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Pacific Science, Volume 78, Number 1, January 2024, pp. 103-117 (Article)

Published by University of Hawai'i Press

Status of Laysan and Black-Footed Albatrosses on O‘ahu, Hawai‘i[1]

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Abstract: Laysan Albatross (*Phoebastria immutabilis*) fledged the first chick on the island of O‘ahu in 1947, but did not begin regularly breeding until 1992, followed by Black-footed Albatross (*P. nigripes*) who began breeding in 2022. Laysan Albatross have attempted to breed at nine locations on O‘ahu since 1979 and have established colonies at four sites: Ka‘ena Point, Kuaokalā, Kahuku Point, and James Campbell National Wildlife Refuge. We monitored Laysan Albatross colonies on O‘ahu weekly from 2004 to 2023; all individuals were censused, banded, and identified to gender. There was a population of 875 adults on O‘ahu in 2023, 490 of which were active breeders. The annual growth rate up to 2015 was 26%, but the growth rate slowed to 20% after human vandalism in 2015 that resulted in the destruction of 17 nests and at least 17 adults. The advent of predator exclusion fencing at Ka‘ena Point (2011) and Kuaokalā (2021) resulted in increased reproductive success (from 0.37 to 0.43) driven by a 25% increase in chick fledging success (from 0.60 before fencing to 0.80 after) which resulted in an estimated additional 69 chicks fledging compared to if the fence had not been constructed. Black-footed Albatross visits increased to O‘ahu from 3 in 2017 to 317 in 2023, coinciding with the disappearance of East Island in Papahānaumokuākea Marine National Monument which displaced 2,000 breeding pairs. These new colonies are at higher elevations and will continue to serve as refugia against sea level rise and as such, are conservation priorities.

Keywords: Laysan Albatross, Black-footed Albatross, Hawai‘i, predator fencing, social attraction, translocation

Laysan and Black-footed Albatrosses (*Phoebastria immutabilis* or mōlī, and *P. nigripes* or Ka‘upu) are large pelagic seabirds that are listed as Near Threatened by the International Union for the Conservation of Nature (IUCN; BirdLife International 2020) and as Species of Concern by the U.S. Fish and Wildlife Service. Causes of decline for both species include bycatch in commercial fishing operations, predation by introduced predators on their terrestrial breeding ground, and historically, collection for the feather and egg trade (Awkerman et al. 2020*a*, 2020*b*). The pelagic range of both species includes most of the North Pacific Ocean and both species have historically bred on a limited number of remote tropical and subtropical islands (Tickell 2000, Awkerman et al. 2020*a*, 2020*b*) from the west coast of North America to Japan (Hyrenbach et al. 2002, Shaffer et al. 2005, Awkerman et al. 2020*a*, 2020*b*).

In the 1970s, Laysan Albatrosses began colonizing islands from Japan to Mexico;

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Pacific Science (2024), vol. 78, no. 1:103–117
doi:10.2984/78.1.7

some sites were recolonizations of islands where the species had been extirpated, such as Mukojima, Japan (Kurata 1978) and Wake Island in the Western Pacific (Rauzon et al. 2008), and Kaua'i in the main Hawaiian Islands (Zeillemaker and Ralph 1977, Tickell 2000). Other sites were range expansions to islands that lacked fossil evidence of prior nesting by either species, including Lehua Islet and O'ahu in the main Hawaiian Islands (VanderWerf et al. 2007, Young et al. 2009*a*), and into the Eastern Pacific on Islas Guadalupe, Clarion, and San Benedicto in Mexico (Gallo-Reynoso and Figueroa-Carranza 1996, Pitman et al. 2004, Hernández-Montoya et al. 2014, Henry et al. 2021). The small Laysan Albatross colonies on O'ahu, Kaua'i, and Lehua in the Hawaiian Islands are of particular importance because they are at higher elevations and will be better able to withstand projected global climate changes and associated rises in sea level (USFWS 2005, Baker et al. 2006, Young et al. 2009*a*, Reynolds et al. 2012, 2015, VanderWerf et al. 2019). In 2018, Hurricane Walaka made a direct pass over Lalo (French Frigate Shoals) within the NWHI and both Trig and East Island disappeared, displacing more than 2,000 pairs of Black-footed Albatrosses (Baker et al. 2020). These threats are expected to increase in severity and frequency over time because of climate change.

Intensive monitoring of Laysan Albatross colonies on O'ahu began in 2003, and monitoring of Black-footed Albatrosses began in 2006. Summaries of the status of both species on O'ahu can be found in Young et al. (2009*a*) and Young and VanderWerf (2016). The Laysan Albatross colony at Ka'ena Point in particular has provided a wealth of information on the species, from rates of same sex pairing (33% of pairs; Young et al. 2008, Young and VanderWerf 2014), survival and demographic parameters (VanderWerf and Young 2011), disease (Young and VanderWerf 2008, VanderWerf and Young 2016), plastics and foraging ecology (Young et al. 2009*b*, Yonehara et al. 2016), population genetics (Young 2010), and the outcomes of conservation actions (Young et al. 2013). Since 2008 there have been several notable events and conservation actions that have changed the population trajectories of these species on O'ahu. Predator exclusion fences were built at three sites to protect the albatross colonies and other species (Young et al. 2012, VanderWerf et al. 2019). Social attraction and translocation of both species has occurred at two sites to create or enhance colonies (Young and VanderWerf 2016, VanderWerf et al. 2019). Lastly, an act of human vandalism occurred at Ka'ena Point in 2015 in which 17 nests out of a total of 79, were destroyed and numerous adults killed (Washington Post 2017), which proved to have a strong negative impact on the colony there. Since the last paper on the status of Laysan Albatrosses on O'ahu in 2009 (Young et al. 2009*a*), two new Laysan Albatross colonies have formed at Kahuku Point and James Campbell National Wildlife Refuge (JCNWR), and Black-footed Albatrosses have begun visiting in large numbers and bred for the first time. The purpose of this paper is to report on the status of both Laysan and Black-footed Albatrosses on O'ahu and to detail the increase in scope and focus of albatross management since 2008.

MATERIALS AND METHODS

Study Sites

We studied Laysan Albatrosses nesting at four locations on O'ahu: Ka'ena Point Natural Area Reserve and Kuaokalā Game Management Area, both owned by the state of Hawai'i, Kahuku Point, which is privately owned, and JCNWR, owned by the US Fish and Wildlife Service. We made observations on Black-footed Albatrosses from the same sites during Laysan Albatross monitoring activities. We also made observations at other sites where Laysan Albatross were known to visit but where there was not an established breeding colony: Mokuleia, Kahuku Golf Course, Dillingham airfield, and Moku Manu (Fisher 1948).

Ka'ena Point is the westernmost tip of O'ahu (21° 58′ N, 158° 27′ W) and the reserve protects 19 ha of arid coastal habitat ranging in elevation from sea level to 30 m. The Laysan Albatross colony at Ka'ena Point is

one of the most accessible Albatross colonies in the world, just 1 h by road from urban Honolulu, and is open to the public at all times. Kuaokalā is located 6 km east of Ka‘ena Point at 350 m elevation in a remote location in the northern Waianae Mountains (21° 56′ N, 158° 23′ W). Predator-exclusion fences capable of excluding all mammalian predators were constructed at Ka‘ena Point in 2011 and at Kuaokalā in 2021, to protect nesting seabirds and other natural resources, and predators were removed from each site shortly afterwards (Young et al. 2013). Prior to fence construction at both sites, alien mammalian predators were controlled, including feral cats (*Felis catus*), dogs (*Canis familiaris*), pigs (*Sus scrofa*), and small Indian mongoose (*Herpestes auropunctatus*), but were still present in reduced densities.

Kahuku Point (Kalaeokauna‘oa) is the northernmost point on O‘ahu (21° 42′ 43″ N, 157° 59′ 3″ W). The Laysan Albatross colony at Kahuku Point is on private land. The albatross nest primarily on a 35-acre conservation easement on the northeastern end of Turtle Bay Resort, with some pairs nesting along the edges of a golf course at Turtle Bay Resort that is adjacent to the easement, and on privately owned land at Marconi Station. The conservation easement was established in 2014 and the land is being actively restored through the removal of invasive plants, especially Ironwood (*Casuarina equisetifolia*) and out-planting native species with a focus on recreating the plant diversity previously observed in the area.

James Campbell National Wildlife Refuge is located at the northeastern tip of O‘ahu and was created in 1976 to protect habitat for endangered waterbirds. In 2005, JCNWR was expanded to include an additional 50.5 ha parcel of coastal strand and sand dunes that provided suitable nesting habitat for seabirds, though none nested there at that time. To protect the future albatross colonies at JCNWR, we built a 6.5 ha predator-exclusion fence in 2016 to keep out all terrestrial mammalian predators (VanderWerf et al. 2019) at the translocation site, and the entire refuge (445 ha) is protected by an ungulate fence and predator control. The habitat where Laysan Albatross nest on the refuge is a mix of native coastal dune and non-native shrubland.

Albatross nesting at other locations, including private properties in Mokuleia, and at the City and County owned Kahuku golf course are also monitored approximately monthly.

Monitoring Techniques

We monitored Laysan Albatrosses at Ka‘ena Point and Kuaokalā from 2003 to 2023, and at Kahuku Point and JCNWR from 2015 to 2023 during the November to June breeding season. Each breeding season spanned two calendar years, so we referred to breeding seasons by the year in which chicks fledged. We banded all chicks in April or May each year, when they were 3–4 months old and 1–2 months before fledging, with a United States Geological Survey Bird Banding Laboratory metal leg band with a unique serial number, and beginning in 2006, with a second field-readable plastic leg band. At all sites except for Kahuku Point, we collected a small (400 μL) blood sample from the tarsal vein of each bird for use in identifying gender and other genetic analyses. All individuals were classified to gender following protocols outlined in Fridolfsson and Ellegren (1999) and Young et al. (2008).

We visited Kahuku Point daily, Ka‘ena Point and JCNWR weekly, and Kuaokalā once or twice a month throughout the breeding season. During each visit, we checked the band number of all birds on nests and recorded reproductive outcomes. We also attempted to identify all other birds from a distance using binoculars and band any new birds in the colony. We monitored nesting attempts from egg-laying through chick fledging. Each time we encountered an adult, its location, status (incubating, brooding, or walking), and association with any other adult or chick were recorded. We also recorded nest number, parent information, hatching date, disease status, and date of either fledging or death for all chicks. Chicks that survived to fledging age were banded with both a federal metal band and a field-readable plastic band.

Management Techniques

Prior to 2011, albatrosses were managed on O‘ahu through mammalian predator control at breeding colonies and ungulate fencing to keep out pigs and dogs. In late 2011, the first predator exclusion fence was constructed at Ka‘ena Point, and since then fences have been built at JCNWR (2016) and Kuaokalā (2021) to improve threat management for albatrosses and other seabirds (Young et al. 2012, Young et al. 2013, VanderWerf et al. 2014). The Kuaokalā fence was built exclusively to protect the LAAL colony because they had been suffering near complete reproductive failure due to mongoose predation. The fence at JCNWR was constructed prior to any seabirds breeding at the site to serve as a safe translocation site for both Laysan and Black-footed Albatross as well as other seabird species (VanderWerf et al. 2019).

There is no predator exclusion fence at Kahuku Point; instead mammalian predators were controlled starting in 2018 using a grid of ~70 traps. Predator control is focused on the introduced small Indian mongoose and feral cats. From 2018 to 2020 mongoose control was conducted from October to July and year-round trapping began in 2020.

In addition to conducting threat control at every active breeding colony, significant efforts have been made to conduct seabird restoration at two of the sites (Ka‘ena Point and JCNWR) in an attempt to bolster existing Black-footed and Laysan Albatross populations and create new ones.

Social attraction for Black-footed Albatrosses was conducted at Ka‘ena Point from 2011 to 2015 using a combination of plastic decoys and acoustic attraction (Young and VanderWerf 2016). The study was successful in attracting more Black-footed Albatross to visit the site but did not result in nesting and so it was discontinued in 2015 to focus on planning translocation of that species to JCNWR. With the disappearance of East Island in 2018 and associated increase in Black-footed Albatross observations at Ka‘ena Point, the decoys (but not the sound system) were re-deployed from 2019 to 2023 to capitalize on the natural increase in visitation.

With the increasing recognition of the impact of sea level rise on populations of both Albatross species, and the simultaneous availability of excess Laysan Albatross eggs from the Pacific Missile Range Facility on Kaua‘i (PMRF), translocations of Laysan Albatross from Kaua‘i to O‘ahu were started in 2015 (VanderWerf et al. 2019). This project replaced the previous egg swap foster program that was devised as a way to simultaneously bolster the Laysan Albatross population on Kaua‘i and reduce a human-wildlife conflict at PMRF (Young et al. 2014). Translocations of Laysan Albatross began at JCNWR using eggs from PMRF that were temporarily fostered under adults at Ka‘ena Point, and then hand-raised at JCNWR and concluded in 2017 (VanderWerf et al. 2019). From 2017 to 2021, translocations and social attraction of Black-footed Albatrosses also began at JCNWR, using chicks from Midway Atoll and Tern Island (VanderWerf et al. 2019). Since Ka‘ena Point had suffered a large setback with the vandalism event of 2017, the PMRF egg swap was modified to include Ka‘ena Point as a recipient location, and from 2018 to 2022, PMRF eggs were placed in foster nests at Ka‘ena Point following the protocols in Young et al. (2014).

Analyses

We determined the number of Laysan and Black-footed Albatrosses present on O‘ahu from 2008 to 2023 by compiling our own banding records and observations and also from the published literature, federal banding records, and discussions with biologists and birders. We included only banded birds in the population estimate to avoid double counting of unbanded birds.

In this paper, we estimated size of the breeding population by counting all birds that bred in a given year and those that bred in one of the prior 2 years, to account for birds that may have skipped a breeding year. Size of the non-breeding population is difficult to estimate in seabirds, particularly in albatrosses, because of their delayed maturation and because a variable portion of breeders skip breeding in a given year (Citta et al. 2007), but

improvements in mark-recapture techniques have allowed better estimation of recruitment age and skipped breeding. For example, VanderWerf and Young (2016) used mark-recapture models with unobservable states to estimate that breeders comprised an average of 56% of the Laysan Albatross population on O'ahu. We estimated the total population size, including non-breeders, by dividing the number of breeders by 0.56. We then calculated the average rate of increase in the breeding population from 2008 (the last status update on O'ahu) to 2023 using the formula: $k = (n_t/n_0)^{-t}$, where k is the rate of increase, n is the number of nesting pairs, and t is time in years. Since Ka'ena Point, the largest albatross colony on the island, suffered a large loss of breeding adults in December 2015, we calculated the growth rates separately for 2008–2016 and 2016–2023 to examine the impact that this event had on the growth rate of the colony.

We calculated reproductive success each year as the number of chicks fledged divided by the number of eggs laid. We calculated hatching success as the number of chicks hatched divided by the number of eggs laid, and fledging success as the proportion of chicks hatched that survive to fledge. We did not include vandalized nests in calculations of hatching rate and fledging rate in hatch year 2016. Likewise, we did not include foster eggs from Kaua'i that we placed at Ka'ena Point and JCNWR and counted those as failed nests because the natural egg would not have hatched, to determine the natural rates of these demographic parameters. We used chi-squared tests to compare hatching, fledging, and reproductive success of birds nesting within predator-exclusion fences and those nesting outside of predator exclusion fences to examine the impact of this management technique on reproductive outcomes.

RESULTS

Laysan Albatross Population History

Laysan Albatrosses have attempted to breed at nine locations on O'ahu since 1979: Ka'ena Point NAR, Kuaokalā GMA, Dillingham Airfield, private and public property in Mokuleia in northwestern O'ahu; Kahuku Point, JCNWR, and Kahuku Golf Course on the northern point; and Kaneohe Marine Corps Base (MCBH) and Moku Manu on the eastern side of O'ahu (Figure 1). Three of these are new sites where albatross had not nested before 2008 (Mokuleia, JCNWR, and Kahuku Golf course). The four sites on O'ahu where Laysan Albatross have successfully established and maintained colonies (defined as successfully fledging chicks) are Ka'ena Point NAR, Kuaokalā GMA, Kahuku Point, and JCNWR, with Kahuku Point and JCNWR only starting in 2018. All colonies started with natural colonization with the exception of JCNWR, which was started through social attraction. Laysan Albatross nested in small numbers at Kahuku Point prior to 2008 (Young et al. 2009*a*), but no chicks were fledged during that time. One Laysan Albatross nest was reported in 2017, and then four nests were discovered in 2018 within the conservation easement on private land owned by Turtle Bay Resort. With the initiation of predator control efforts in 2019, up to 17 eggs are now laid each year. At JCNWR, Laysan Albatrosses began visiting almost immediately after social attraction began in 2015. The first nesting attempt by a socially attracted pair occurred in the 2017–2018 season, and the first chick fledged in 2019. The number of nests had grown to nine by 2023 (Table 1).

Laysan Albatross have still attempted to nest intermittently at MCBH, Dillingham Airfield, Kahuku Golf Course, and Mokuleia Beach Park, but eggs were legally removed at those sites to reduce the chance of aircraft strikes and prevent mortality of breeding adults from dogs and people and placed under wild foster nests across the island. All adults encountered at MCBH and Dillingham have been banded by USDA, Wildlife Services personnel and removed from the site; some have been released at Ka'ena Point NAR. The last known nesting attempts at Dillingham Airfield were in 2019 and in 2016 at MCBH.

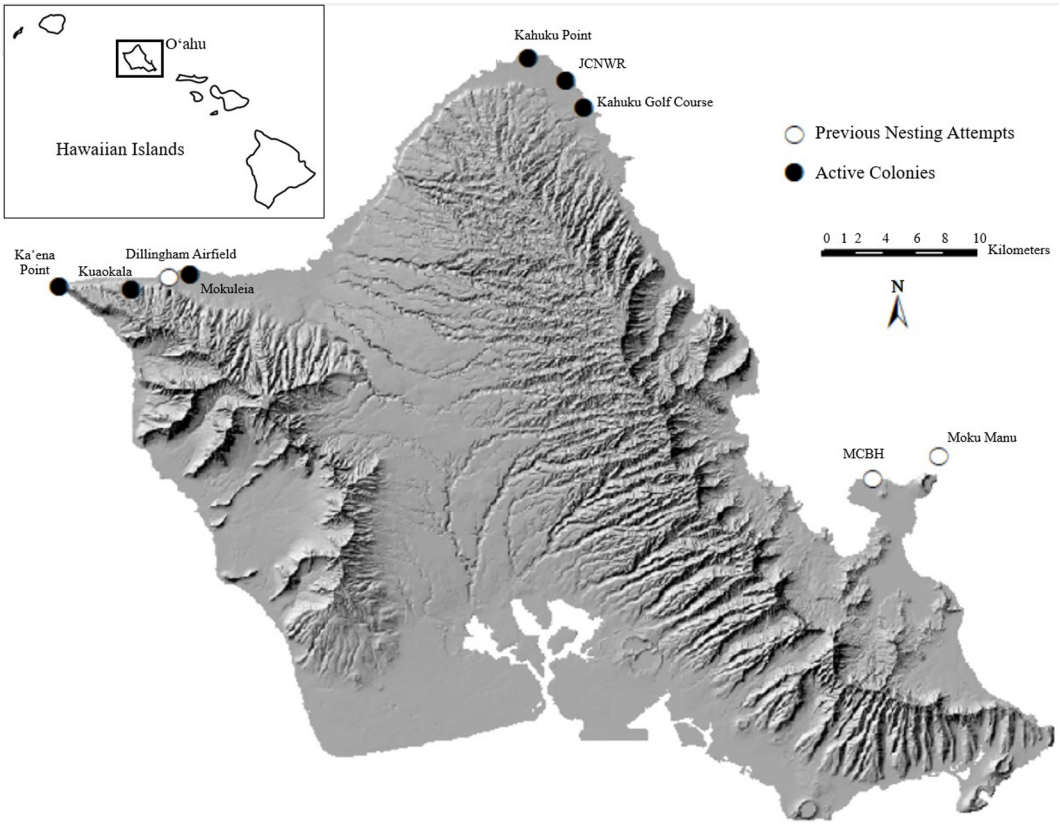

FIGURE 1. Current and historical colonies of Laysan Albatrosses on O'ahu.

Laysan Albatross Population Estimates and Reproductive Success

The Laysan Albatross breeding population on O'ahu in 2023 was 490, including birds that bred in 2023 and those that bred in 2022 and likely skipped 2023. Using the estimated proportion of the population comprised by breeders (56%; VanderWerf and Young 2016), the total population, including non-breeders, was 875. The average breeding population annual growth rate from 2008 to 2023 (163–490 breeders) was 20.0%. The growth rate has slowed despite an increase in colony size and an increase in the number of chicks fledged over time. When the annual growth rate was calculated separately before and after the vandalism event in 2015, the growth rate after the vandalism (2016–2023) was lower, 20.4%, than the growth rate before the vandalism from 2008 to 2016 (26.4%). The minimum number of adult Laysan Albatross killed was estimated to be 17 based on the number of destroyed nests and other evidence found at the site but could have been as high as 25.

A total of 2,283 Laysan Albatross have been banded on O'ahu since they began visiting in the late 1980s. The sex ratio of chicks produced on O'ahu has been equal (0.508 female; N = 891 chicks with known gender). The female-biased sex ratio previously reported at both colonies (60%; Young and VanderWerf 2014) is relatively unchanged at 62% female and this appears to be due to female biased immigration as there are no gender differences in chicks produced or adult survival (VanderWerf and Young 2011, 2016).

While the total number of eggs laid increased over time (Figure 2), the hatching,

TABLE 1

Summary of Attempted and Current Nesting Locations of Laysan Albatross on Oʻahu, Hawaiʻi

	Year First Seen	Year First Nest	Year First Successful Nest	Last Known Nest	# Pairs 2023	Avg. Reproductive Success	Year Predator Management Started	Predator Fenced?	BFAL Status
Kaʻena Point	1985	1991	1992	Current	106	0.48	1995	2011	Bred once
Kuaokalā	1985	1990	1995	Current	54	0.37	1999	2021	Not present
Kahuku Point	1979	1979	2018	Current	17	0.26	2018	None	Visiting
JCNWR	1987	2019	2019	Current	9	0.3	2015	2016	Visiting
Kahuku Golf Course	1978	2020	N/A	2023	2	0	N/A	None	Visiting
Mokuleia	1988	2020	2020	Current	2	0.5	N/A	None	Not present
Dillingham Airfield[a]	1985	1990	N/A	2019	0	N/A	N/A	None	Not present
MCBH[a]	1985	Early 2000s	N/A	2016	0	N/A	N/A	None	Not present
Moku Manu	1947	1947	1947	1948	0	N/A	N/A	None	Not present

[a] Birds are actively discouraged from nesting due to a bird–aircraft strike hazard.

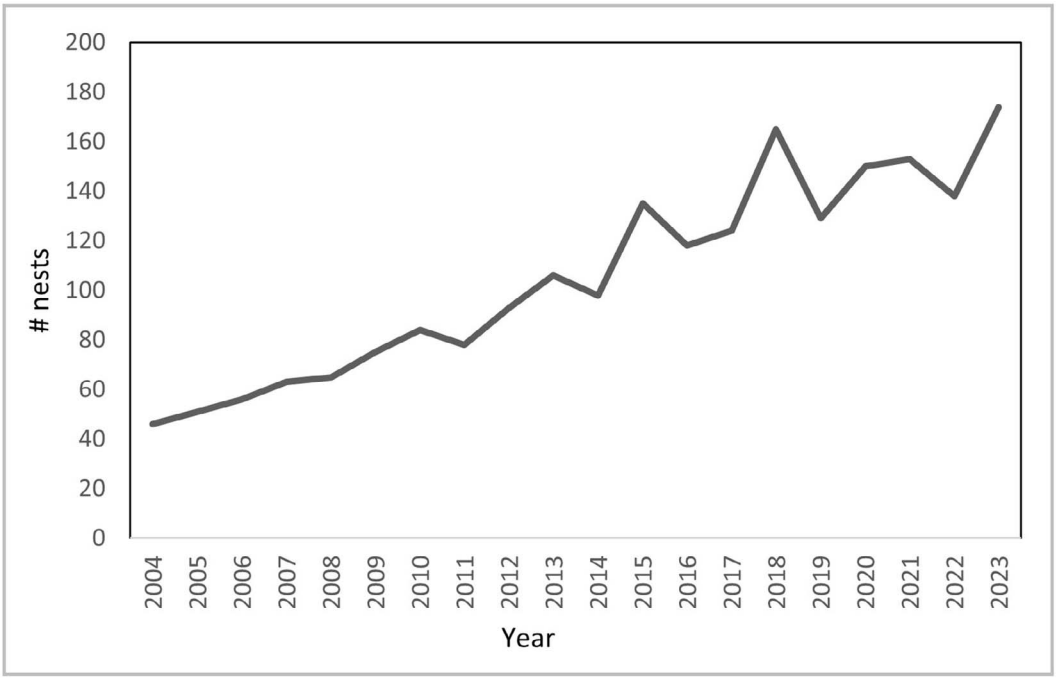

FIGURE 2. Total number of Laysan Albatross nests on O'ahu over time

fledging and thus reproductive success have been variable at both sites due to a combination of predation, vandalism, and oceanographic events. Kuaokalā showed higher variability compared to Ka'ena. Hatching success has been relatively constant over time, but the periodic catastrophic predation on chicks by mongooses caused large fluctuations in fledging, and thus overall reproductive success. Hatching success at Kahuku has ranged from 0.17 to 0.81, and similarly, fledging success has also varied widely, ranging from 0.33 to 0.60 (Figures 3 and 4).

Black-footed Albatross Population History

Black-footed Albatross sightings increased with the initiation of social attraction at Ka'ena Point in 2011, and then declined after the social attraction project at Ka'ena Point was discontinued in 2015, when the system was destroyed in the vandalism event. There was a lull from 2015 to 2018 with very few sightings, and then a dramatic increase at Ka'ena Point from 2018 (0 sightings) to 2019 (42 sightings); the 2019 breeding season commenced a few weeks after the 2018 hurricane event. Sightings at Ka'ena increased to a peak of 88 in 2021 with up to four birds visiting at one time and a total of nine unique individuals (based on banding records) including one bird banded as a chick on Lehua Islet. The first nesting attempt occurred at Ka'ena Point in November 2021 (2022 breeding season), though the egg was not fertile and thus failed to hatch. No breeding occurred in 2023 and the male from the breeding pair was not seen in 2023. Black-footed Albatross sightings at Ka'ena Point declined dramatically to only 15 in 2023, which coincided with an increase in activity at JCNWR in association with the return of translocated individuals there. On several occasions, the same individual birds were noted at multiple sites within the same day demonstrating that the birds traveled between sites (Figure 5).

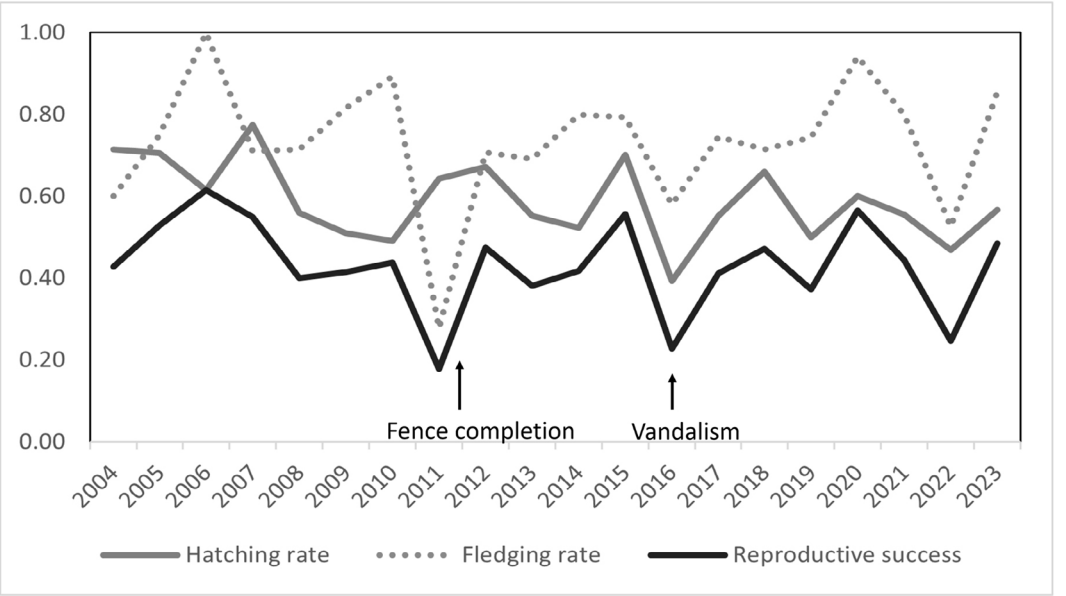

FIGURE 3. Rates of hatching, fledging, and reproductive success for Laysan Albatross at Ka'ena Point, Hawai'i.

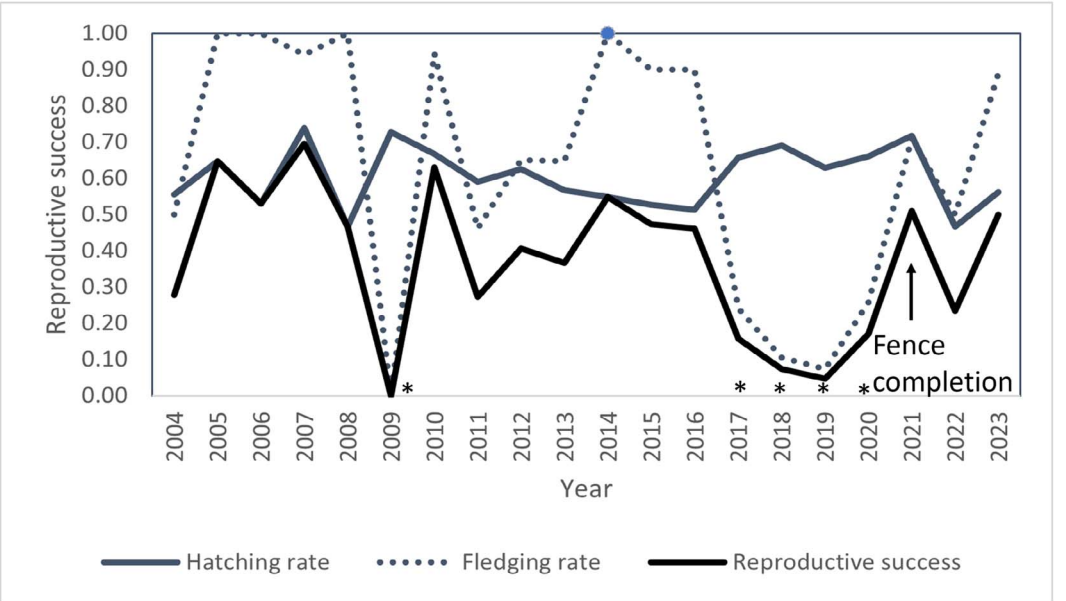

FIGURE 4. Rates of hatching, fledging, and reproductive success for Laysan Albatross at Kuaokalā, Hawai'i. * denotes mongoose predation events.

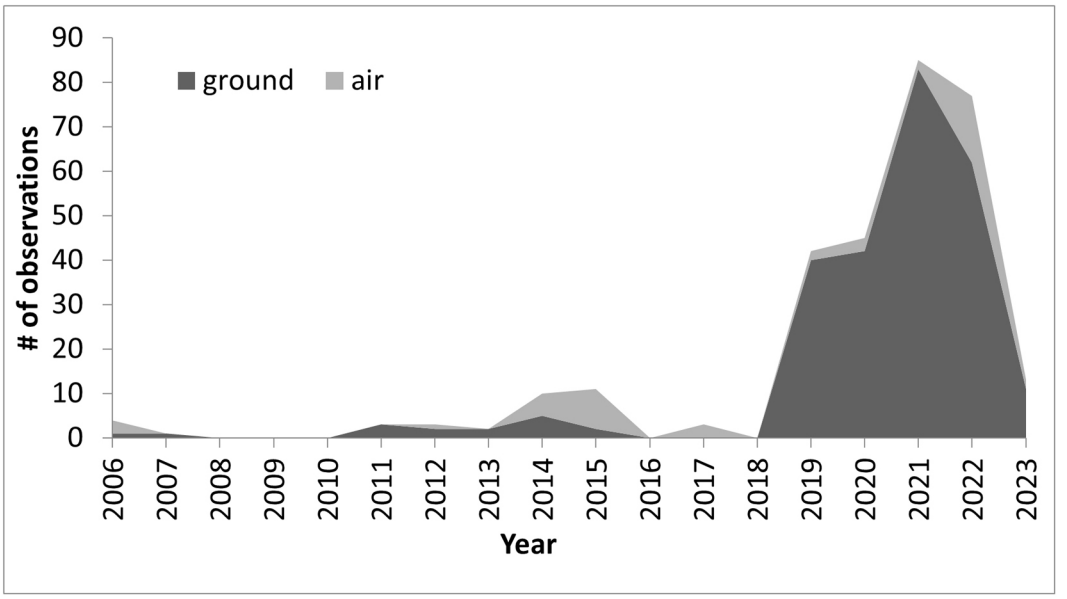

FIGURE 5. Number of Black-footed Albatross visits to Ka'ena Point, Hawai'i each year and whether birds were observed on the ground or flying above the colony. From 2011 to 2015 social attraction equipment was deployed. In 2018, 2,000 pairs were displaced as a result of nesting habitat disappearance on East Island.

Impact of Management Activities on Reproductive Outcomes

The advent of predator exclusion fencing resulted in greater protection of existing colonies. At Ka'ena Point and Kuaokalā, hatching rates were similar before and after predator exclusion fences (0.61 vs. 0.58; $X^2 = 2.4$, df = 1, $N = 1{,}984$, $p = 0.121$), but fledging rates increased by 25% after predator fence construction, from 0.60 ± 0.09 to

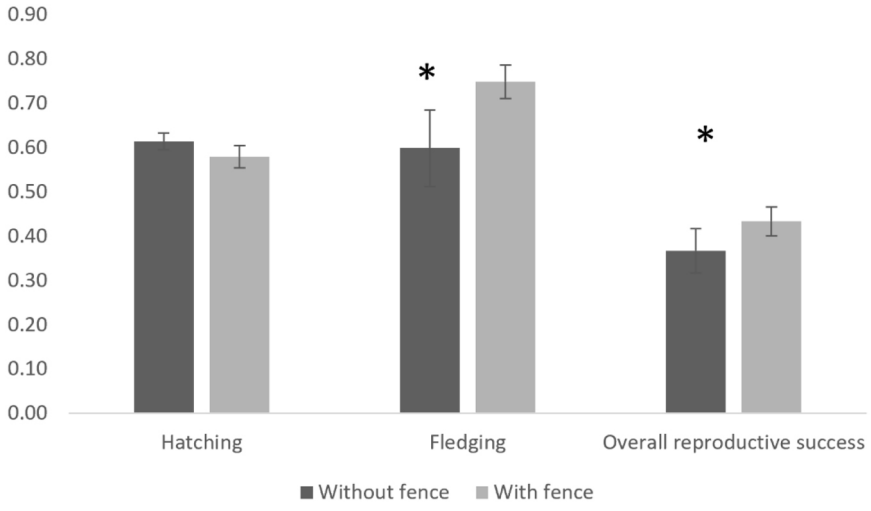

FIGURE 6. Laysan Albatross reproductive success with and without predator exclusion fencing. * denotes statistical significance $p \leq 0.05$.

0.75 ± 0.04 (df = 1, N = 1,179, X^2 = 31.03, $p < 0.00001$; Figure 6). This resulted in a 16% increase in reproductive success from 0.37 ± 0.05 to 0.43 ± 0.03 (df = 1, N = 1,984, X^2 = 9.21, p = 0.0024).

DISCUSSION

Activity for both Laysan and Black-footed Albatross increased significantly across O'ahu both in terms of population size and distribution in the last 15 years. This was due to a combination of natural population increase and efficacy of various management actions. The number of established Laysan Albatross breeding colonies doubled from two to four, with one new site arising through natural colonization after decades of unsuccessful nesting attempts (Kahuku Point) and a second from social attraction (JCNWR). While it is still too soon to report on the full impact of translocation activities at JCNWR since Albatrosses do not begin breeding until 8–9 years old, it is clear that birds of both species are returning and will almost certainly nest in the coming years.

While initial attempts at Black-footed Albatross social attraction were unsuccessful (Young and VanderWerf 2016) the disappearance of East Island, French Frigate Shoals in October 2018 may have jump-started the colonization across O'ahu. Five adult Black-footed Albatrosses were banded at Ka'ena Point, and in 2022 a pair (both banded at Ka'ena as adults) laid the first egg ever recorded in the inhabited Hawaiian Islands. Unfortunately, the egg did not hatch, and the nest ultimately failed, but the number of sightings continued to increase throughout that year. However, during the 2023 breeding season, the male from the first Black-footed pair was not seen, and there were no breeding attempts at Ka'ena Point. The number of Black-footed Albatross sightings also declined at Ka'ena Point in 2023, but interestingly, the number of sightings increased dramatically during the same time period at JCNWR. The first translocated Black-footed Albatross began returning in 2021 to JCNWR when the oldest chicks were 4 years old. By 2023, the younger cohorts also began to return and spend significant amounts of time there. With the decrease in attendance of the breeding pair at Ka'ena Point, the presence of the returning translocation chicks likely acted as a strong attractant to wild Black-foots to JCNWR. So while the number of visits at Ka'ena decreased, overall visitation island wide continues to increase as a result of a combination of translocation and social attraction, and a possible influx of displaced birds from East Island.

The population of Laysan Albatross on O'ahu has grown dramatically from an estimated 291 birds in 2008 to 814 in 2023 with an annual growth rate of 20%. The rate of increase exceeds natural recruitment from chicks hatched on island and is still driven, in large part, by immigration to the population from other colonies. Despite this high rate of increase, it has slowed from the rate of 27% prior to 2008, and from 26% in the 2008–2016 time period. The main cause of the decline in population growth was the massacre that happened at Ka'ena Point in 2015, which resulted in death of up to 25 adults, or 9% of the total number of adults (N = 282) in the colony that year. Since Laysan Albatross can skip multiple breeding seasons, and recruitment takes 8–9 years from the year of hatching, it was not possible to fully estimate the magnitude of this event until now. While the exact number of adults killed will never been known, it is clear that it was a large number that took a heavy toll on the colony. The slowed population growth was likely due to the loss of potential reproduction from the killed breeders, which would continue until they were replaced through recruitment. Continued management is needed to help this colony continue recovering from the vandalism event.

The techniques to manage Albatross have changed dramatically since 2008 with large gains achieved in terms of predator exclusion and removal, and restoration in areas that have been secured against predators. The introduction of predator exclusion fencing for albatross management in Hawai'i has resulted in a 25% increase in fledging success and a 16% increase in overall reproductive output. Based on the number of breeding seasons each

fence has been in place, this has resulted in an additional 69 Laysan Albatross chicks added to the population. Interestingly, Albatross on O‘ahu appear to be most vulnerable to predation during the chick phase when they are unattended by adults rather than the egg phase. It is likely that the presence of adult birds acts as a deterrent for most predators due to their large size whereas smaller unattended chicks are easier to approach. Mongoose appear to be particularly tuned into chick predation and contributed to the near total reproductive failure of birds at Kuaokalā in 2009, and again from 2017 to 2020. The predation event in 2009 resulted not only in every single chick dying, but every shred of the carcasses being consumed to the point where detection dogs could no longer determine where the bodies were. It had initially been assumed that the colony experienced human vandalism, but when it happened again in 2017, trail cameras were able to capture mongooses and a suite of scavengers, consuming the carcasses whole and thus causing the complete disappearance of the chicks. It was the visual demonstration of the intensity of the predation that facilitated funding of the full predator exclusion fence that exists at the site today. While not every Albatross colony has the topography or underlying land use and zoning regulations that make it suitable as a candidate for predator exclusion fencing, effective predator control can still achieve positive outcomes in these cases.

The main Hawaiian Islands, and O‘ahu in particular, continue to increase in importance for the long-term conservation of both Laysan and Black-footed Albatrosses. With sea level rise rapidly decreasing the size of their available breeding habitat in the NWHI, these high island breeding colonies will serve as refugia and beacons for birds that will be displaced in the coming years. Both Laysan and Black-footed Albatross would benefit from expanding translocations and social attraction to predator free locations on islands outside of O‘ahu to increase the number of secure high island colonies. The congruency between demographic and reproductive parameters between these small colonies and their larger counterparts in the NWHI also make these small colonies ideal natural laboratories to continue long-term studies on the biology and natural history of these species. Finally, and perhaps most importantly, these colonies collectively are among the most visited albatross colonies worldwide and serve as an important link between people and the ocean. While this access comes with the potential for destruction, it provides opportunities to engage the public and the next generation of scientists in continuing the work to protect these sentinels of our oceans.

ACKNOWLEDGMENTS

We thank the Hawaii Division of Forestry and Wildlife and the Natural Area Reserves System for their management efforts and permission to conduct work at Ka‘ena Point NAR and Kuaokalā GMA. We thank Chris Miller, Tammy Turgeau, Leilani Fowlke, Lynx Gallagher, Tim Tybuszewsi, Laura Zoller, Christine Tarshi, Alice Terry, Sue Cortez, Cindy Jenness, Krissi Jenness, Karen Turner, Sadie Hausman, Christine Lonie, Gwen Young, Therese Atalla, Ty Spangler, Michael Tuerk, Nahaku Kekauoha, and numerous Kupu and Americorps volunteers for assistance in the field. We thank North Shore Community Land Trust for their management at Kahuku Point and Hawaii Marine Animal Response who organized volunteers to monitor the Kahuku Point nests daily. We thank Ken Hayes and the staff at the Bishop Museum Pacific Center for Molecular Biodiversity for identifying the gender of the Laysan Albatross. Portions of this work was funded by the David and Lucile Packard Foundation and the National Fish and Wildlife Foundation. All work was conducted under required state and federal wildlife permits. This paper is dedicated to the memory of Betsy Gagne and Brent Liesemeyer who spent decades ensuring that Ka‘ena Point was a safe place for the native flora and fauna of Hawai‘i.

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