Focal Species: Northwestern Hawaiian Islands Passerines:

- Millerbird (*Acrocephalus familiaris*)
- Laysan Finch (*Telespiza cantans*)
- Nihoa Finch (*Telespiza ultima*)

Synopsis: These three species occur only on tiny, uninhabited islands in the remote northwestern region of the Hawaiian Archipelago. There formerly were two subspecies of Millerbird, one on Laysan (*A. f. familiaris*), which was extinct by 1923, and another on Nihoa (*A. f. kingi*), which was discovered in the same year. In 2011 and 2012, a total of 50 Millerbirds were translocated from Nihoa to Laysan, and the birds are now breeding there, but the population is very small and its long-term survival is not yet certain. Both finches are Hawaiian honeycreepers and are primarily restricted to their namesake islands, though small numbers of translocated Laysan Finches persist at Pearl and Hermes Reef. Keys to the conservation of these species are continued biosecurity and habitat management on the islands where they currently occur, and creation of additional populations on other islands to reduce extinction risk.

Nihoa Millerbird. Photo Eric VanderWerf

Nihoa Finch male. Photo Eric VanderWerf

Laysan Finch male. Photo C. Rutt

Geographic region: Northwestern Hawaiian Islands
Taxonomic Group: Passerines
Federal Status: Endangered
State status: Endangered
IUCN status: Critically Endangered (Millerbird and Nihoa Finch), Vulnerable (Laysan Finch)
Conservation score, rank: 18/20, At-risk
Watch List 2007 Score: Red
Climate Change Vulnerability: High

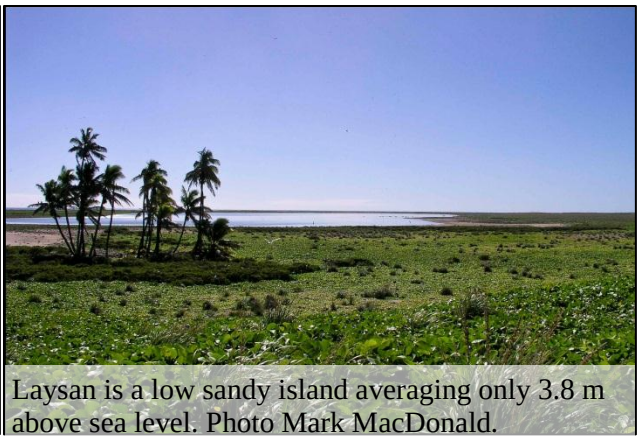
Population Size and Trend:
Millerbird. Estimates of the Millerbird population size on Nihoa have fluctuated widely during 1967-2011, from as few as 31 birds to a maximum of 814 (Kohley et al. 2011). The most recent estimate was 384 in 2012. However, these estimates must be viewed with caution because of the large errors resulting from the transect-based monitoring method used (Conant et al. 1981), and this has made it difficult to detect changes in population size (Gorresen et al. 2012). Genetic analyses indicate the effective population size is much smaller than the actual population size and that there has been some loss of genetic diversity (Fleischer et al. 2007, Addison and

Diamond 2011). In 2011 and 2012, a total of 50 Millerbirds was removed from Nihoa and translocated to Laysan to create a second population. All birds survived the journey each year, and breeding began within a few weeks of release. The population size on Laysan is changing rapidly, but in September 2012 it was thought to be 63 birds, consisting of 14 adults from the 2011 translocation cohort, 26 adults from the 2012 translocation cohort, and 23 fledglings (USFWS and American Bird Conservancy [ABC], unpubl. data).

Nihoa Finch. Estimates of the Nihoa Finch population size have fluctuated from 945-4647 birds during the years from 1967-2011. The most recent estimate in 2012 was 4475±909 birds. The population size appeared to be fairly stable from 2009-2011 at 2400-2900 birds (VanderWerf et al. 2011), but the 2012 estimate was substantially higher. These estimates have greater relative precision than those for the Millerbird because the finches are easier to detect than Millerbirds, but the fluctuating numbers and large errors associated with estimates still have made it difficult to determine the population trend.

Laysan Finch. The mean population estimate on Laysan from 1968 through 1990 was 11,044±3,999 (SD; Morin and Conant 1994). In 1998, year of the latest published estimate, the population was estimated to be 9,911±1,755 (Morin and Conant 2002). On four islets of Pearl and Hermes Atoll where this species was translocated, the total population was estimated to be 373 birds in 1998 (Morin and Conant 2002) and 1,043 ± 253 in 2007 (Kropidlowski, 2007). These islands were partly inundated by the 2011 Japan tsunami and severe storms the same year, and the finches have not been surveyed since then so the current status and size of these populations is unknown.

Nihoa is a steep, rocky island only 63 ha in size. Photo Eric VanderWerf.



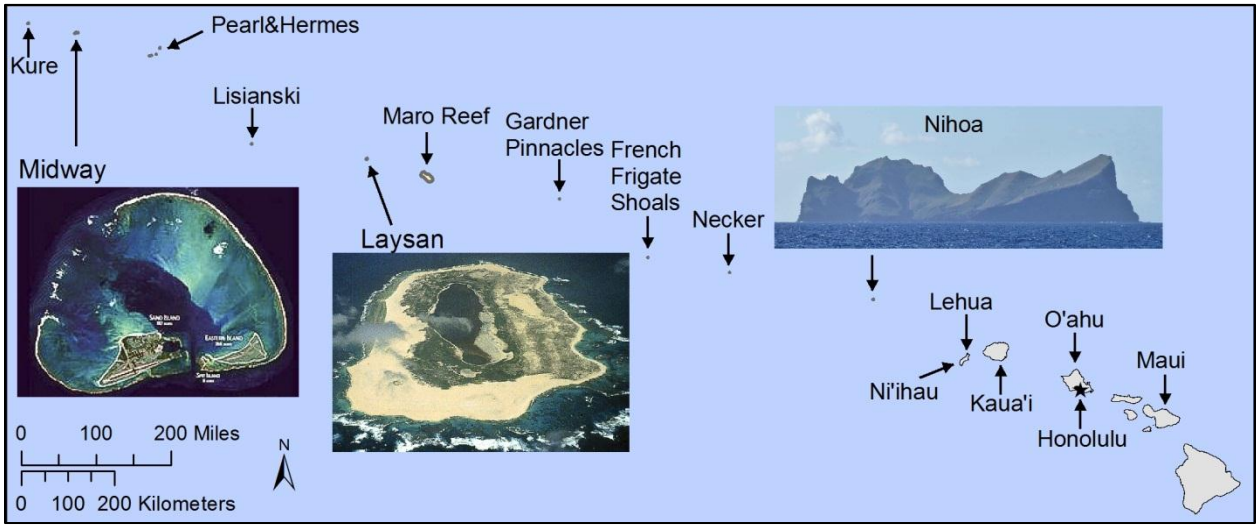
Laysan is a low sandy island averaging only 3.8 m above sea level. Photo Mark MacDonald.

Range:

Millerbird. The Millerbird is found only on the small islands of Nihoa and Laysan in the remote northwestern region of the Hawaiian Archipelago. Nihoa is a high, rocky island with a maximum elevation of 277 m (910 feet) and is only 63 hectares (156 acres) in size. Laysan is somewhat larger at 415 ha (1,025 acres), and is a low-lying atoll with a maximum elevation of only 12 meters above sea level. The Laysan Millerbird was extinct by 1923 after all vegetation on the island was destroyed by alien rabbits and human activities, but in 2011 and 2012 a total of 50 Millerbirds was translocated from Nihoa to Laysan. The population on Laysan is still very small and is not yet securely established.

Nihoa Finch. The Nihoa Finch is restricted to the island of Nihoa, which is 63 hectares (156 acres) in size. Finches occur throughout the island. Introduced populations on Tern Island and East Island at French Frigate Shoals were extirpated by the early 1980s.

Laysan Finch. The Laysan Finch is found primarily on Laysan, a 415-ha (1,025-acre) island with an average elevation of 3.8 meters (12 feet). Finches are restricted to approximately 200 ha (450 ac) on Laysan that is vegetated. Since 1967, translocated Laysan Finches have occupied the 12-ha (25-ac) and two-hectare (5-ac) vegetated areas of Southeast Island and Grass Island (respectively) at Pearl and Hermes Reef, but these islands were partly inundated by the 2011 Japan tsunami. Some birds are known to have survived the inundation but the population has not been surveyed. Between 1973 and 1998, introduced populations also existed on North Island and Seal-Kittery Island at Pearl and Hermes Reef, but those populations were extirpated by 1998. Laysan Finches were introduced to Midway beginning in 1891 and persisted there until they were extirpated in 1944 by rats (Fisher and Baldwin 1946).



Essential Biology:

Millerbird. The Millerbird is a small (16-19 g), gray-brown Old World Warbler (Sylviidae) with a long tail, strong legs, and a thin, straight bill. Males are slightly larger than females, though there is some overlap (MacDonald et al. 2010). The Millerbird consisted of two island-specific subspecies (Fleischer et al. 2007), one from Laysan (*A. f. familiaris*), which was extinct by 1923, and one from Nihoa (*A. f. kingi*), which was discovered in 1923 (Wetmore 1924).

Millerbird pairs defend territories ranging in size from 0.19–0.40 ha, and show a high degree of year-to-year territory fidelity (Morin et al. 1997, MacDonald 2011). Millerbirds are somewhat secretive and spend much of the time in dense low bushes, particularly pōpolo (*Solanum nelson*) and ʻilima (*Sida fallax*). They also forage in dense stands of fan-palms (*Pritchardia remota*) and are attracted to small freshwater seeps and puddles for drinking and bathing. On Laysan, they prefer dense thickets of naupaka (*Scaevola taccada*). The Millerbird is a generalist insectivore that gleans native and non-native insects from shrubs and other plants. It also forages in leaf litter, on the soil surface, and has been observed eating insects from bird carcasses (Morin et al. 1997). Captive feeding trials conducted on Nihoa in 2009 and 2010

demonstrated that Millerbirds will consume any suitably sized arthropods (<4 cm length), including flies, moths, beetles, and cockroaches (Kohley et al. 2010).

The Millerbird breeding season usually extends from January through September, but timing appears to be variable and may depend on rainfall and prey availability. Bird translocated to Laysan began nesting in September shortly after being released. On Nihoa nests are built in available dense shrubs, particularly pōpolo and ʻilima. Laysan Millerbirds reportedly nested in bunchgrass around Laysan lake (Morin and Conant 2007), but the Millerbirds recently translocated from Nihoa are nesting in naupaka. Clutch size is usually two eggs and both sexes incubate, brood chicks, and provision nestlings and juveniles. Hatching success, fledging success, and survival to reproductive age are unknown (Morin et al. 1997), but this information is being collected from the birds now breeding on Laysan.

Nihoa Finch. The Nihoa Finch is similar and closely related to the Laysan Finch, but is slightly smaller and has a smaller bill (Morin and Conant 2002). Males are more brightly colored and females have more streaking, but there is much variation, some of it probably age-related.

Nihoa Finches are omnivorous and are known to eat seeds, fruit, leaves, flowers, invertebrates, eggs, and carrion. They are somewhat curious but are not as bold as Laysan Finches. Nihoa Finches forage in all types of vegetation and also on bare soil and rock. They are especially fond of native *Pritchardia* fan palms, taking fruit, nectar, and arthropods. Nihoa Finches use all habitats on the island, and are often attracted to small freshwater seeps and puddles for drinking and bathing.

Nihoa finches nest exclusively in rock crevices or piles of loose rock (Morin and Conant 2002). The clutch size is usually 3 (range 2-5), but little is known about nesting behavior or success. There is no information on adult survival or movements.

Laysan Finch. The Laysan Finch is a large (32-34 g), sexually dimorphic Hawaiian honeycreeper with a thick bill. Adult males are yellow on the head, breast, and back, with a gray neck and white belly. Females are grayer, especially on the back, with brownish streaks. Both sexes require two years to acquire adult plumage; first-year birds are browner and more heavily streaked (Morin and Conant 2002).

The Laysan Finch is omnivorous and is bold and inquisitive in search of food. It is known to eat seeds, fruit, leaves, flowers, invertebrates, eggs, and carrion, and forages in all types of vegetation, on bare soil, rock, and sand, and may enter seabird burrows. Plant species with which it is often associated include the bunch grass kāwelu (*Eragrostis variabilis*), naupaka, ʻalena (*Boerhavia repens*), pohuehue (*Ipomoea pes-caprae*), and nohu or puncture vine (*Tribulus cistoides*; Morin and Conant 2002). It is particularly attracted to humans and human objects and can become trapped inside tents, buckets, and tarps.

The nesting season usually extends from March-July, but timing appears to be variable and may depend on rainfall and prey availability. On Laysan, finches nest almost exclusively in kāwelu, the native bunch grass. On Pearl and Hermes, where kāwelu is uncommon, finches nest in a wider variety of vegetation and in man-made objects and marine debris such as plastic buckets, fishing buoys, and crates (Morin and Conant 2002). The female builds the nest, incubates, and broods the young, while the male plays a larger role in feeding the young, by regurgitation. Mean clutch size is 3.2 eggs. Apparently capable of raising more than one brood per season, but the frequency is unknown (Morin and Conant 2002). Males may not breed until two years of age, once they acquire adult plumage.

Primary Threats: All three species face a similar suite of threats, but the severity of threats varies somewhat among the species depending on aspects of their biology and the environment of the islands on which they occur. The most serious potential threat to all three species is the introduction of non-native plants, predators, pathogens, and competitors. The small range and population size of these species also makes them vulnerable to extinction from a variety of natural demographic and stochastic factors.

- Invasive alien plants. Although these birds are adaptable in habitat use and might integrate some non-native plants into their diet, certain invasive plants could alter habitat structure and diversity to such an extent that they would degrade habitat quality and reduce carrying capacity of the islands. The alien southern sandspur (*Cenchrus echinatus*) is such a plant and was expensive and time-consuming to eradicate from Laysan (Flint and Rehkemper 2002). A few individuals of this plant were discovered on Nihoa in 2011 and removed (VanderWerf et al. 2011), and little regrowth was observed in 2012. Eradicating this invasive grass is crucial to preventing further habitat alteration on Nihoa. Golden crownbeard (*Verbesina encelioides*) is another habitat-altering invasive that is established at Midway, Kure, and Southeast Island at Pearl and Hermes Atoll. It can favor Laysan Finches during nesting because it provides dense cover but once this annual dies back it leaves a desolate landscape with no forage or cover because it displaces all native plants.
- Non-native predators. The introduction of predators, particularly rats (*Rattus* spp.), by shipwrecks or in supplies and equipment transported to the islands is a serious potential threat to all three birds. Because they nest on or near the ground, all nests would be accessible to rats. Laysan Finches translocated from Laysan to Midway in 1891 thrived there until 1944 when the introduction of black rats caused their extirpation.
- Non-native Arthropods. Although all three bird species eat a variety of insects, introduction of certain arthropods could have serious negative effects on vegetation structure, plant diversity, and ecosystem-functioning through herbivory on native plants and their seeds and as competitors for other insects as food. The non-native gray bird grasshopper (*Schistocerca nitens*) was reported from Nihoa in 1977 (Beardsley 1980), and probably has altered the vegetation, and subsequently the food resources on which the Millerbirds and Nihoa Finch depend (Latchininsky 2008). The native shrub ʻāweoweo (*Chenopodium oahuense*) was formerly a common habitat component on Nihoa but is now rare (MacDonald 2011, Farmer et al. 2011). Several ant species are known to drastically alter island ecosystems and can be extremely difficult to eradicate.
- Disease. The Laysan Finch is known to be highly susceptible to avian poxvirus (*Poxvirus avium*) and avian malaria (*Plasmodium relictum*), which in Hawai'i are carried by the southern house mosquito (*Culex quinquefasciatus*; Warner 1968, van Riper et al. 1986, Morin and Conant 2002). There is no information about these diseases in the Nihoa Finch, but considering its close relationship with the Laysan Finch it presumably is similarly susceptible. The susceptibility of the Millerbird to mosquito-borne diseases also is unknown, but it belongs to a family widely distributed across the Paleotropics, where avian malaria is indigenous, so it might be more tolerant of disease. Mosquitoes and the diseases they carry are not known to occur on Nihoa or Laysan, but they are present on Midway and all the larger Hawaiian Islands and thus are relevant to selecting sites for translocations.
- Climate Change and Sea Level Rise. Climate change and associated sea-level rise is a serious long-term threat to all birds on atolls in the Northwestern Hawaiian Islands,

including the Laysan Finch and the Millerbird on Laysan. Recent projections estimate a rise in sea level of 1-2 meters by the end of the 21st century (Vermeer and Rahmstorf 2009), which would result in substantial loss of suitable habitat on Laysan, which has a mean elevation of Laysan is 3.8 meters (12 feet), by inundation, physical damage, and salt water incursion (Berkowitz et al. 2012, Krause et al. 2012). Increases in frequency and intensity of storms also projected in many climate changes scenarios would exacerbate sea level rise. Laysan Finch populations at Pearl and Hermes are at even greater risk; the mean elevation at Southeast Island is just over one meter (3 feet), so that during spring tides, most of the island would be inundated.

- Small Population Size and Range. Species with single, small populations are inherently more vulnerable to extinction than widespread species because of the higher risks posed by random fluctuations in population size, sex ratio, and other demographic parameters. Small populations are also more at risk from catastrophes such as hurricanes, fires, droughts, and disease outbreaks (Wiley and Wunderle 1994), and genetic issues (Keller and Waller 2002). Nihoa is dry and variation in rainfall and subsequent plant growth is thought to drive the large fluctuations in Millerbird and Nihoa Finch abundance. The larger population size of the Laysan Finch makes it somewhat less vulnerable. Genetic variation in the Millerbird is extremely low and recent research showed that the species has lost alleles over the last 15 years (Fleischer et al. 2007, Addison and Diamond 2011). The low genetic variation has not been demonstrated to be affecting the species viability, however, and is not surprising given the founder effect inherent in the original colonization and the genetic bottlenecks experienced for many years due to the population fluctuations.

Conservation Actions to Date:

All three species were federally listed as endangered on 11 March 1967 (USFWS 1984). Protection of the Northwestern Hawaiian Islands began in 1909, when the Hawaiian Islands Reservation was established by President Theodore Roosevelt. In 1940, the islands' status was changed to a national wildlife refuge. On 15 June 2006, the Papahānaumokuākea Marine National Monument was established and is managed jointly by the State of Hawai'i, the U.S. Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration.

There has been extensive habitat restoration on Laysan since rabbits denuded the island, causing the extinction of the original Laysan Millerbird. Management has included removal of invasive alien plants such as sandspur (*Cenchrus echinatus*) and Indian fleabane (*Pluchea indica*), and restoration of native plants such as the bunch grass *Eragrostis variabilis* and the loulu fan palm *Pritchardia remota*. Concern that control of the invasive species *Verbesina encelioides* at Pearl and Hermes would eliminate nest cover for Laysan Finches led Refuge staff to install 30 nest boxes (hollow cement blocks) in 2001 (Wegmann and Kropidlowski, 2001). These boxes were well received and during the 2003 breeding season 21 of the 30 boxes showed signs of use. An additional 29 boxes were added in 2003 and almost all were being used in 2007.

Research on the life history and demography of the Laysan Finch has been conducted at Laysan and Pearl and Hermes (Morin 1992, Morin and Conant 2002, McClung 2005). Monitoring methods for all species have been developed (Conant et al. 1981, Morin and Conant 1994) and are being improved (Gorresen et al. 2012). Conant and Morin (2001) used population viability analysis to argue that the probability of extinction for the Nihoa Millerbird is very high, that management actions were unlikely to increase carrying capacity on Nihoa, and that the most

effective way to increase the population size and decrease the risk of extinction was to establish additional populations.

Islands were evaluated and ranked as potential near-term and long-term translocation sites for the Millerbird, Nihoa Finch, and Laysan Finch (Morin and Conant 2007). For the Millerbird, Laysan was recommended as clearly the best site for establishment of an additional population, followed by Lisianski, Kure, and Midway, though which of those islands was next best was not entirely clear. Among high islands, Lehua was judged to have the greatest potential. For the Nihoa Finch and Laysan Finch, Lisianski, Kure, Necker, and Midway were ranked highly.

In September 2011 and August 2012, 50 Millerbirds were translocated from Nihoa to Laysan to create a second population. Results have been encouraging thus far, with birds forming pairs almost immediately after release and breeding successfully in 2012 (USFWS and ABC unpubl. data). Close monitoring of this nascent population is ongoing as of this writing.

Planning/Research Needs:

- Selection of Translocation Sites. Millerbirds have been translocated to the island deemed most suitable (Laysan; Morin and Conant 2007), but translocation sites still must be selected for the Nihoa Finch and the Laysan Finch. Although the previous translocation site assessment produced partially ambiguous recommendations (Morin and Conant 2007), the island assessments are still useful and can be combined with additional information now available to select the best island(s) for each species. Subfossils indicate that Laysan and Nihoa Finches co-existed previously on at least Molokaʻi prior to human arrival, and that at least two other now-extinct species of *Telespiza* were found in the main Hawaiian Islands (James and Olson 1991).
- Disease. Some islands that would otherwise be suitable for translocation of Millerbirds and finches have mosquitoes, poxvirus, and avian malaria, such as Midway and Lehua. Determining the feasibility of mosquito eradication and subsequent mosquito recolonization would allow better evaluation of various islands as translocation sites. Once Millerbirds are thriving and abundant on Laysan, a disease susceptibility study should be undertaken. If this species proves to be resistant to these mosquito-borne pathogens, a wider array of potential translocation sites could be considered.
- Monitoring. Improved monitoring methods that use a variable circular plot design are being developed for Nihoa (Gorresen et al. 2012) and were field tested in 2011 and 2012. They are anticipated to produce more precise population estimates that will allow better assessment of population trend. Similar improvements could be implemented for Laysan Finches. The previous, transect-based monitoring method (Conant et al. 1981) also was used to monitor abundance of the alien grasshopper on Nihoa. Once monitoring is switched entirely to the new VCP method an alternative method of monitoring grasshopper abundance will be needed, and should include measures of herbivory and plant cover.
- Millerbird. Additional demographic studies are needed on both Nihoa and Laysan to provide more information on population structure, dispersal, survivorship, nesting phenology and success, and other life history and behavioral characteristics.
- Laysan Finch. Assess which management options (e.g., additional translocations, supplementation of existing small populations on Pearl and Hermes, or both) would be most beneficial in terms of extinction risk reduction. The tiny islets at Pearl and Hermes probably cannot support a viable population in the long-term in their current state. The

vegetation is dominated by non-native *Verbesina encelioides*, which dies back each year, leaving little habitat for finches. Habitat management could make them more suitable. Compilation and publication/dissemination of unpublished data and observations would help to inform management decisions and determine whether additional demographic research is needed.

- Nihoa Finch. Demographic studies are needed to provide information on population structure, dispersal, survivorship, and nesting phenology and success, though lack of this information should not preclude translocation.

5-Year Conservation Goals:

- Maintain biosecurity on Nihoa, Laysan, and all other Northwestern Hawaiian Islands.
- Continue habitat management on Laysan, including removal of alien plants.
- Ensure the new population of Millerbirds on Laysan is self-sustaining, through continued monitoring, and if necessary, augmentation by translocating additional birds from Nihoa.
- Plan and carry out at least one translocation each of the Nihoa Finch and Laysan Finch.
- Determine the Millerbird's susceptibility to avian malaria and avian pox.

Conservation Actions:

- Invasive alien plants.
    - Eradicate the incipient population of the invasive alien grass *Cenchrus echinatus* from Nihoa. Visiting the island in spring before the plants have set seeds would increase the chance of eradication. If visits are made after seed-set, then pre-emergent herbicide may be required to prevent germination of seeds in the soil. Visits must be made for several consecutive years to deal with germination of seeds already in the soil.
    - Eradicate alien plants from Laysan, including *Pluchea indica* and *Verbesina encelioides*, and continue habitat restoration and management.
- Non-native arthropods. Develop and implement a method of monitoring abundance of the grasshopper on Nihoa, including herbivory levels and plant species cover.
- Create Additional Populations.
    - Continue to monitor the newly created Millerbird population on Laysan to ensure it becomes self-sustaining or whether additional translocations are needed.
    - Translocate Nihoa Finches to another island.
    - Translocate Laysan Finches to another island.

Summary of 5-year Actions, 2013-2017:

Conservation Action	Year(s)	Annual cost	Total Cost
Continue habitat management on Laysan, including eradication of invasive plants	1-5	$300,000	$1,500,000
Eradicate incipient population of the invasive alien grass *Cenchrus echinatus* from Nihoa	1-3	$30,000	$90,000
Monitor Millerbirds on Laysan	1-2	$100,000	$200,000
Monitor Millerbirds on Nihoa	1-5	$30,000	$150,000
Determine feasibility of mosquito eradication and recolonization on Midway and Lehua	1-2	$50,000	$100,000
Select translocation sites for Nihoa and Laysan	2-3	$40,000	$80,000

finches and develop translocation plans			
Translocate Nihoa Finches to another island and monitor them post-release	4-5	$300,000	$600,000
Translocate Laysan Finches to another island and monitor them post-release	4-5	$300,000	$600,000

Potential Partners: U.S. Fish and Wildlife Service, Papahānaumokuākea Marine National Monument, American Bird Conservancy, Hawai'i Division of Forestry and Wildlife, Pacific Rim Conservation, Pacific Bird Conservation.

Ancillary Species: Protection, restoration, and biosecurity on Nihoa, Laysan, and other islands will benefit numerous species of endemic landbirds, seabirds, and migratory shorebirds that inhabit these islands, including: the endangered Laysan Duck (*Anas laysanensis*), Bonin Petrel (*Pterodroma hypoleuca*), Bulwer's Petrel (*Bulweria bulwerii*), Wedge-tailed Shearwater (*Puffinus pacificus*), Christmas Shearwater (*Puffinus nativitatis*), Tristram's Storm-Petrel (*Oceanodroma tristrami*), White-tailed Tropicbird (*Phaethon lepturus*), Red-tailed Tropicbird (*Phaethon rubricada*), Masked Booby (*Sula dactylatra*), Brown Booby (*Sula leucogaster*), Red-footed Booby (*Sula sula*), Great Frigatebird (*Fregata minor*), Gray-backed Tern (*Sterna lunata*), Sooty Tern (*Sterna fuscata*), Brown Noddy (*Anous stolidus*), Black Noddy (*Anous minutus*), Blue Noddy (*Procelsterna cerulea*), White Tern (*Gygis alba*), Pacific Golden Plover (*Pluvialis fulva*), Wandering Tattler (*Tringa incanus*), Bristle-thighed Curlew (*Numenius tahitiensis*), and Ruddy Turnstone (*Arenaria interpres*).

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