Chapter

Galapagos Pinnipeds, Challenges to Their Survival

Marjorie Riofrío-Lazo and Diego Páez-Rosas

Abstract

Pinnipeds endemic to the Galapagos archipelago are in endangered conservation status. The Galapagos sea lion, *Zalophus wollebaeki*, and Galapagos fur seal, *Arctocephalus galapagoensis*, have adapted to an ecosystem with high environmental variability and unpredictable marine productivity to survive. In addition to the environmental factors that pressure their populations, these species are exposed to anthropogenic influence, mainly in rookeries on islands with human settlements. It has been determined that the populations of Galapagos pinnipeds have different growth trends between regions of the archipelago, islands of the same region, and between rookeries of the same island. 58% of the Galapagos sea lion population is in the southeastern, with the largest rookery in direct contact with the inhabitants. Various strategies have been proposed to reduce the negative impacts of human–animal interaction, ensure the population's viability over time, and reduce the species' extinction risk.

Keywords: Galapagos sea lion, Galapagos fur seal, population trends, anthropogenic disturbances, conservation strategies

1. Introduction

The world's smallest sea lion and fur seal inhabit the Galapagos archipelago, a Natural Heritage of Humanity, located in the Eastern Tropical Pacific at 1000 km off Ecuador's mainland. This ecosystem is exposed to strong environmental variability as a product of local and regional processes that establish unique ecological characteristics that provide the home of a wide diversity of taxa and a high level of endemism [1, 2].

The Galapagos sea lion, *Zalophus wollebaeki*, and Galapagos fur seal, *Arctocephalus galapagoensis*, are endemic otariids of the archipelago that face different challenges to survive [3–5]. Environmental and anthropogenic factors impact the population dynamics of pinnipeds [6], so both species developed adaptation mechanisms allowing them to persist in the archipelago despite the ecosystem's uncertainty in terms of variability in feeding resources and climatic conditions [5, 7] and human-induced pressures that contribute to the deterioration of their habitat [8, 9].

The natural environmental variability of the ecosystem influences the life history strategies, abundance, and distribution of pinnipeds [10–12]. The Galapagos Islands present different levels of productivity and wide seasonal climate variability [13, 14] influenced by oceanographic current systems and upwelling patterns [15, 16] that

determine biogeographic patterns within the archipelago [17, 18]. Environmental disturbances such as ENSO (El Niño Southern Oscillation), occurring periodically in the Galapagos, intensify interannual environmental variability [19], causing fluctuations in marine productivity that alter the trophic network and impact the demography of top predators [20, 21]. A situation that is worrying given that the frequency and intensity of these effects increase with global warming [22].

Natural disturbances generate negative effects that are exacerbated when combined with anthropogenic disturbances [23]. In Galapagos, the anthropogenic influence recorded in the last decades is related to local population growth and unsustainable tourism [24]. Among the human-induced pressures are fishing, pollution, marine litter, species introduction, and disease agents, which reduce habitat quality and threaten the health of the species [25–27].

Like other marine predators, the Galapagos pinnipeds serve as indicators of ecosystem health [28, 29]. They depend on terrestrial and marine habitats and are exposed to different stressors [5, 30]. Depending on the rookery location and the level of human interaction, Galapagos pinniped populations will present different growth trends and threat levels, which have important implications for management schemes [8, 21]. We provide an overview of how these species have adapted to the Galapagos environment, facing natural and anthropogenic stressors. We also analyze their population growth trends in the last 21 years and management actions to improve their conservation.

2. Galapagos Sea lions and Fur Seals

Z. wollebaeki and *A. galapagoensis* share some similarities due to their common environment. They inhabit the Galapagos Islands throughout the year [31], and their rookeries are small (<1300 individuals) compared to otariids from high latitudes [21]. They direct their foraging trips to specific areas within the archipelago [11, 32] and have long-lasting lactation periods [7, 33]. They are non-migratory species, although vagrants have been sighted along the coast of South and Central America to Mexico [34, 35].

The Galapagos sea lion is distributed throughout the archipelago, mainly on southeastern islands where 62% of its population is concentrated [9]. It is more numerous than the Galapagos fur seal and has a larger size, approximately 40% larger [7, 36]. It presents a marked sexual size dimorphism. Adult males reach a length of 210 cm and a weight of 200 kg, and females reach a length of 176 cm and a weight of 95 kg [7]. Like other sea lions, they are highly gregarious, polygynous, and territorial [5]. They breed, nurse, rest, and thermoregulate in semiaquatic spaces along beaches on islands and islets [30]. They are philopatric to their reproductive rookeries [31] and feeding areas (**Figure 1**) [28, 37].

Female Galapagos sea lions give birth to one pup after 11 months of gestation between August and January [7], although this varies slightly, being earlier in the western and later in the southeastern region of the archipelago [38]. The maternal care consists of feeding cycles of the female in the sea, which ranges from a few hours to 4 days, and suckling of the pup on land, which lasts on average five hours [38, 39]. Weaning occurs after 18 months of birth and extends to three years [33], so females nurse all their reproductive lives [7].

The Galapagos fur seal breeds on eight main rookeries on western and northern islands, with 95% of its population on Fernandina Island [9], which corresponds to

Figure 1.
Juvenile Galapagos sea lion (Zalophus wollebaeki) swimming in shallow waters in Champion Islet. Photo by Andrés Moreira-Mendieta.

regions with greater productivity and strong upwellings [19]. In seven rookeries, it lives in sympatry with the Galapagos sea lion, where each one has specialized in a specific foraging niche [11, 40, 41]. It presents typical characteristics of fur seals, except for the long investment of mothers in the care of pups [33]. It has a marked sexual dimorphism. Adult males reach a length of 150 cm and a weight of 70 kg, while adult females reach a length of 120 and a weight of 40 kg [36]. They are polygynous and highly philopatric to their reproductive rookeries [31, 42] and their feeding sites [11, 43]. They rest, thermoregulate, and breed on rocky shores near deep productive waters and use crevices, caves, large boulders, and rock ledges for shade and shelter (**Figure 2**) [44].

Between August and November is the Galapagos fur seal reproductive season. Females give birth to one pup yearly after 11 months of gestation [44]. Mothers alternate pup suckling periods (7 days ±1.2 days) and foraging trips (17.9 ± 10.6 h) [32, 38]. Lactation lasts 18–36 months after birth, depending on environmental conditions [44], and mothers often nurse newborns and older young simultaneously [33].

3. Environmental variability

Climate variability strongly influences marine productivity with effects that spread via the food chain to top predators [45, 46]. The oceanic conditions of lower productivity and the high seasonal climate variability recorded in the Galapagos represent an ecological disadvantage for the survival of these pinnipeds compared to others that live at higher latitudes [47].

Some of the adaptations developed by the Galapagos pinnipeds include the reduction of their body size, energy requirements [48], and the extension of the lactation

Figure 2.
Adult male Galapagos fur seal (Arctocephalus galapagoensis) in Cabo Hammond rookery. Photo by Andrés Moreira-Mendieta.

period (2–3 years) [33, 44]. These mechanisms allow them to cope with lower availability of prey in their habitats and increase the chances of survival of the offspring when animals are exposed to food stress [33, 38].

The reduction in prey availability causes animals to increase foraging effort, prolonging the duration of their foraging trips, reaching greater distances, or spending less time in the rookery nursing their young [38, 49]. From January to May (warm season), when food availability is lower, fur seals make more foraging trips and spend less time ashore [38]. Feeding behavior modifications are mainly observed in strong El Niño-years, where female Galapagos fur seals prolong their foraging trips up to three times longer than in a normal year [50].

The El Niño event causes variations in marine productivity, reducing the availability of the main prey of Galapagos pinnipeds, resulting in nutritional stress that is reflected in the mortality rates of their populations, mainly of the offspring [20, 50]. The Galapagos sea lion and fur seal use different foraging niches, and there is no overlap in their diet; however, during anomalous years, both feed on prey of similar trophic levels in the regions where they cohabit [11, 40]. The high flexibility in the feeding behavior of the sea lion allows it to reduce competition with the fur seal, counteract the decrease in food in its habitat, and thus increase its survival [51].

The distinctive environmental characteristics between archipelago regions influence these otariids [52, 53]. Both direct their foraging trips to specific patches within the archipelago depending on the location of their rookeries and the feeding strategy used [32, 37, 41, 51]. The diversification of feeding strategies of the sea lion varies with the rookery and region of the archipelago [54]. It is considered an adaptation to the availability of prey, oceanographic characteristics, and the topography of its feeding sites that allows for reducing competition between individuals from the same rookery [51, 53].

The geographical distribution of the Galapagos sea lion and Galapagos fur seal rookeries, together with adaptation mechanisms, have contributed to the

differentiation of genetically structured populations within the archipelago [52, 55–57]. The intra- and inter-specific niche segregation has produced differences between western, central, and southeastern sea lion populations [52, 55]. In contrast, the long-term site fidelity and long-distance foraging trips in fur seals have contributed to differences between populations in the archipelago's west, center, and northeast [56, 57].

The abundance and distribution of Galapagos pinnipeds are influenced by climate variability and intensified by the El Niño event [5]. The intensity, length, and frequency of the El Niño event have increased in the last two decades because of global warming [58–60]. Global warming and the associated climate changes are predictable. In Galapagos marine ecosystems, there is expected a reduction in biodiversity, an increase in sea surface temperature and the thermocline depth, and intensifying upwelling winds [60–62].

These changes will increase species that withstand warming stress, the displacement of endemic species adapted to cold waters by circumtropical species with Panamic and Indo-Pacific affinities, and the tropicalization of the ecosystem by 2050 [60]. Galapagos sea lion and fur seal populations are predicted to decline during strong El Niño events [9, 21], increase the likelihood of disease outbreaks, and increase their vulnerability to the impacts of pollutants [63].

4. Anthropogenic disturbances

As natural disturbances, anthropogenic ones may alter the structure and function of the ecosystems [64]. Oceanic insular ecosystems are susceptible to these effects [23]. Therefore, climate change and other human-induced pressures have degraded marine ecosystems worldwide, creating challenges for species and human societies [65].

The booming tourism industry in the last decades in the Galapagos Islands has led to the rising resident and tourist populations [24]. The human population increase has led to overfishing and the introduction of alien species, greater use of resources and services, and generation of waste and pollution [24, 62]. These problems cause negative impacts on the natural resources of the Galapagos, especially on species exposed to high human interaction [25, 66].

Like other top predators, marine mammals are threatened by varying human-induced pressure levels [29]. In the Galapagos Islands, pinnipeds experience adverse effects related to the alteration of their behavior, deterioration in the quality of their habitat, and dangers to their health and physical integrity [25, 26, 67]. These effects occur due to the interaction of otariids with humans, fisheries, and introduced species, specifically dogs, cats, and rodents [25, 27].

Human presence in sea lion rookeries alters the animals' behavior, both the haul-out behavior and nursing patterns [68–70]. The level of aggression of Galapagos sea lions decreases as the level of exposure to human disturbance increases [26]. This behavior is observed on beaches near San Cristóbal Island town due to the large influx of bathers to which the animals have become accustomed (**Figure 3**). The level of human exposure is unrelated to rookery size [26]; however, may influence the quality of maternal care to pups [68]. The largest rookery of sea lions is, in turn, the most exposed to human presence [9], which, in the long term, could negatively impact the breeding successes of this species because of continuous stress, as has been revealed in other pinnipeds [71, 72].

Figure 3.
Galapagos sea lions from the El Malecón rookery resting on Playa Mann, a highly crowded beach near the town on San Cristóbal Island. Photo by Camila Páez-Riofrío.

The interaction of marine mammals with fisheries poses a threat to these species due to by-catch and vessel strike [73]. Adult Galapagos sea lions are more prone to wounds from propeller strikes when they try to steal fishermen's catch during fishing activities at sea, causing damage to hooks and gillnets [25]. They also cause damage to fishing vessels when they climb onto them to rest during the day, causing them to sink [30]. These adverse effects of fishing by sea lion behavior led fishers to take actions that threaten the species' integrity and protect boats with barbed wire and wood with nails [8].

Marine litter constitutes a significant global threat to biodiversity [74]. Impacts on Galapagos sea lions include cuts, entanglement, strangulation, suffocation, and intestinal obstruction [75]. Plastics are the primary debris type found in oceans affecting otariids [76–79] and are one of the main threats to Galapagos sea lions (**Figure 4**) [79, 80]. This is due to the susceptibility of this species to biomagnification of persistent organic pollutants (POPs), which can be absorbed and transported by microplastics [67, 81].

The Galapagos pinnipeds are exposed to POPs and mercury, which are toxic and bioaccumulative [75, 81]. These compounds impact the immune and endocrine systems of animals, affecting their ability to fight diseases and reproduce successfully [75, 81], especially during periods of nutritional and environmental stress such as those recorded during strong El Niño events [67]. Climate change can exacerbate the effects of pollutants on species, increasing their vulnerability and the risk of reaching their population tipping point [63].

Introduced animals in continuous interaction with endemic species may increase the risk of pathogen spillover in island ecosystems [82, 83]. Diseases with low pathogenicity may become life-threatening for marine mammals during food stress periods [84],

Figure 4.
Galapagos sea lions exposed to plastic residues in Champion Islet, an uninhabited site of Floreana Island. Picture taken during the Galapagos pinniped 2022 annual census. Photo by Marjorie Riofrío-Lazo.

producing significant mortalities in pinnipeds [85]. Galapagos pinnipeds face an increasing threat due to infectious diseases related to domestic animals (dogs, cats, and rats) [27, 83, 86, 87]. Pathogens of canine and feline origin have been reported in the four populated islands of the archipelago [82]. As a consequence, Galapagos sea lions have shown symptoms of infection by Leptospira, Canine distemper virus [88], *Dirofilaria immitis* [27], Mycoplasma [87], and group A rotaviruses [86]. The latter, in turn, is present in Galapagos fur seals [86].

5. Population abundance and conservation status

The Galapagos sea lions and Galapagos fur seals are among the endemic species with conservation priority in the archipelago [9]. They are cataloged in endangered status by the International Union for Conservation of Nature IUCN as their populations have declined over the last decades with no apparent recovery [3, 4, 9].

The causes of population reduction include (1) the environmental variability of the ecosystem [5]; (2) natural disturbances such as the intense El Niño events recorded in 1982/83 and 1997/98 [21, 89] whose residual effects persist; and ((3) anthropogenic disturbances with notable effects in rookeries located on islands with human settlements [8, 21, 89, 90].

Ten censuses were carried out in the entire archipelago from 1978 to 2022 [9, 31, 91]. The correction factors used in the first two censuses (1978 and 2001) for population estimates were not reported. However, from 2014 to the present, this methodology and animal counting have been standardized [5], reducing the uncertainty in population estimates in the last eight years.

The Galapagos sea lion suffered a substantial 50% population decline from 1978 to 2001 (**Table 1**) [3]. Monitoring in the El Malecón rookery in the southeast indicated an annual growth rate of 2% from 2005 to 2015 [21]. El Malecón is the largest rookery in the archipelago, currently making up 16% of the total population (Riofrío-Lazo

Census year	Population counted	Population estimated	Reference
1978	8000	30,000–40,000	Trillmich [31]
2001	4937	14,000–16,000	Alava and Salazar [91]
2014	4980	18,864–26,895	Páez-Rosas, Torres [9]
2015	3791	14,579–20,726	Páez-Rosas, Torres [9]
2016	4309	16,809–23,963	Páez-Rosas, Torres [9]
2017	4344	16,313–22,951	Páez-Rosas, Torres [9]
2018	4891	17,617–24,649	Páez-Rosas, Torres [9]
2019	4435	–	DPNG unpublished data
2021	4561	–	DPNG unpublished data
2022	4385	13,411–18,487	Riofrío-Lazo et al. unpublished data

Table 1.
Galapagos sea lion population abundance in the archipelago per census year.

et al., unpublished data). From 2014 to 2018, the population in the archipelago increased at an average annual rate of 1% [9]. From 2018 to 2022, the number of animals counted decreased by 14% in the archipelago, registering 4385 individuals in 2022 (Riofrío-Lazo et al., unpublished data).

The Galapagos sea lion population in 2022 is estimated at 13,411–18,487 individuals. It has maintained fluctuations in its number over the last eight years, with a slight tendency to decrease from 2014 to 2022 (Riofrío-Lazo et al., unpublished data). The average annual variation rates of the population are different between regions and tend to increase (<6.5%) in the west and north and decrease slightly (<2%) in the center and southeast (Riofrío-Lazo et al., unpublished data, **Figure 5**). The little variability in abundance from 2001 to 2022 and concerning the

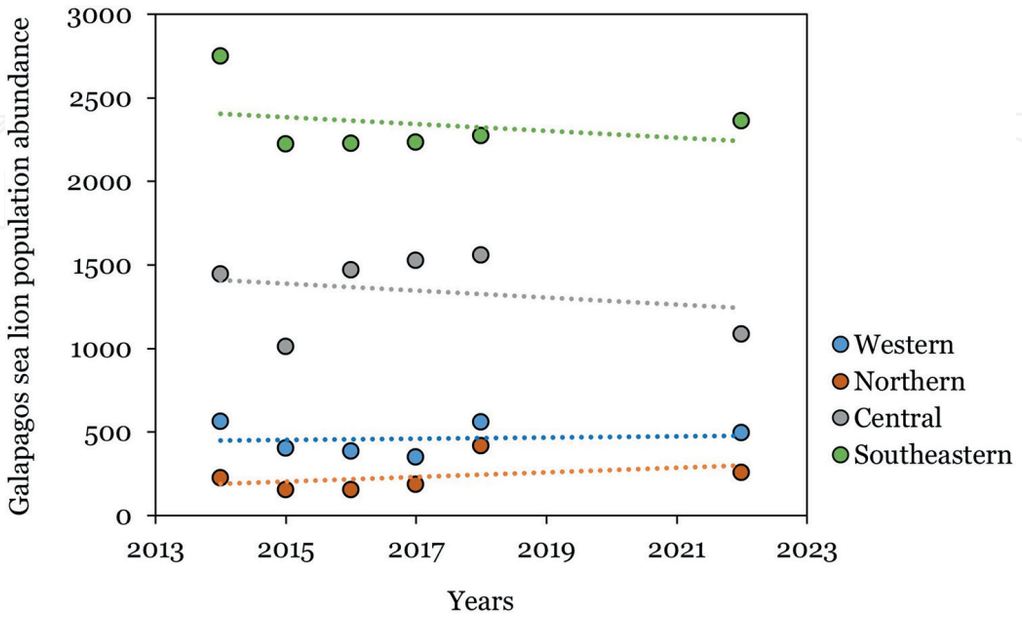

Figure 5.
Population trend (from 2014 to 2022) of the Galapagos sea lion by archipelago region. 2014–2018 census data taken from Páez-Rosas, Torres [9] and 2022 census data (Riofrío-Lazo et al., unpublished data).

Census year	Population counted	Population estimated	Reference
1978	9785	30,000	Trillmich [31]
2001	2733	6000–8000	Alava and Salazar [91]
2002–2005	—	15,000	Salazar and Denkinger [92]
2014	2843	10,676–15,173	Páez-Rosas, Torres [9]
2015	1760	6990–10,230	Páez-Rosas, Torres [9]
2016	2118	7591–10,858	Páez-Rosas, Torres [9]
2017	1996	7110–10,025	Páez-Rosas, Torres [9]
2018	3093	11,615–16,512	Páez-Rosas, Torres [9]
2019	2791	—	DPNG unpublished data
2021	3183	—	DPNG unpublished data
2022	2834	8815–12,005	Riofrío-Lazo et al. unpublished data

Table 2.
Galapagos fur seal population abundance in the archipelago per census year.

first census in 1978 suggests that the reduction of more than 50% of the population persists in the last four generations and that its IUCN conservation status should be kept as endangered.

The Galapagos fur seal suffered a drastic population reduction of 74–80% from 1978 to 2001 (**Table 2**) [4]. Based on extrapolation from 2002 to 2005 primary rookery surveys, it was estimated that the population had decreased by more than 60% from 1978 to 2005 [90]. However, from 2014 to 2018, an average annual increase rate of 3% was estimated [9]. The census 2022 shows values close to those recorded in 2001 [91], with 2834 animals counted.

The increasing trend of the Galapagos fur seal is maintained in the three regions where it lives, with fluctuations over the last 8 years (**Figure 6**). In the west and

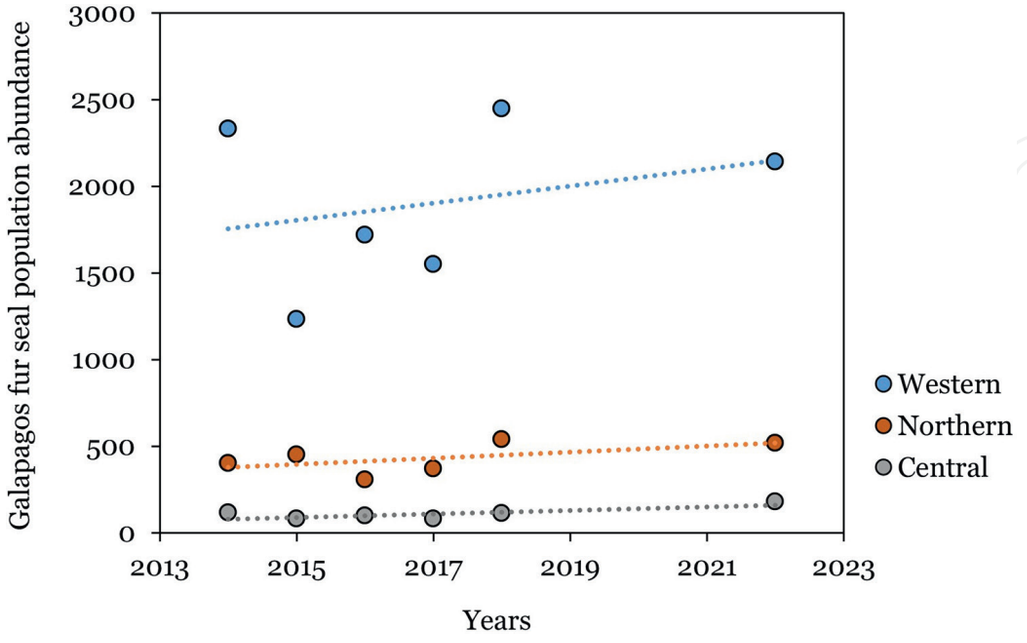

Figure 6.
Population trend (from 2014 to 2022) of the Galapagos fur seal by archipelago region. 2014–2018 census data taken from Páez-Rosas, Torres [9] and 2022 census data (Riofrío-Lazo et al., unpublished data).

north, the population decreased by 12.47% and 3.73% from 2018 to 2022, respectively, while, in the center, the population increased by 58.93% in those years (Riofrío-Lazo et al., unpublished data). Little abundance changes from 2001 to 2022 suggest that the population remains stable, and about the first population monitoring, more than 60% reduction persists in the last four generations (1978–2022). Therefore, its IUCN conservation status should be maintained as endangered.

5.1 Analyzing population trends

Habitat characteristics and population dynamics of Galapagos pinnipeds influence their habitat use in each region [43, 55]. Abundance patterns between regions and between rookeries in the same region of the archipelago are different [9, 21]. Therefore, the population trend of a single rookery should not be considered representative of the trend in the entire region or archipelago [21, 89].

Population trends from 2014 to 2022 of the Galapagos fur seal in the west, center, and north follow the same pattern of increase; however, the average annual growth rates (~3 to 8%) are distinct (Riofrío-Lazo et al., unpublished data). Differences in growth rates show that Galapagos fur seals' most important breeding rookeries are in the west, where greater production of offspring is recorded annually [9], which is related to high-quality habitat and greater availability of prey [11, 41].

The differences in the Galapagos sea lion population trends between regions are explained by various factors: (1) Shelf habitat characteristics that could lead to a restriction of food resources in the north [32]; (2) High levels of marine productivity that promote greater abundance and availability of food but are not used by the sea lion by limiting their feeding effort and the size of their rookery to reduce competition with the fur seal in the west [11, 32]; (3) Different rates of offspring production between rookeries around the archipelago linked to feeding resources available for mothers [28, 51]; and (4) Specific foraging areas with distinct prey species in the diet of individuals for each region [43, 54]. This last explains that sea lions inhabiting less productive areas, such as the center and southeastern, consume prey of high caloric value [43, 51, 93], which allows them to sustain large populations in these regions.

Three of the four populated islands are in the southeast and center; in one of them, San Cristóbal Island, is the El Malecón rookery, which is the most numerous with the highest annual pup production, near the town, and in direct contact with Galapagos residents and tourists [9, 21]. Anthropogenic disturbances to which this population is exposed are domestic animal contact and the potential transmission of infectious diseases [27, 87, 88], wounds resulting from propeller strikes, marine litter, human-fecal contamination by domestic sewage effluents and other sources of pollution [25, 67, 79]. Although the El Malecón rookery has shown a trend of sustained growth in recent years [21], human-induced pressures can have long-term effects on the population, impacting its survival [25, 26]. Due to not all rookeries showing the same growth trend and being exposed to similar problems, for the management actions design, it is relevant to evaluate each rookery independently according to its specific conditions [9].

6. Importance of conservation strategies

Marine protected areas, along with other management tools, are helpful for resource management and biodiversity conservation [2]. However, they should be established based on a comprehensive analysis of the ecosystem functioning [94].

After 22 years of the implementation of the zoning of the Galapagos Marine Reserve, it does not provide sufficient protection for threatened species and key areas for the functioning of the ecosystem, and primary fishing resources are overexploited [62, 94, 95].

Various species are protected for their high economic or esthetic value rather than their importance in nature [96, 97]. From an ecosystem-based management perspective, it is essential to protect species that maintain the ecosystem's functioning, order, and resilience [64]. The Galapagos pinnipeds are charismatic species with high economic and ecological value in the archipelago [64, 98]. This recognition has a great social impact reflected in the attention of its populations regarding management and conservation [8].

The global concern for the protection of Galapagos pinnipeds has led various institutions to carry out outstanding research efforts to understand the population dynamics of these species [9] and establish specific conservation plans for the management of its natural environment [8]. The product of this is the Galapagos pinniped monitoring program developed since 2008 on San Cristóbal Island in the southeastern region, and the global monitoring of these populations through annual research cruises throughout the archipelago (from 2014 to 2022). This knowledge is relevant for decision-makers in establishing effective protected areas that facilitate wildlife management [9].

Each reproductive rookery should be evaluated independently to improve management strategies since population dynamics are variable. The relevance of certain rookeries has been identified by analyzing the population growth trends of both species in different regions [9]. Factors to consider are (1) the high degree of philopatry to its breeding rookeries [99], (2) the high mobility of individuals between rookeries [52, 99] that provide the potential for transmission of infectious diseases, and (3) the level of interaction with humans. Considering these factors, different levels of importance or vulnerability of populations may be determined, and those rookeries with conservation priority to be identified.

Under normal conditions of environmental variability, only two-thirds of all pups survive to the age of one year, and half of the juveniles to the age of two years [100]. An increase in mortality due to human-induced pressures or disease may impede population recovery in the long term [25]. Thus, actions aimed at improving the quality of their habitat, avoiding the deterioration of their health, and raising awareness among the human population about protecting these species must be intensified.

Various strategies have been implemented and suggested to reduce the exposure of sea lions to human presence, avoid the deterioration of the quality of their marine-terrestrial habitats in urban sites as a result of the daily activities of their inhabitants, reduce the negative impact of sea lions on fishing vessels, and reduce their interaction with introduced species; see [9]. However, to achieve these objectives, it is necessary: (1) the joint effort and long-term commitment of the authorities responsible for management, (2) compliance with the regulations by all inhabitants and tourists who visit the Galapagos, (3) the continuation of the annual global censuses of these otariids, and (4) the reinforcement of health studies of their populations, to adopt prevention and early control measures of their infectious agents.

A greater understanding of the threats that the Galapagos pinnipeds face for their survival and monitoring their population allows the establishment of more effective protection measures. The conservation of these species benefits the entire socio-ecosystem of the Galapagos Islands as it promotes a healthier and more resilient ecosystem [64].

Acknowledgements

We acknowledge the financial support from the Universidad San Francisco de Quito and the Galapagos Science Center. We also thank the Galapagos National Park Directorate for the research permit and technical support.

Author details

Marjorie Riofrío-Lazo* and Diego Páez-Rosas
Universidad San Francisco de Quito USFQ and Galapagos Science Center GSC, Galapagos Islands, Ecuador

*Address all correspondence to: mriofriol@usfq.edu.ec

References

[1] Palacios DM, Cantor M. Priorities for ecological research on cetaceans in the Galápagos Islands. Frontiers in Marine Science. 2023;**10**:159

[2] Edgar GJ, Banks S, Bensted-Smith R, Calvopiña M, Chiriboga A, Garske LE, et al. Conservation of threatened species in the Galapagos marine reserve through identification and protection of marine key biodiversity areas. Aquatic Conservation: Marine and Freshwater Ecosystems. 2008;**18**(6):955-968

[3] Trillmich F. *Zalophus wollebaeki*. The IUCN Red List of Threatened Species 2015. 2015.e.T41668A45230540. Available from: https://doi.org/10.2305/IUCN.UK.2015-2.RLTS.T41668A45230540.en [Accessed: October 3, 2023]

[4] Trillmich F. *Arctocephalus galapagoensis*. The IUCN Red List of Threatened Species 2015: . 2015;e.T2057A45223722. Available from: https://doi.org/10.2305/IUCN.UK.2015-2.RLTS.T2057A45223722.en. [Accessed: October 3, 2023]

[5] Riofrío-Lazo M, Páez-Rosas D. Galapagos sea Lions and fur seals, adapted to a variable world. In: Campagna C, Harcourt RG, editors. Ethology and Behavioral Ecology of Otariids and the Odobenid: . Ethology and Behavioral Ecology of Marine Mammals. Cham: Springer; 2021. pp. 643-661

[6] Forcada J, Trathan PN, Reid K, Murphy EJ. The effects of global climate variability in pup production of Antarctic fur seals. Ecology. 2005;**86**:2408-2417

[7] Trillmich F, Jeglinski JW, Meise K, Piedrahita P. The Galapagos sea lion: Adaptation to spatial and temporal diversity of marine resources within the archipelago. In: Denkinger J, Vinueza L, editors. The Galapagos Marine Reserve. Social and Ecological Interactions in the Galapagos Islands. Cham: Springer; 2014. pp. 61-70

[8] Páez-Rosas D, Guevara N. Management strategies and conservation status of Galapagos sea lion populations at San Cristóbal Island, Galapagos, Ecuador. In: Alava JJ, editor. Tropical Pinnipeds: Bio-Ecology, Threats and Conservation. 1st ed. Boca Raton: CRC Press; 2017. pp. 159-175

[9] Páez-Rosas D, Torres J, Espinoza E, Marchetti A, Seim H, Riofrío-Lazo M. Declines and recovery in endangered Galapagos pinnipeds during the El Niño event. Scientific Reports. 2021;**11**(1):8785

[10] Soto KH, Trites AW, Arias-Schreiber M. The effects of prey availability on pup mortality and the timing of birth of south American sea lions (*Otaria flavescens*) in Peru. Journal of Zoology. 2004;**264**(4):419-428

[11] Páez-Rosas D, Aurioles-Gamboa D, Alava JJ, Palacios DM. Stable isotopes indicate differing foraging strategies in two sympatric otariids of the Galapagos Islands. Journal of Experimental Marine Biology and Ecology. 2012;**424**:44-52

[12] Elorriaga-Verplancken FR, Sierra-Rodríguez G, Rosales-Nanduca H, Acevedo-Whitehouse K, Sandoval-Sierra J. Impact of the 2015 El Niño-Southern Oscillation on the abundance and foraging habits of Guadalupe fur seals and California sea lions from the San Benito Archipelago, Mexico. Plos One. 2016;**11**(5):e0155034

[13] Wellington GM, Strong AE, Merlen G. Sea surface temperature

variation in the Galapagos Archipelago: A comparison between AVHRR nighttime satellite data and in situ instrumentation (1982-1998). Bulletin of Marine Science. 2001;**69**(1):27-42

[14] Schaeffer BA, Morrison JM, Kamykowski D, Feldman GC, Xie L, Liu Y, et al. Phytoplankton biomass distribution and identification of productive habitats within the Galapagos Marine Reserve by MODIS, a surface acquisition system, and in-situ measurements. Remote Sensing of Environment. 2008;**112**(6):3044-3054

[15] Sweet W, Morrison JM, Kamykowski D, Schaeffer B, Banks S, McCulloch A. Water mass seasonal variability in the Galápagos Archipelago. Deep Sea Research Part I: Oceanographic Research Papers. 2007;**54**(12):2023-2035

[16] Forryan A, Naveira Garabato AC, Vic C, Nurser AG, Hearn AR. Galápagos upwelling driven by localized wind–front interactions. Scientific Reports. 2021;**11**(1):1277

[17] Edgar G, Banks S, Fariña J, Calvopiña M, Martínez C. Regional biogeography of shallow reef fish and macro-invertebrate communities in the Galapagos archipelago. Journal of Biogeography. 2004;**31**(7):1107-1124

[18] McKinley SJ, Saunders BJ, Rastoin-Laplane E, Salinas-de-León P, Harvey ES. Functional diversity of reef fish assemblages in the Galapagos Archipelago. Journal of Experimental Marine Biology and Ecology. 2022;**549**:151695

[19] Palacios DM, Bograd SJ, Foley DG, Schwing FB. Oceanographic characteristics of biological hot spots in the North Pacific: A remote sensing perspective. Deep Sea Research Part II: Topical Studies in Oceanography. 2006;**53**(3-4):250-269

[20] Trillmich F, Dellinger T. The effects of El Nino on Galapagos pinnipeds. In: Trillmich F, Ono K, editors. Pinnipeds and El Niño: Responses to Environmental Stress. New York: Springer-Verlag; 1991. pp. 66-74

[21] Riofrío-Lazo M, Arreguín-Sánchez F, Páez-Rosas D. Population abundance of the endangered Galapagos sea lion *Zalophus wollebaeki* in the southeastern Galapagos archipelago. PLoS One. 2017;**12**(1):e0168829

[22] Dueñas A, Jiménez-Uzcátegui G, Bosker T. The effects of climate change on wildlife biodiversity of the Galapagos Islands. Climate Change Ecology. 2021;**2**:100026

[23] Russell JC, Kueffer C. Island biodiversity in the Anthropocene. Annual Review of Environment and Resources. 2019;**44**:31-60

[24] Mena CF, Quiroga D, Walsh SJ. Threats to sustainability in the Galapagos Islands: A social–ecological perspective. In: Sarmiento FO, Florich LM, editors. The Elgar Companion to Geography, Transdisciplinarity and Sustainability. Cheltenham: Edward Elgar Publishing Limited; 2020. pp. 342-358

[25] Denkinger J, Gordillo L, Montero-Serra I, Murillo JC, Guevara N, Hirschfeld M, et al. Urban life of Galapagos sea lions (*Zalophus wollebaeki*) on San Cristobal Island, Ecuador: Colony trends and threats. Journal of Sea Research. 2015;**105**:10-14

[26] Walsh JT, Kovaka K, Vaca E, Weisberg DS, Weisberg M. The effects of human exposure on Galápagos sea lion behavior. Wildlife Biology. 2020;**2020**(4):1-8

[27] Gregory TM, Livingston I, Hawkins EC, Loyola A, Cave A, Vaden SL, et al. Dirofilaria immitis identified in Galapagos sea lions (*Zalophus wollebaeki*): A wildlife health and conservation concern. Journal of Wildlife Diseases. 2023;**59**(3):487-494

[28] Drago M, Franco-Trecu V, Cardona L, Inchausti P, Tapia W, Páez-Rosas D. Stable isotopes reveal long-term fidelity to foraging grounds in the Galapagos sea lion (*Zalophus wollebaeki*). PLoS One. 2016;**11**(1):e0147857

[29] Alves F, Rosso M, Li S, Nowacek DP. A sea of possibilities for marine megafauna. Science. 2022;**375**(6579):391-392

[30] Montero-Serra I, Páez-Rosas D, Murillo JC, Vegas-Vilarrúbia T, Fietz K, Denkinger J. Environment-driven changes in terrestrial habitat use and distribution of the Galapagos sea lion. Endangered Species Research. 2014;**24**(1):9-19

[31] Trillmich F. Galapagos sea lions and fur seals. Noticias de Galápagos. 1979;**29**:8-14

[32] Villegas-Amtmann S, Jeglinski JW, Costa DP, Robinson PW, Trillmich F. Individual foraging strategies reveal niche overlap between endangered Galapagos pinnipeds. PLoS One. 2013;**8**(8):e70748

[33] Trillmich F, Wolf JB. Parent–offspring and sibling conflict in Galápagos fur seals and sea lions. Behavioral Ecology and Sociobiology. 2008;**62**:363-375

[34] Páez-Rosas D, Valdovinos LA, Elorriaga-Verplancken FR. Northernmost record of the Galapagos fur seal (*Arctocephalus galapagoensis*): A consequence of anomalous warm conditions around the Galapagos Archipelago. Aquatic Mammals. 2017;**43**(6):629-634

[35] Elorriaga-Verplancken FR, Morales-Vázquez JE, Ortega-Ortiz CD, Llamas-González M, Meza-Yáñez R, Páez-Rosas D. Northernmost Record of the Galapagos sea lion (*Zalophus wollebaeki*): Sightings along the Mexican Central Pacific and the Gulf of California during La Niña conditions. Aquatic Mammals. 2022;**48**(6):478-484

[36] Trillmich F. Maternal investment and sex-allocation in the Galapagos fur seal, *Arctocephalus galapagoensis*. Behavioral Ecology and Sociobiology. 1986;**19**:157-164

[37] Villegas-Amtmann S, Costa DP, Tremblay Y, Salazar S, Aurioles-Gamboa D. Multiple foraging strategies in a marine apex predator, the Galapagos sea lion *Zalophus wollebaeki*. Marine Ecology Progress Series. 2008;**363**:299-309

[38] Trillmich F. Attendance behavior of Galapagos fur seals. In: Gentry RL, Kooyman GL, editors. Fur Seals: Maternal Strategies on Land and at Sea. Princeton, NJ: Princeton University Press; 1986. pp. 168-185

[39] Villegas-Amtmann S, McDonald BI, Páez-Rosas D, Aurioles-Gamboa D, Costa DP. Adapted to change: Low energy requirements in a low and unpredictable productivity environment, the case of the Galapagos sea lion. Deep Sea Research Part II: Topical Studies in Oceanography. 2017;**140**:94-104

[40] Dellinger T, Trillmich F. Fish prey of the sympatric Galapagos fur seals and sea lions: Seasonal variation and niche separation. Canadian Journal of Zoology. 1999;**77**:1204-1216

[41] Jeglinski JW, Goetz KT, Werner C, Costa DP, Trillmich F. Same size–same niche? Foraging niche separation between sympatric juvenile Galapagos

sea lions and adult Galapagos fur seals. Journal of Animal Ecology. 2013;**82**:694-706

[42] Bonner WN. Seals of the Galapagos Islands. Biological Journal of the Linnean Society. 2008;**21**(1-2):177-184

[43] Páez-Rosas D, Rodríguez-Pérez M, Riofrío-Lazo M. Competition influence in the segregation of the trophic niche of otariids: A case study using isotopic Bayesian mixing models in Galapagos pinnipeds. Rapid Communications in Mass Spectrometry. 2014b;**28**:2550-2558

[44] Trillmich F. Galapagos fur seal, *Arctocephalus galapagoensis*. In: Croxall JP, Gentry RL, editors. Status, Biology, and Ecology of fur Seals. NOAA Technical Report NMFS 51. Seattle, Washington: US Department of Commerce; 1987. pp. 23-28

[45] Doney SC, Ruckelshaus M, Emmett Duffy J, Barry JP, Chan F, English CA, et al. Climate change impacts on marine ecosystems. Annual Review of Marine Science. 2012;**4**:11-37

[46] Wernberg T, Smale DA, Tuya F, Thomsen MS, Langlois TJ, De Bettignies T, et al. An extreme climatic event alters marine ecosystem structure in a global biodiversity hotspot. Nature Climate Change. 2013;**3**(1):78-82

[47] Chilvers BL, Robertson BC, Wilkinson IS, Duignan PJ. Growth and survival of New Zealand sea lions, *Phocarctos hookeri*: Birth to 3 months. Polar Biology. 2007;**30**:459-469

[48] Trillmich F, Kooyman GL. Field metabolic rate of lactating female Galápagos fur seals (*Arctocephalus galapagoensis*): The influence of offspring age and environment. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology. 2001;**129**(4):741-749

[49] Costa DP. Energetics. In: Perrin WF, Wursig B, Thewissen JGM, editors. Encyclopedia of Marine Mammals. San Diego: Academic; 2009. pp. 383-391

[50] Trillmich F, Limberger D. Drastic effects of El Niño on Galapagos pinnipeds. Oecologia. 1985;**67**:19-22

[51] Páez-Rosas D, Villegas-Amtmann S, Costa D. Intraspecific variation in feeding strategies of Galapagos sea lions: A case of trophic specialization. PLoS One. 2017;**12**(10):e0185165

[52] Wolf JB, Harrod C, Brunner S, Salazar S, Trillmich F, Tautz D. Tracing early stages of species differentiation: Ecological, morphological and genetic divergence of Galápagos sea lion populations. BMC Evolutionary Biology. 2008;**8**:1-14

[53] Páez-Rosas D, Riofrío-Lazo M, Aurioles-Gamboa D. Flexibility in the foraging strategies of the Galapagos sea lion inferred from a multiple approach analysis. In: Denkinger J, Vinueza L, editors. The Galapagos Marine Reserve, Social and Ecological Interactions in the Galapagos Islands. Cham: Springer; 2014. pp. 71-80

[54] Páez-Rosas D, Aurioles-Gamboa D. Spatial variation in the foraging behaviour of the Galapagos sea lions (*Zalophus wollebaeki*) assessed using scat collections and stable isotope analysis. Journal of the Marine Biological Association of the United Kingdom. 2014;**94**(06):1099-1107

[55] Jeglinski JW, Wolf JB, Werner C, Costa DP, Trillmich F. Differences in foraging ecology align with genetically divergent ecotypes of a highly mobile

marine top predator. Oecologia. 2015;**179**:1041-1052

[56] Chaves JA, Lopes F, Martínez D, Cueva DF, Gavilanes GI, Bonatto SL, et al. Population genetics and phylogeography of Galapagos fur seals. Frontiers in Genetics. 2022;**13**:725772

[57] Lopes F, Hoffman JI, Valiati VH, Bonatto SL, Wolf JBW, Trillmich F, et al. Fine-scale matrilineal population structure in the Galapagos fur seal and its implications for conservation management. Conservation Genetics. 2015;**16**(5):1099-1113

[58] Thompson DM, Conroy JL, Collins A, Hlohowskyj SR, Overpeck JT, Riedinger-Whitmore M, et al. Tropical Pacific climate variability over the last 6000 years as recorded in Bainbridge Crater Lake, Galápagos. Paleoceanography. 2017;**32**(8):903-922

[59] Rustic GT, Koutavas A, Marchitto TM, Linsley BK. Dynamical excitation of the tropical Pacific Ocean and ENSO variability by little ice age cooling. Science. 2015;**350**(6267):1537-1541

[60] Banks S, Edgar G, Glynn P, Kuhn A, Moreno J, Ruiz D, et al. A review of Galápagos marine habitats and ecological processes under climate change scenarios. In: Larrea Oña I, Di Carlo G, editors. Climate Change Vulnerability Assessment of the Galápagos Islands. USA: WWF and Conservation International; 2011. pp. 47-68

[61] Larrea Oña I, Di Carlo G, editors. Climate Change Vulnerability Assessment of the Galapagos Islands. USA: WWF and Conservation International; 2011. 116p

[62] Escobar-Camacho D, Rosero P, Castrejón M, Mena CF, Cuesta F. Oceanic islands and climate: Using a multi-criteria model of drivers of change to select key conservation areas in Galapagos. Regional Environmental Change. 2021;**21**(2):47

[63] Alava JJ, McMullen K, Jones J, Barragán-Paladines MJ, Hobbs C, Tirape A, et al. Multiple anthropogenic stressors in the Galápagos Islands' complex social–ecological system: Interactions of marine pollution, fishing pressure, and climate change with management recommendations. Integrated Environmental Assessment and Management. 2023;**19**(4):870-895

[64] Riofrío-Lazo M, Reck G, Páez-Rosas D, Zetina-Rejón MJ, Del Monte-Luna P, Reyes H, et al. Food web modeling of the southeastern Galapagos shelf ecosystem. Ecological Indicators. 2021;**132**:108270

[65] Hoegh-Guldberg O, Bruno JF. The impact of climate change on the world's marine ecosystems. Science. 2010;**328**(5985):1523-1528

[66] Nieto-Claudin A, Deem SL, Rodríguez C, Cano S, Moity N, Cabrera F, et al. Antimicrobial resistance in Galapagos tortoises as an indicator of the growing human footprint. Environmental Pollution. 2021;**284**:117453

[67] Alava JJ, Ross PS. Chapter 8 – pollutants in tropical marine mammals of the Galápagos Islands, Ecuador: An Ecotoxicological quest to the Last Eden. In: Fossi MC, Panti C, editors. Marine Mammal Ecotoxicology. London: Academic Press; 2018. pp. 213-234

[68] Kovacs K, Innes S. The impact of tourism on harp seals (*Phoca groenlandica*) in the Gulf of St. Lawrence, Canada. Applied Animal Behaviour Science. 1990;**26**(1-2):15-26

[69] Suryan R, Harvey J. Variability in reactions of Pacific harbor seals, *Phoca vitulina* richardsi, to disturbance. Fishery Bulletin. 1999;**97**(2):332-339

[70] Kucey L, Trites AW. A review of the potential effects of disturbance on sea lions: Assessing response and recovery. In: Trites AW, Atkinson SK, DeMaster DP, Fritz LW, Gelatt TS, Rea LD, Wynne KM, editors. Sea Lions of the World. Fairbanks: Alaska Sea Grant College Program; 2006. pp. 581-589

[71] Johnson WM, Lavigne DM. Mass tourism and the Mediterranean monk seal. The Monachus Guardian. 1999;**2**(2):1-30

[72] French SS, Gonzalez-Suarez M, Young JK, Durham S, Gerber LR. Human disturbance influences reproductive success and growth rate in California sea lions (*Zalophus californianus*). PLoS One. 2011;**6**(3):e17686

[73] Schipper J, Chanson JS, Chiozza F, Cox NA, Hoffmann M, Katariya V, et al. The status of the world's land and marine mammals: Diversity, threat, and knowledge. Science. 2008;**322**(5899):225-230

[74] Alfaro-Núñez A, Astorga D, Cáceres-Farías L, Bastidas L, Soto Villegas C, Macay K, et al. Microplastic pollution in seawater and marine organisms across the tropical Eastern Pacific and Galápagos. Scientific Reports. 2021;**11**(1):6424

[75] Alava JJ, Palomera C, Bendell L, Ross PS. Pollution as an emerging threat for the conservation of the Galapagos Marine Reserve: Environmental impacts and management perspectives. In: Denkinger J, Vinueza L, editors. The Galapagos Marine Reserve. Social and Ecological Interactions in the Galapagos Islands. Cham: Springer; 2014. pp. 247-283

[76] Perez-Venegas DJ, Toro-Valdivieso C, Ayala F, Brito B, Iturra L, Arriagada M, et al. Monitoring the occurrence of microplastic ingestion in Otariids along the Peruvian and Chilean coasts. Marine Pollution Bulletin. 2020;**153**:110966

[77] Ortega-Borchardt JÁ, Ramírez-Álvarez N, Mendoza LMR, Gallo-Reynoso JP, Barba-Acuña ID, García-Hernández J, et al. Detection of microplastic particles in scats from different colonies of California sea lions (*Zalophus californianus*) in the Gulf of California. Mexico: A preliminary study. Marine Pollution Bulletin. 2023;**186**:114433

[78] Donohue MJ, Masura J, Gelatt T, Ream R, Baker JD, Faulhaber K, et al. Evaluating exposure of northern fur seals, *Callorhinus ursinus*, to microplastic pollution through fecal analysis. Marine Pollution Bulletin. 2019;**138**:213-221

[79] Moreira-Mendieta A, Garcia-Garin O, Muñoz-Pérez JP, Urquía DO, Drago M, Borrell A, et al. Detection and quantification of microplastic pollution in the endangered Galapagos sea lion. Science of the Total Environment. 2023;**896**:166223

[80] Muñoz-Pérez JP, Lewbart GA, Alarcón-Ruales D, Skehel A, Cobos E, Rivera R, et al. Galápagos and the plastic problem. Frontiers in Sustainability. 2023;**4**:18

[81] Alava JJ, Salazar S, Cruz M, Jiménez-Uzcátegui G, Villegas-Amtmann S, Paéz-Rosas D, et al. DDT strikes back: Galapagos sea lions face increasing health risks. Ambio. 2011;**40**:425-430

[82] Culda CA, Dionnet R, Barbu AC, Cârstolovean AS, Dan T, Grijalva J, et al.

The presence of *Dirofilaria immitis* in Domestic Dogs on San Cristobal Island, Galapagos. Pathogens. 2022;**11**(11):1287

[83] Brock P, Hall A, Goodman S, Cruz M, Acevedo-Whitehouse K. Applying the tools of ecological immunology to conservation: A test case in the Galapagos sea lion. Animal Conservation. 2013;**16**(1):19-31

[84] Simeone CA, Gulland FM, Norris T, Rowles TK. A systematic review of changes in marine mammal health in North America, 1972-2012: The need for a novel integrated approach. PLoS One. 2015;**10**(11):e0142105

[85] Osterhaus A, Groen J, Spijkers H, Broeders H, UytdeHaag F, de Vries P, et al. Mass mortality in seals caused by a newly discovered virus-like morbillivirus. Veterinary Microbiology. 1990;**23**(1-4):343-350

[86] Coria-Galindo E, Rangel-Huerta E, Verdugo-Rodríguez A, Brousset D, Salazar S, Padilla-Noriega L. Rotavirus infections in Galapagos sea lions. Journal of Wildlife Diseases. 2009;**45**(3):722-728

[87] Sarzosa MS, Duignan P, DeRango EJ, Field C, Ríos C, Sanchez S, et al. Occurrence of mycoplasmas in Galapagos sea Lions (*Zalophus wollebaeki*) and their association with other respiratory pathogens. The Journal of Wildlife Diseases. 2021;**57**(3):623-627

[88] Denkinger J, Guevara N, Ayala S, Murillo JC, Hirschfeld M, Montero-Serra I, et al. Pup mortality and evidence for pathogen exposure in Galapagos sea lions (*Zalophus wollebaeki*) on San Cristobal Island, Galapagos, Ecuador. Journal of Wildlife Diseases. 2017;**53**(3):491-498

[89] Trillmich F, Meise K, Kalberer S, Mueller B, Piedrahita P, Pörschmann U, et al. On the challenge of interpreting census data: Insights from a study of an endangered pinniped. PLoS One. 2016;**11**(5):e0154588

[90] Alava JJ, Cheung WWL, Ross PS, Sumaila UR. Climate change–contaminant interactions in marine food webs: Toward a conceptual framework. Global Change Biology. 2017;**23**(10):3984-4001

[91] Alava JJ, Salazar S. Status and conservation of Otariids in Ecuador and the Galapagos Islands. In: Trites AW, Atkinson SK, DeMaster DP, Fritz LW, Gelatt TS, Rea LD, Wynne KM, editors. Sea Lions of the World. Fairbanks: Alaska Sea Grant College Program; 2006. pp. 495-519

[92] Salazar S, Denkinger J. Possible effects of climate change on the populations of Galapagos pinnipeds. Galapagos Research. 2010;**67**:45-49

[93] Blakeway J-A, Arnould JP, Hoskins AJ, Martin-Cabrera P, Sutton GJ, Huckstadt LA, et al. Influence of hunting strategy on foraging efficiency in Galapagos sea lions. PeerJ. 2021;**9**:e11206

[94] Riofrío-Lazo M, Zetina-Rejón MJ, Reck G, Páez-Rosas D, Arreguín-Sánchez F. Challenges in the application of the ecosystem approach to fisheries Management in the Galapagos Islands. In: Walsh SJ, Mena CF, Stewart JR, Muñoz Pérez JP, editors. Island Ecosystems: Challenges to Sustainability. Cham: Springer International Publishing; 2023. pp. 319-334

[95] Moity N. Evaluation of No-take zones in the Galapagos Marine Reserve, Zoning Plan 2000. Frontiers in Marine Science. 2018;**5**:244

[96] Jordán F. Keystone species and food webs. Philosophical Transactions of the

Royal Society B: Biological Sciences. 2009;**364**(1524):1733-1741

[97] Simberloff D. Flagships, umbrellas, and keystones: Is single-species management passé in the landscape era? Biological Conservation. 1998;**83**(3):247-257

[98] Kovacs KM, Aguilar A, Aurioles D, Burkanov V, Campagna C, Gales N, et al. Global threats to pinnipeds. Marine Mammal Science. 2012;**28**(2):414-436

[99] Meise K, Krüger O, Piedrahita P, Trillmich F. Site fidelity of male Galápagos sea lions: A lifetime perspective. Behavioral Ecology and Sociobiology. 2013;**2013**:1-11

[100] Kraus C, Mueller B, Meise K, Piedrahita P, Pörschmann U, Trillmich F. Mama's boy: Sex differences in juvenile survival in a highly dimorphic large mammal, the Galapagos sea lion. Oecologia. 2012;**171**:893-903