorariidae	*Catharacta skua*	Great skua	[10]
Alcidae	*Cephphus grylle*	Black guillemot	[6]
Laridae	*Creagrus furcatus*	Swallow-tailed gull	[9–11]
Procellariidae	*Daption capense*	Cape petrel	[9]
Diomedeidae	*Diomedea exulans*	Wandering albatross	[8]
Diomedeidae	*Diomedea sanfordi*	Northern royal albatross	[8, 9]
Alcidae	*Fratercula arctica*	Atlantic Puffin	[6]
Fregatidae	*Fregata andrewsi*	Christmas frigatebird	[10]
Fregatidae	*Fregata aquila*	Ascension frigatebird	[10]
Fregatidae	*Fregata ariel*	Lesser frigatebird	[10]
Fregatidae	*Fregata magnificens*	Magnificent frigatebird	[10]
Fregatidae	*Fregata minor*	Great frigatebird	[10]
Oceanitidae	*Fregetta grallaria*	White-bellied storm petrel	[8]
Procellariidae	*Fulmarus glacialis*	Northern fulmar	[6, 12]
Procellariidae	*Hydrobates pelagicus*	European storm petrel	[6]
Laridae	*Larus argentatus*	Herring gull	[6, 10]
Laridae	*Larus armenicus*	Armenian gull	[10]
Laridae	*Larus brunnicephalus*	Brown-headed gull	[10]
Laridae	*Larus cachinnans*	Yellow-legged gull	[10]
Laridae	*Larus canus*	Mew gull	[6]
Laridae	*Larus fuscus*	Lesser black-backed gull	[6, 10]

http://dx.doi.org/10.5772/intechopen.75458

Family	Scientific name	Common name	Reference
Laridae	*Larus glaucescens*	Glaucous-winged gull	[10]
Laridae	*Larus kumelieni*	Kumlien's gull	[10]
Laridae	*Larus marinus*	Great black-backed gull	[6]
Laridae	*Larus ridibundus*	Black-headed gull	[6]
Laridae	*Larus schistisagus*	Slaty-backed gull	[10]
Laridae	*Larus scopulinus*	Red-billed gull	[13]
Laridae	*Larus thayeri*	Thayer's gull	[10]
Procellariidae	*Macronectes giganteus*	Southern giant petrel	[9]
Procellariidae	*Morus bassanus*	Northern gannet	[6]
Procellariidae	*Oceanites oceanicus*	Wilson's storm petrel	[8]
Procellariidae	*Oceanites gracilis*	Elliott's storm petrel	[9]
Pelecanoididae	*Oceanodroma leucorhoa*	Leach's storm petrel	[6, 14]
Procellariidae	*Pacronectes halli*	Northern giant petrel	[9]
Laridae	*Pagophila eburnean*	Ivory gull	[21]
Procellariidae	*Pelagodroma marina*	White-faced storm petrel	[8, 9]
Procellariidae	*Pelecanoides garnotii*	Peruvian diving petrel	[9]
Procellariidae	*Pelecanoides urinatrix*	Common diving petrel	[8]
Pelecanidae	*Pelecanus occidentalis*	Brown pelican	[10, 21]
Phaethontidae	*Phaethon aethereus*	Red-billed tropicbird	[8–10]
Phaethontidae	*Phaethon lepturus*	White-tailed tropicbird	[10]
Phaethontidae	*Phaethon rubricauda*	Red-tailed tropicbird	[15]
			[16]
Phalacrocoracidae	*Phalacrocorax aristotelis*	European shag	[6]
Phalacrocoracidae	*Phalacrocorax carbo*	Great cormorant	[6]
Scolopacidae	*Phalaropus lobatus*	Red-necked phalarope	[9]
Scolopacidae	*Phalaropus fulicarius*	Red phalarope	[9]
Alcidae	*Pinguinnis impenni*	Great auk	[10]
Procellariidae	*Procellaria aequinoctiallis*	White-chinned petrel	[8]
Procellariidae	*Procellaria parkisoni*	Parkinson's petrel	[8]
Procellariidae	*Procellaria westlandica*	Westland petrel	[9]
Procellariidae	*Pterodroma deflippiana*	De Filippin's petrel	[9]
Procellariidae	*Pterodroma externa*	Juan Fernandez petrel	[9]
Procellariidae	*Puffinus gravis*	Great shearwater	[6, 10]
Procellariidae	*Puffinus griseus*	Sooty shearwater	[6, 10]

Family	Scientific name	Common name	Reference
Procellariidae	*Puffinus puffinus*	Manx shearwater	[6]
Procellariidae	*Puffinus tenuirostris*	Short-tailed shearwater	[10]
Procellariidae	*Pufnus assimilus*	Little shearwater	[8]
Procellariidae	*Pufnus pufnus*	Manx shearwater	[8]
Stercorariidae	*Rhodostethia rosea*	Ross's gull	[10]
Laridae	*Rissa tridactyla*	Black-legged kittiwake	[6, 17]
Rhynchopidae	*Rynchops niger*	Black skimmer	[18]
Spheniscidae	*Spheniscus mendiculus*	Galapagos penguin	[10]
Stercorariidae	*Stercorarius chilensis*	Chilean skua	[8]
Stercorariidae	*Stercorarius longicaudus*	Long-tailed jaeger/skua	[6, 19]
Stercorariidae	*Stercorarius maccormicki*	South polar skua	[9]
Stercorariidae	*Stercorarius parasiticus*	Parasitic jaeger/Arctic skua	[6, 9]
Stercorariidae	*Stercorarius pomarinus*	Pomarine skua	[6, 20]
Stercorariidae	*Stercorarius skua*	Great skua	[6]
Sternidae	*Sterna bengalensis*	Lesser crested tern	[7]
Sternidae	*Sterna dougallii*	Roseate tern	[21]
Sternidae	*Sterna hirundo*	Common tern	[6, 21]
Sternidae	*Sterna paradisaea*	Arctic tern	[6]
Sulidae	*Sula leucogaster*	Brown booby	[21]
Sulidae	*Sula sula*	Red-footed booby	[22]
Diomedeidae	*Thalassarche bulleri*	Buller's/Pacific albatross	[9]
Diomedeidae	*Thalassarche chrysostoma*	Gray-headed albatross	[9, 23]
Diomedeidae	*Thalassarche eremite*	Chatham albatross	[9]
Diomedeidae	*Thalassarche melanophris*	Black-browed albatross	[9, 10, 23]
Diomedeidae	*Thalassarche salvini*	Black-browed albatross	[9]
Diomedeidae	*Thalassarche salvini*	Salvin's albatross	[9]
	Uria aalge	Common murres	[6]
Laridae	*Xema sabini*	Sabine's gull	[10]

Table 1. List of seabird species detected by different ornithologist.

Seabird are dull in color, i.e., black, white or black and white in color. They are bioindicators of land, productivity (food resources), and environment [24]. Boobies, gulls, terns, and alcids are colonial seabirds which often live in colonies and colonies may encompass of several species to million individuals, (e.g., Sooty Shearwaters, Wilson's Storm-petrel—*Oceanites oceanicus*) while others prefer to live solitary considered as the rarest, (i.e., only 10–20 pairs), e.g., Chatham Island Petrel—*Pterodroma magenta* and Chinese Crested Tern—*Sterna bernsteini* [25].

http://dx.doi.org/10.5772/intechopen.75458

Seabirds often prefer to live marine near shore (depositional areas) foraging and upland areas (erosional environment) for loafing and breeding.

Bermuda Petrel—*Pterodroma cahow* and Black-capped Petrel—*P. hasitata* are endemic to only few marine sites of West Indies. Likewise, Fiji Petrel—*P. macgillivaryi* and Christmas Island Frigatebird—*Fregata andrewsi* are endemic to Guam South Pacific Island. In contrast, the other are migrant species which travel thousands of kilometers while migration from one area to another, i.e., pelagic seabird, e.g., sooty shearwater—*Puffinus griseus* [26].

Apparently, information on seabird community parameters (i.e. species composition, relative abundance, diversity, foraging guilds and density), habitat characteristics and closed relationship with food resources and water quality is insufficient. Marine habitat is a distinctive set of physical sea areas that seabird species use for its survival and reproduction. Notably, the marine habitat is not solely comprised vegetation, but also a combination of biotic and abiotic factors that influence the level of seabird use under certain conditions. For this reason, marine areas are ideal habitats for diverse seabird species where seabirds foraged, inhabit, and reproduced. Various globally threatened and non-threatened seabird species depend on different marine areas to fulfill their daily requirements, such as food, water and shelter for their survival and breeding purposes.

Seabird community parameters have been used to examine the status, productivity, and threats to the habitat marine ecosystem. Monitoring the various aspects of seabird community parameters provide detailed information on migration pattern, seasonal distribution, foraging ecology, breeding biology, physiology that will help in conservation activities. The population and community parameters of seabirds fluctuate from time to time and depend on productivity, prey availability, natality, mortality, immigration and emigration (**Figure 11**; [27–32]).

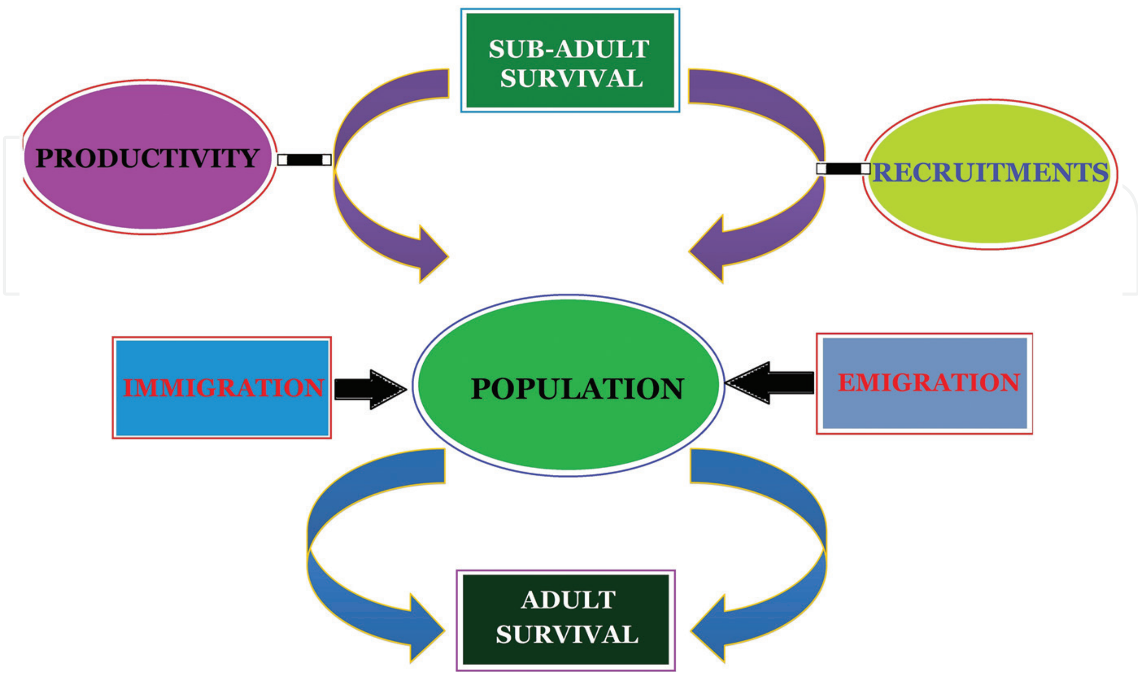

Figure 11. The major driven variable which regulates the population and community parameters of seabirds in the marine ecosystem.

Monitoring the seabird's parameters in marine habitats provides the data to evaluate the factors that cause population fluctuations among different marine habitats. In addition, monitoring, thus helps in conservation and better management of threatened and endangered seabird species.

Detailed information on the seabird's behavior and ecology in marine habitat is lacking, i.e., very little information is available on seabirds as bioindicators of marine ecosystems. Conversely, long-term population trends of seabirds, microhabitat and microclimate characteristics as well as correlationship between the seabird species with microclimate and microhabitat characteristics have not been examined. In fact, very little is known on the ecological roles of seabird species in relation to microhabitat and habitat disturbances, i.e., What would happen to the seabird species when their habitat is altered? Would the seabird population be increased or decreased? or would they move to other areas less suitable for foraging and breeding?

Seabirds have accommodated themselves in different ecosystems from North Pole to Antarctica. They directly or indirectly depend on the marine environment, such as: coastal area (i.e., mangrove, mudflats, estuaries, and islands) to perform various activities such as inhabit, foraging, perching, loafing, roosting, and breeding, etc. for their survival and existence. Seabirds are aerial birds in nature, i.e., spend hours, weeks, months, and even years at sea. Majority of seabirds observed hovering above the sea surface for searching vast areas for food that can be caught and carried from long distance to the colony. Some of seabirds, i.e., pelican, cormorant, gulls, terns, skimmers are often observed near shore and estuarine areas [33]. Likewise, albatrosses, petrels, and boobies always occur offshore. The most common characteristics of all seabirds are that they forage in salt water. Seabirds often inhabit and exploit a wide range of habitats for foraging and breeding purposes.

3. Seabirds as bioindicators of marine ecosystem

Seabirds have been used as good bioindicators of marine ecosystems. They respond more quickly to environmental changes, show their occurrence through vocalization, and are easy to detect and identify [4, 34, 35]. Previously, seabirds have been used as a bioindicators of pollution [36–39], oil spills [40, 41], contamination in the Antarctic ecosystem [42–44], evaluate wetland ecosystem health [45, 46], climate change [47], primary productivity [48], and environmental pollution in aquatic system [49–51]. This could be that, seabirds may show distinctive habitat preferences and display a variety of adaptations to exploit the marine resources and can be used to determine the marine ecosystem integrity.

Cause variable or abiotic factors may indicate the existing condition of the particular area while seabird community parameters highlight environmental condition, productivity. The cause-effect relationship is the utmost essential tool to decide what actions should be taken for conservation and protection of specific site. The information on seabird's community parameters would be more suitable to use them as bioindicators of threats and contamination due to satisfactory sample sizes and ease of sampling, i.e., colonial breeders often occur in large numbers [52]. Detailed information on seabird ecology provides the basis for interpretation to examine the toxic effect patterns and levels of contamination [53].

The choice of seabird species and study site is crucially important, i.e., some species become panic due to human presence and may cause mortality of eggs or chicks (e.g., Great Cormorant, Black-legged Kittiwakes) while other species are highly tolerant of disturbance (e.g., Northern Gannet). Seabird species should be selected as a bioindicators of marine ecosystem which has following attributes, namely accumulate high concentration of contamination, resistant to toxic effects, forage on narrow define and consistent diet feed predominantly or exclusively on prey in the food web under investigation, often occur in large number of colonies and large population size with known breeding biology, physiology, and ecology, less disturbed with human interference, easily identifiable, and easy to collect samples [52].

4. Foraging behaviour of seabirds

Fish is potential prey of seabirds, i.e., they foraged on >100 fish species (i.e., herring, sardines, anchovies, menhaden, sand eels, smelts, and flying fish, etc.) and invertebrates, e.g., squids, crustaceans, crabs, molluscs, and krills [54, 55]. The capture and handling food of depends on morphological and physiological adaptations (e.g., bill shape, feed, and body shape) and enables them to exploit a wide array of food resources in myriad ways. Furthermore, the foraging behaviour of seabird species influenced by foraging range, ability to dive, foraging efforts, energy expands on foraging, ability to catch, handle, and consume prey items [56]. Seabirds employ heterogeneous foraging techniques to catch their prey. For example: *pursuit diving*; following their prey into the water (penguins, alcids, cormorant, and diving petrels), *dipping*; picking prey, i.e., squid and krill while floating on the water surface (storm's petrels, skuas, gulls, terns, large petrels, pelicans, and albatrosses), *plunge diving* (gannets, boobies, tropicbirds, terns, and pelicans), *piracy and cannibalism* (Frigatebirds and skuas), and *aerial pursuit* [7, 57, 58]. Some species are solitary feeders while other forage in flocks [59, 60]. The occurrence of food resources and distribution may alter the demographic characteristics of seabird species [61]. Seabird can be classified according to habitat preference, e.g., albatrosses often prefer to forage over open sea and avoid utilizing the coastal area and are known as pelagic seabirds. On the contrarily, gulls and terns tend to forage in coastal areas and loaf on beaches considered as shorebirds. However, some seabird species utilized pelagic as well as coastal area during breeding and non-breeding seasons and rarely use terrestrial areas, i.e., alcids and penguins.

Seabirds detect their prey visually and tactile way and employ various foraging techniques to catch their prey. Mostly, seabirds are visual diurnal predators, i.e., mostly foraging during daylight hours, i.e., Common Murre—*Uria aalge* [62] and some are nocturnal, prey during the night, such as: Bulwer's Petrel—*Bulweria bulwerii*, Wedge-rumped Storm Petrel—*Oceanodroma tethys*, Red-footed Booby—*Sula leucogaster*, Dovekie—*Alle alle*, Red-legged Kittiwake—*Rissa brevirostris*, Swallow-tailed Gull—*Creagrus furcatus*, and White Tern—*Gygris alba*, Thick-billed

Murre—*Uria lomvia*, and Macaroni Penguin—*Eduyptes chrysolophus*, etc. [63, 64]. However, some species exhibit both diurnal and nocturnal foraging behaviour.

For example: Storm-Petrels forage on surface zooplankton, penguin consumed pelagic fish and squid, gulls and albatrosses feed on dead animals, i.e., scavengers [65, 66]. Inshore bird species such as gulls and terns often concentrate where plenty of food is available, penguins and alcids dive at greater depth to catch their prey, albatrosses, shearwaters, and petrels soar at the sea surface in search of food.

5. Threats to seabirds

The habitat degradation due to water pollutants has caused the great threats to marine birds and their population had declined, i.e., some of them become endangered, threatened and endangered, critically endangered and even some species become extinct out of many seabird species around the world. Seabirds are facing different challenges such as weather influence on foraging, salt load (i.e., diving Petrels—*Pelecanoides* spp.) ingestion of salt water while diving [67], anthropogenic contamination, and competition from fisheries.

The major threat to seabirds is killing by fishing gear or culling (e.g., mass mortality of diving auks, common guillemots, razorbills, and Atlantic Puffins in gill nets, drift net, and other fixed fishing gears in coastal or offshore shallow waters), alteration in food resources due to over exploitation of fishery resources, oil spills, water pollution, hunting, predation by mammals, human disturbance, climate change, introduction of invasive species in breeding area, and disturbance natural oceanographic factors that effects on prey availability [68–73]. These are major driven factors which directly or indirectly effects on seabird population community parameters, e.g., some seabird species become endangered or threatened and vulnerable to the brink of extinction.

It has been stated that human population growth in some coastal areas has been increased up to 40% in the last 10 years [55]. Rapid increase of human population in coastal areas may cause disturbances that exerts physiological stress to Adelie Penguins—*Pygoscelis adeliae*, Gentoo Penguins—*Pygoscelis papau*, Herring Gulls—*Larus argentatus*, and Redshanks—*Tringa tetanus*, egg and nestling mortality of Sooty Tern—*Sterna fuscata*, premature fledging of Rhinoceros Auklets *Cerorhinca monocerata* and Spectacled Guillemots—*Cepphus carbo*, and colony abandonment, e.g., cormorant species [74–76].

An oil spill is a serious threat to the seabird, i.e., it may cause the mass mortality among seabird species. Seabirds are the most conspicuous and prone to marine oil spills as compared to other animals [77–79]. This could be that, they spend much time of their life at sea and their populations are patchily distributed and concentrated in coastal areas and offshore habitats which often faces the oil spill problems and their survival probability is very low in case of oil spills incidence [80–83]. For example: in 2002–2003 about 60,000-ton prestige oil was spilled in the Iberian Coastal area of northern Portugal to France and caused mass mortality of auks (i.e., 9826 individuals), Common Murres—*Uria aalge* (4492 individuals), Razorbills—*Alca torda* (2861 individuals), and Atlanic Puffins—*Fratercula arctica* (2473 individuals) [84].

6. Conclusion

In conclusion, it has been clearly determined that the seabirds are closely associated with the marine environment and can be used as bioindicators to detect the changes in water quality, productivity, and other threats to the marine ecosystem. Seabirds are top predators of the marine ecosystems and easy to identify and survey. Hence, it is crucially important that the population of seabird communities must be protected to reduce the threats, to enhance the population of seabirds, and keep nature in balance for proper functions of the marine ecosystems on a sustainable basis for future generation.

7. Recommendation for future research and conservation

1. In future a detailed research on seabird ecology, interaction with food resources and marine habitats should be conducted to identify the major driven factors which effect on seabird community parameters. This will identify what are the major factors, i.e., environmental, ecological and anthropogenic, etc. variable due to which seabirds are facing severe threats for their survival and existence.
2. A mass awareness among public should be created how disturbance affects the population parameters of different seabird species and what is their ecological importance of balance and proper functions of the marine ecosystem. In addition, how to utilize marine resources without causing disturbance to the seabird while seeking for human welfare.
3. A detailed strategy should be developed to address the issues, viewing guidelines, i.e., ecological importance, threats, and disturbance to the seabirds.

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