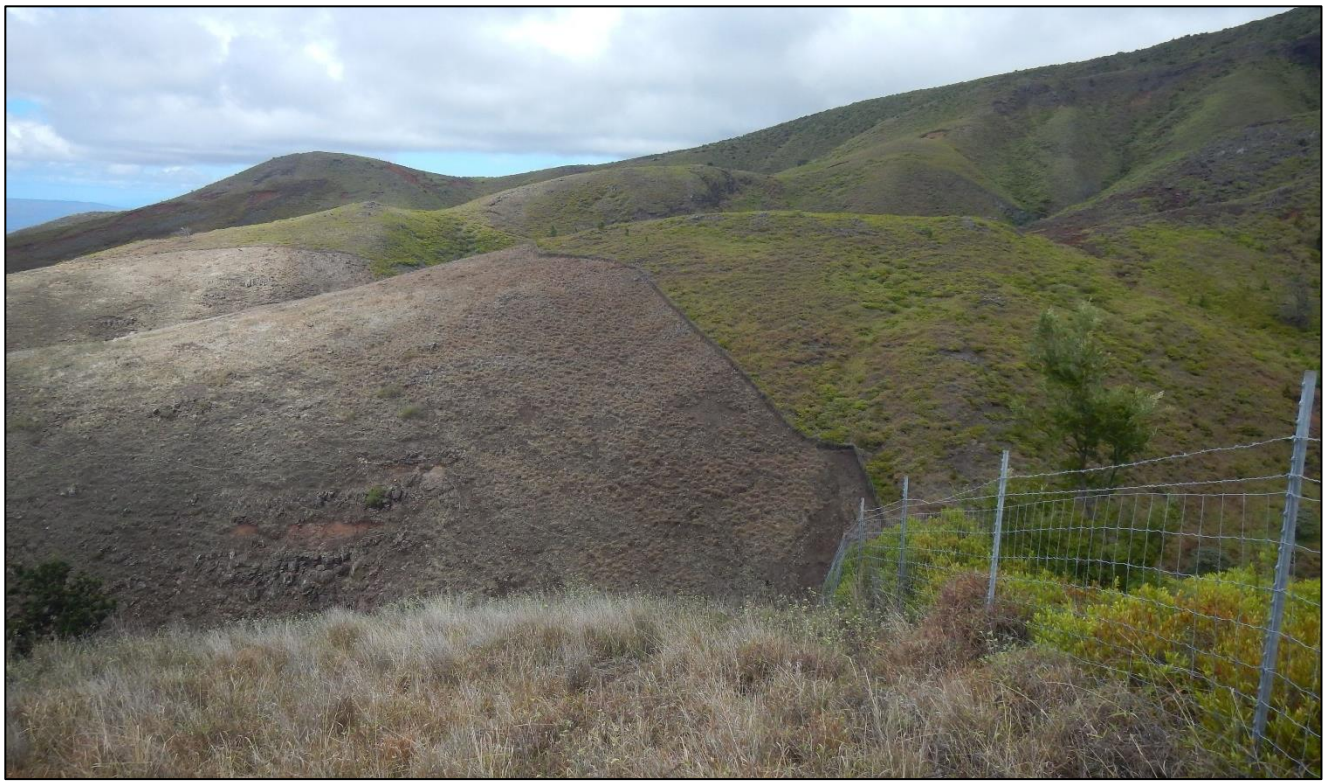

National Fish and Wildlife Foundation

Hawai‘i Conservation Business Plan

March 2021

Purpose of a Business Plan

The purpose of a NFWF business plan is to provide a concise blueprint of the strategies and resources required to achieve the desired conservation outcomes. The strategies discussed in this plan do not represent solely the foundation's view of the actions necessary to achieve the identified conservation goals, but also reflects the view of the many federal, state, academic, and organizational experts consulted during plan development. This plan is not meant to duplicate ongoing efforts, but rather to invest in areas where gaps might exist so as to support the efforts of the larger conservation community.

Acknowledgements

NFWF gratefully acknowledges the time, content expertise, and support provided by individuals and organizations that contributed significantly to this business plan. In particular, thanks go to: David Smith, State of Hawai'i Division of Forestry and Wildlife (DOFAW); Emma Yuen, DOFAW; Scott Fretz, DOFAW; Katie Ersbak, DOFAW; Lainie Berry, DOFAW; Jackie Gaudioso-Levita, DOFAW; Afsheen Siddiqi, DOFAW; Cynthia King, DOFAW; Fern Duvall, DOFAW; Irene Sprecher, DOFAW; Matthew Keir, DOFAW; David Sischo, DOFAW; Dwight Matsuwaki, DOFAW; Elliott Parsons, DOFAW; Lance DeSilva, DOFAW; Edith Adkins, DOFAW; Chris Brosius, DOFAW; Shelley Gustafson, Hawai'i Association of Watershed Partnerships; Brian Neilson, State of Hawai'i Division of Aquatic Resources (DAR); Russell Sparks, DAR; Ryan Okano, DAR; Kimberly Fuller, DAR; Michelle Bogardus, U.S. Fish and Wildlife Service (USFWS); Ric Lopez; USFWS; John Vetter, USFWS; Aaron Nadig, USFWS; Megan Laut, USFWS; Joshua Fisher, USFWS; Sheldon Plentovich, USFWS; Dan Polhemus, USFWS; Jodi Chew, U.S. Forest Service (USFS); Chris Fischer, USFS; Ryan Monello, National Parks Service; Travis Thomason, Natural Resources Conservation Service (NRCS); Susan Kubo, NRCS; Dave Elliott, O'ahu Resource Conservation and Development Council; John Stock, U.S Geological Survey (USGS); Jim Jacobi, USGS; Lucas Fortini, USGS; Michael Fields, USGS; Kevin Brinck, USGS; Rick Camp, USGS; Paul Banko, USGS; Eben Paxton, USGS; Ralph Tingley (USGS); Myron Honda, State of Hawai'i Department of Health, Clean Water Branch; Karl Magnacca, O'ahu Army Natural Resources Program; Phil Taylor, O'ahu Army Natural Resources Program; Brad Keitt, American Bird Conservancy (ABC); Chris Farmer, ABC; Teya Penniman, ABC; Hannah Nevins, ABC; Lindsay Young, Pacific Rim Conservation (PRC); Eric VanderWerf, PRC; Rachel Sprague, Pūlama Lāna'i; Hannah Mounce, Maui Forest Bird Recovery Project; Lisa "Cali" Crampton, Kauai Forest Bird Recovery Project; Bryce Masuda, San Diego Zoo Global; Helen Raine, Pacific Birds Habitat Joint Venture (PBHJV); Brad Bales, PBHJV; Russell Kallstrom, The Nature Conservancy (TNC); Kim Falinski, TNC; Stephanie Dunbar-Co, TNC; Jeffrey Maynard, SymbioSeas; Paul Krushelnycky, University of Hawai'i; Mary Donovan, HIMARC, Arizona State University; Dana Infante, University of Missouri.

About NFWF

The National Fish and Wildlife Foundation (NFWF) protects and restores the nation's fish, wildlife, plants and habitats. Chartered by Congress in 1984, NFWF directs public conservation dollars to the most pressing environmental needs and matches those investments with private contributions. NFWF works with government, nonprofit and corporate partners to find solutions for the most complex conservation challenges. NFWF has funded more than 5,000 organizations and committed more than $6.8 billion to conservation projects. Learn more at www.nfwf.org.

Cover photo credit: *Ungulate control fence Kawela, Moloka'i* (The Nature Conservancy); *Kiwikiu* (Andrew Smith); *'Ua'u*; *Palila* (Aaron Maizlish); *Manini and corals in Hawaiian waters* (NOAA)

Updated August 2021

Conservation Need

Located in the central north Pacific Ocean and spanning 1,523 miles, the Hawaiian Archipelago consists of eight major and 124 minor islands separated into two distinct regions: the human populated Main Hawaiian Islands (MHI), which includes Hawai'i Island, Maui, Kaho'olawe, Lāna'i, Moloka'i, O'ahu, Kaua'i and Ni'ihau, and the mostly uninhabited Northwestern Hawaiian Islands (NWHI). Both the NWHI and MHI and are collectively referred to throughout this document as "Hawai'i" and the "State of Hawai'i". This is a unique global location with a natural environment that evolved in isolation and consequently is vulnerable to threats resulting from globalization pressures. Imported vertebrate and invertebrate species, non-native plants, fungus, and disease are rapidly degrading habitats and driving native species to extinction. Urgent action is needed to prevent extinction of Hawai'i's unique native species and to restore the health of its forests and coral reefs that are vital for the resilience of human and natural systems in Hawai'i.

IMPERILED NATIVE SPECIES

More than 2,000 miles from the nearest continent, the Hawaiian Archipelago emerged between seven and 30 million years ago from a stationary volcanic hot spot without any biota species (Clague et al. 1989). Due to Hawai'i's remoteness, relatively few species as initial chance arrivals, were able to successfully survive the vast ocean crossing and establish populations (DLNR 2016). On land, arrivals were rare, seemingly random events, to which many never survived the journey. For example, Hawai'i has no native amphibians or terrestrial reptiles, and only one land mammal, a bat species. Those individuals that persevered evolved over thousands of years in an abundance of ecological niches across an array of climatic zones, including a multitude of microenvironments, with minimal threats and competition resulting in unique species adaptations (Pratt 2013). As such, Hawai'i has the world's highest percentage of endemic species—90% of terrestrial and over 25% of marine species are found nowhere else on Earth (Mitchell, et al. 2005). Among the most notable groups are plant genera, land snails, damselflies, and fruit flies, and birds. In fact, every native forest bird species can only be found in Hawai'i. Many of these birds are stunning in terms of beauty and sound; more than 55 species of honeycreeper originated from a founding group of Eurasian rosefinches such as the now extinct Kaua'i 'akialoa, for which half of its length was accounted for by its long sickle-shaped bill. Hawaiian plants and animals the foundation of Hawai'i's ecosystems, culture, and traditions.

Unfortunately, native ecosystems and biodiversity are under threat. Of the more than 10,000 native Hawaiian flora and fauna species (DLNR 2015), most are ill equipped to survive the challenges presented by a range of intentional and accidental introductions of species and diseases, climate change and development. For instance, of the 59 known Hawaiian honeycreepers species, only 17 survive today giving Hawai'i the distinction of being the epicenter for birds at risk globally. The State of Hawai'i now has more than 40% (481 species as of 2018) of the nation's federally listed threatened and endangered species, even though the State comprises of only 0.18% of the land area. Furthermore, many species not federally listed are either in decline or little is known about their population status.

SIGNIFICANCE OF WATERSHED FORESTS

Protection of native watershed forest are essential to sustaining Hawai'i's ecological, economic, and cultural resources as they provide important habitat for birds and wildlife, all while playing an integral role in maintaining resilient coral reef ecosystems. Dense forest vegetation in the upper reaches of the

forest are particularly efficient at groundwater recharge, slowing waterflow, and stabilizing the islands' highly erodible volcanic soil thereby reducing the frequency and severity of flooding, erosion, and sedimentation caused by heavy rain events that negatively impact the coast and nearshore marine environment. Watershed ecosystem services to human communities bolster the protection of beaches, homes, businesses, tourism, and the economy.

THREATS TO CONSERVATION

Despite the known benefits of these vital watershed functions, over half of Hawai'i's forests have been lost, fragmented, and degraded (Reeser et al. 2005) due to threats affecting the upper watershed, coastal environment, and nearshore marine environment.

Mauka ("Towards the Mountain" or "Inland") Threats

Feral Ungulates. Ungulates were first introduced to Hawai'i 800 years ago starting with early Polynesian settlers who brought small, domesticated pigs as a food source. In later centuries, larger European boars, sheep, goats, deer, and cattle were brought for trade or as game animals. The mild climate, high reproductive rates, absence of predators and competition, and lack of rigorous management regimes allowed for the growth of wild non-native ungulate populations that significantly degrade the landscape (Dixon 2011). Ungulates feed on native plants which lack thorns, toxins, and other defenses. They also trample seedlings, uproot vegetation, and strip bark from trees, negatively impacting forest habitat (DLNR 2015). Herd movements compact soil, spread noxious weeds and disease, and damage cultural and archaeological resources. Pigs create wallows resulting in mosquito breeding habitat that contributes to the spread of mosquito-borne avian diseases to Hawaiian forest birds (DLNR 2015) and are direct predators on seabird chicks and adults. The destruction caused by ungulates leaves the watershed bare and susceptible to the invasion of non-native flora, which contribute to severe and chronic erosion that washes downstream and affects water quality in the nearshore marine environment, negatively impacting adjacent coral reefs (DLNR 2015).

Introduced Predators. Primary predators of native birds, such as O'ahu elepaio and Hawaiian petrel ('ua'u), include a suite of non-native small mammals including house mice, rats, Indian mongoose, and feral cats. Pigs, dogs, and barn owls are also predators for some taxa. Predation and competition by alien mammals and birds have played an important role in the collapse of Hawaiian avifauna in conjunction with a suite of anthropogenic threats (Lindsey et al. 2009). Mammalian and avian predators prey on endemic bird eggs, nestlings, and adults. Rodents disrupt the balance of critical bird habitat by eating seeds and seedlings of native plants, which severely limits regeneration and food availability while enabling invasive plant invasion.

Invasive Plants. Over 10,000 plant species have been introduced to Hawai'i, of which 1,215 have established wild populations and 10% are categorized as highly invasive and aggressive (DLNR 2015). Invasive plants outcompete endemic flora by disrupting nutrient cycling and freshwater recapture processes, thereby decreasing water availability within watersheds. They also degrade suitable native habitats resulting in a reduction in range for many endemic plant and animal species.

Rapid 'Ōhi'a Death (ROD). As a foundation species to Hawaiian mesic and wet montane forests, 'ōhi'a (*Metrosideros polymorpha*) is the principal providers of shelter, nutrients, water, and nesting sites for a variety of native flora and fauna, including a critical resource for nectarivorous Hawaiian honeycreepers

(Camp et al. 2019). Two fungal pathogens thought to have arrived in Hawai‘i in 2010 have been identified: ROD canker disease and ROD wilt disease, and are primarily impacting Hawai‘i Island, O‘ahu, and Kaua‘i, with one known detection on Maui (UH 2020). These diseases spread quickly causing catastrophic damage to native watersheds, as ‘ōhi‘a make up 80% of Hawai‘i’s native forests. Scientific understanding has increased as the problem has been examined, but an effective solution has not yet been identified.

Mosquitoes and Avian Disease. Introduced from cargo ships in the early 1800s, mosquitoes are vectors of avian disease including malaria and pox, to which many species of Hawaiian forest birds, such as the Hawaiian honeycreepers and the iconic ‘alalā, are extremely vulnerable. Many Hawaiian honeycreeper populations are restricted to high elevation areas where few mosquitoes can survive cooler temperatures. Due to warming climate conditions, mosquitoes are moving into high elevation habitats increasing the risk and potential for disease transmission to native forest birds, such as Maui parrotbill (kiwikiu).

Wildfire. The annual percentage of land area burned by wildfires in Hawai‘i is on average greater than the percentage of area burned in the entire U.S. mainland (Trauernicht et al. 2015) making wildfires a considerable threat to watersheds and coastal marine ecosystems. Wildfires are not a natural part of Hawaiian ecosystems and few native species are able to re-establish after such events. Wildfires leave the landscape bare and vulnerable to more frequent flood events, erosion, and sedimentation that negatively impact water quality and nearshore coral reef ecosystems. Fire-adapted invasive weeds, such as fountain grass, quickly reclaim burned areas and outcompete native plants poorly adapted to fire.

Makai (“Towards the Ocean” or “Coastal and Nearshore Environment”) Threats

Coastal Development and Habitat Loss. Development pressure in Hawai‘i is high along the coastline, leading to the conversion of many important wetland and coastal habitats that once served as filters of sediment and nutrient-laden runoff, while providing coastal protection and essential habitat. Excessive sedimentation and polluted runoff negatively affect nearshore marine ecosystems by decreasing light penetration and increasing both inorganic nutrients and organic matter that impact the survival of corals and other marine life. Furthermore, shoreline alterations from seawalls, harbors, dredging activities, and shipping disturb marine ecosystems by transporting invasive aquatic species into new locales, destroying habitat, impairing water quality, and changing water flow and sediment deposition patterns.

Ocean Warming. Global and local environmental stressors are threatening coral reef ecosystems. In recent years, Hawaiian coral reefs have suffered large-scale bleaching and mortality due to unprecedented ocean warming (Winston et al. 2020). Exacerbated by climate impacts, large-scale disturbances such as bleaching, severe storms, and disease can weaken coral resilience, hindering corals’ ability to cope with and recover from climate-related stressors. These threats impact the multitude of services that coral reef ecosystems provide including subsistence use, recreation, commercial fisheries, and coastal protection. By reducing chronic, localized stressors such as overfishing and poor water quality, it is possible to strengthen coral reef resilience and increase the likelihood that corals recover from, and even resist the effects of, large-scale disturbance events (Anthony et al. 2015).

Marine Invasives. An estimated 463 non-native aquatic species have been introduced (DLNR 2019), ranking Hawai‘i as one of the highest in the world for an area of comparable size (Friedlander 2019). Introduced algae thrive on excessive nutrients from nearshore runoff and outcompete coral and native algal species, sometimes smothering wildlife. Overfishing of herbivores compounds the problem since

native fishes keep algal growth in balance. Introduced fish compete for food and habitat, as well as prey on native species.

Plastics in the Ocean – Coral reefs and other marine and coastal habitats throughout the Hawaiian Islands are significantly impacted by the growing abundance of plastic waste, derelict fishing gear and other marine debris in the Pacific Ocean. Despite their remoteness, currents carry these plastics to the islands and cause the degradation of nesting habitat and mortality of seabirds, sea turtles and the endemic Hawaiian monk seal.

Background on NFWF Investments

NFWF has a long history of investment in the restoration and protection of native species and habitat in Hawai‘i dating back to the early 1990s. In 2009, the first long-term strategic planning effort was completed, aimed at making measurable conservation impacts for key Hawaiian forest bird species. Since then, NFWF’s three focused investment portfolios—Hawaiian Forest Birds Business Plan (HIFB), Pacific Seabird Program, and Coral Reef Conservation Fund—have made considerable on-the-ground conservation progress in the Hawai‘i landscape, which is outlined below.

Hawaiian Forest Birds Business Plan (HIFB)

NFWF’s HIFB Business Plan investments (2009–2019) centered on reducing the risk of extinction for endemic birds including three federally listed endangered species: finch-billed Hawaiian honeycreeper (palila), kiwikiu, and Nihoa millerbird (ulūlu). Seventeen projects totaling $3.8 million were awarded. Outcomes included the successful translocation of 50 Nihoa millerbird to Laysan Island, where the new population has more than tripled. In 2015, a workshop was convened to discuss Hawaiian forest conservation priorities as emerging data revealed rapid declines in the Kaua‘i forest bird community including three range restricted Endangered Species Act (ESA)-listed endemic species (puaiohi, ‘akikiki and ‘akeke‘e; Paxton et al. 2016). NFWF responded by approving new funding to address rat predation on Kaua‘i and initiated support for releases of captive ‘alalā, representing the first releases since the 1990s. Although these species were not formally adopted in the business plan, partners commended NFWF for its sustained commitment to Hawai‘i’s endemic species.

Over the 10-year period of performance of the HIFB Business Plan, the long-recognized threat posed by mosquito-borne avian malaria accelerated in scope and impact and now poses significant threats to an increasing number of Hawaiian forest birds. The unsuccessful translocation of kiwikiu on East Maui in 2019, a key strategy of the HIFB, is symbolic of the catastrophic impact caused by avian malaria and spread of mosquitoes and disease into habitats previously thought to be at low risk. As for palila, despite nearly full implementation of the HIFB strategies, the population has continued to decline. However, a closer examination of the data shows that the rate of decline has decreased by more than 50% since the beginning of the business plan and suggests that active restoration and management are improving conditions within the māmane/naio dry forest which requires a minimum of 10-20 years prior to flowering/seed production.

Pacific Seabird Program

Through the 2012 and 2016 Pacific Seabird Business Plans, NFWF has invested more than $17 million in conservation of Hawaiian seabirds with a focus on four species: black-footed albatross (ka‘upu), ‘ua‘u, Laysan albatross (mōlī), and Newell’s shearwater (‘a‘o). Key strategies to increase survival and reproductive success for these species include the management of non-native invasive animals, restoration of degraded nesting habitat, reduction of seabird bycatch, translocation to establish

predator safe and resilient colonies to sea level rise in new locations, and filling critical information gaps for focal species. Due in part to the program's early success, NFWF has been able to expand its partnerships to support additional work for ʻuaʻu, ʻaʻo, and band-rumped storm petrel (ʻakeʻake) on Kauaʻi and on Lānaʻi. Accomplishments to date include an increase in reproductive success for all four focal seabirds, an increase in the number of nesting pairs of Laysan albatross, the translocation of more than 600 seabird eggs and chicks of six species to two sites on Kauaʻi and Oʻahu, the removal of rats from Lehua Island, and the construction of one ungulate and four predator proof fences (with three additional predator proof fences in construction).

Coral Reef Conservation Fund

Since 2000, NFWF has responded to declining coral reef ecosystems in Hawaiʻi through coordination with local, state, federal and regional partners, including the U.S. Coral Reef Task Force[1]. NFWF's Business Plan for U.S. Coral Reefs (2009-2019) piloted a new approach to site-based conservation investment in Puerto Rico. In 2012, the Board of Directors approved the development of a similar approach for two watersheds NFWF had made investments in previously on Maui (Wahikuli and Honokowai). During this time, NFWF awarded $1.8 million to projects in the West Maui focal area, including investments to support the establishment of a community-based water quality monitoring program, a reduction in over one million pounds of sediment and nutrient runoff and a 40% increase in herbivorous fish biomass in the Kahekili Herbivore Fisheries Management Area (Williams et al. 2016). While NFWF has since closed the Business Plan for U.S. Coral Reefs, a 2017 internal assessment found that the approach was an effective model for future NFWF coral conservation investments, in which a comprehensive set of threats was addressed in a narrowly targeted geography in collaboration with a diverse set of partners.

Coordinated Landscape-Level Strategy

In addition to previous business plans, NFWF has invested in conservation projects in Hawaiʻi over the past 10 years through a variety of programs including but not limited to the Papahānaumokuākea Research and Conservation Fund, Kuahiwi a Kai: Lānaʻi Watershed Conservation Program, National Coastal Resilience Fund, and Pulling Together Initiative. NFWF's selection of, and fidelity to, focal species and priority geographies are a major factor in the conservation gains that are currently being made and provide the foundation to build a landscape-specific conservation strategy that capitalizes on potential synergies.

Current Conservation Context

Numerous conservation practitioners in Hawaiʻi, including federal, state, and local agencies, nonprofit organizations, charitable trusts, businesses, private landowners, and communities, are working to holistically and comprehensively protect and enhance indispensable native habitats for Hawaiʻi's wildlife and people. Years of collaborative science development and implementation projects by NFWF, State agencies and NGO partners continue to inform current wildlife management priorities and actions.

State of Hawaiʻi's Sustainable Hawaiʻi Initiative. The State of Hawaiʻi, as the largest landowner, has a mandate to conserve and protect Hawaiʻi's natural beauty and resources. In 2016, the State expanded

[1] The U.S. Coral Reef Task Force, a body of 12 federal agency leads and jurisdictional representatives, was established in 1998 by Presidential Executive Order to lead U.S. efforts to preserve and protect coral reef ecosystems.

upon the *Aloha+ Challenge*[2] by launching the *Sustainable Hawai'i Initiative*, a multi-pronged effort to ensure a healthy environment and economy for Hawai'i's people. Building upon Hawai'i's cultural legacy of holistic mountain-to-ocean stewardship through the ahupua'a[3] system, the State adopted goals to protect 30% of priority watershed forests and establish 30% of nearshore waters as marine management areas by 2030 to increase freshwater security capacity, invasive species control, and native species restoration. The State's initiative provides a framework for NFWF's business plan efforts and identifies targeted outcomes to further the State of Hawai'i's conservation goals.

Hawai'i Association of Watershed Partnerships (HAWP). Composed of ten Watershed Partnerships (WP) across Hawai'i Island, Maui, Moloka'i, O'ahu, and Kaua'i, HAWP is a voluntary alliance between private and public landowners working collaboratively to manage more than two million acres of critical watersheds for water security, habitat protection, and other ecosystem services. Each WP has its own management plan and priorities based on their unique geographic and social context. As a unified group, the WP address many cross-cutting themes by sharing knowledge and technical expertise. The WP assist Hawai'i Division of Forestry and Wildlife (DOFAW) to achieve landscape-level watershed conservation and meet the State's watershed protection goals by implementing: 1) ungulate-proof fencing, 2) restoration, 3) invasive species control, and 4) outreach and education. NFWF has and will continue to invest in all four priority actions.

Birds, Not Mosquitoes Steering Committee. In 2017, State, Federal, and non-governmental organizations formed a steering committee to advance novel techniques to prevent the extinction of Hawai'i's forest birds and protect human health. Known today as *Birds, Not Mosquitoes*, the steering committee is coordinating all efforts, including meaningful community engagement, to develop, permit, test, and register a biopesticide strain of *Wolbachia*[4]-infected southern house mosquitoes (*Culex quinquefasciatus*), that when released at a landscape scale will inhibit mosquito reproduction[5]. NFWF's business plan will support coordination of key actions by member organizations to expedite solutions to save imperiled Hawaiian forest birds from avian malaria.

A Shared Vision. NFWF, its partners, and stakeholders are working together to support a shared vision of management from mauka to makai to strategically protect and enhance critical habitats, while recognizing that shrinking State and Federal budgets heighten the need for innovative public–private partnerships to coordinate objectives to meet targeted conservation outcomes. This business plan fits squarely with this vision as there are tremendous opportunities for NFWF—as an important funder supporting the implementation of landscape-scale conservation projects—to sustain healthy and resilient populations of native species. In consultation with the State, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, and other Hawai'i conservation partners, this business plan conceptualizes an integrated strategy to prioritize actions, increase investment efficiency, and measure cumulative impacts that complement the State's landscape-level initiative over the next 10 years, while building upon NFWF's conservation investments in Hawai'i since the early 1990s.

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[2] A 2014 statewide cross-sector commitment bringing together diverse partners to develop community-based 2030 goals and measurable targets across six priority areas.

[3] Traditional Hawaiian system of land division, typically extending from the top of the mountain to the ocean (mauka to makai), to efficiently and sustainably manage natural resources to meet the needs of the community.

[4] *Wolbachia* is a naturally occurring bacteria found in ~50% of insect species, including native Hawaiian insects.

[5] Mosquito suppression can be achieved by introducing mosquitoes to strains of *Wolbachia* because male and female mosquitoes that have been infected by different strains of *Wolbachia* fail to successfully reproduce.

Conservation Outcomes

The vision of the Hawai‘i Conservation Business Plan is to **strategically protect and enhance essential habitats in Hawai‘i, from mauka to makai, to reduce extinction risk and sustain resilient populations of native species**. Building on NFWF's past experience and investments in this landscape, this plan outlines goals for watershed forest health, endemic birds, and coral reefs that it aims to achieve over the next 10 years (Tables 1-3). The plan also identifies prospective species and sites that will be considered for NFWF investment following further examination of available scientific data (Tables 4).

Watershed Forest Conservation

The business plan goal for watershed forests is to **restore or improve native watershed function and biodiversity** by increasing or sustaining native plant cover, increasing forest tree density, and increasing richness of native species. Hawai‘i's forests host a high diversity of native plants and wildlife, while providing essential habitat for these unique species. Apart from species benefits, native Hawaiian forests are critical in providing the islands' supply of freshwater by absorbing rainfall and cloud moisture. However, it is estimated that 61% of Hawai‘i's native mesic forests have been lost to invasive species, and land conversion for agricultural uses (DLNR 2015). Invasive plants and animals have severely reduced the forest's ability to sequester and store freshwater resources and have also contributed to high rates of erosion and pollution of coral reef systems.

For the focal watershed forests identified, a suite of threats will be addressed to improve forest condition or prevent any future degradation of intact habitats. Watershed forest strategies, such as constructing new ungulate-proof fencing in conjunction with ungulate management and invasive plant removal and outplanting of native vegetation, aim to reduce or eliminate the presence of ungulates, increase the percent of native plant cover, increase tree density and increase plant species richness. Conservation outcomes for one or more watershed forests will require a consistent commitment to monitoring to measure the response of native flora as a result of successful management or restoration.

Table 1. Business Plan Goals for Focal Watershed Forests

Focal Watershed Forests	10-yr Business Plan Goals
Waiakoa watershed, Maui	Improve watershed condition and function in the Kamehamenui fence unit: Increase native plant cover from 10% to 35% Establishing 5 endangered plant species Increasing native species diversity from 0 to 5 species per acre
Pāhihi watershed, Maui	Improve watershed condition and function in the Pāhihi Pūka‘i fence unit by: Increase native plant cover from 0% to 30% Increase native species diversity from 0 to 5 species per acre

Bird Conservation

Investments through this plan are designed to **reduce extinction risk for individual endemic bird species** by addressing direct threats and improving habitat conditions for suites of species. Since 1800, six bird species have become extinct in North America; one additional species is presumed extinct and two sub-species have disappeared (Elphick et al. 2010). Overall, bird extinction in North America is a relatively rare event. In Hawai'i, by contrast, a minimum of 70 species or sub-species disappeared prior to the arrival of Europeans in 1778. Since 1800, at least 31 additional species have gone extinct including 10 in the last 50 years (Banko and Banko 2009). Further, 14 of the 25 remaining endemic forest bird species or subspecies are listed as Endangered under the ESA (Banko and Banko 2009).

Pervasive and ongoing threats for Hawaiian birds include avian malaria and other non-native pathogens, invasive predators (rats, mongoose, cats and barn owls), habitat loss and degradation (due to ungulates, development), invasive plants (Strawberry guava, Himalayan ginger, Australian tree fern, fountain grass, etc.), competition from introduced birds, artificial lighting, utility line collisions and climate change.

By addressing a suite of these direct threats, the goals of the business plan for individual bird species include reducing extinction risk by establishing robust captive populations, increasing breeding performance (in captivity and in native habitat), re-establishing captive species in native habitat when the enabling conditions for release have been met, preventing further population decline and increasing the area of occupancy for species through habitat management and restoration.

Table 2. Business Plan Goals for Focal Bird Species

Focal Birds	10-yr Business Plan Goals
'alalā (Hawaiian crow)	Establish one or more populations of 'alalā in native forest through captive releases of 5 or more individuals annually.
palila (finch-billed Hawaiian honeycreeper)	Achieve a stable population of 100 palila (+/- 10)[6].
kiwikiu (Maui parrotbill)	Establish at least one new captive population to reduce species extinction risk.
'ua'u (Hawaiian petrel)	Achieve a reproductive success rate of 0.7 chicks/pair/year on Lāna'i for the next 10 years.
O'ahu elepaio (monarch flycatcher)	Increase O'ahu elepaio territorial occupancy by 100% in the Ko'olau Mountains.

Coral Reef Conservation

The business plan aims to **foster healthy coral reef ecosystems that are resilient to current and predicted environmental stressors by reducing local threats within an interconnected network of reef tracts in Maui Nui,[7] Hawai'i.** In Hawai'i and around the globe, climate-related stressors are expected to increase in frequency and severity over the coming decades (van Hooidonk et al. 2016, Hughes et al. 2018). The business plan prioritizes coral reef tracts that have a lower vulnerability to environmental

[6] The palila goal relies on detection data—defined as the number of individual palila detections recorded in core habitat from point/transect survey data conducted annually in February.

[7] Maui Nui (the combined islands of Moloka'i, Maui, Lāna'i and Kaho'olawe, which were joined as one island for most of their history (Cowie & Holland 2008).

stressors and that serve as important sources of coral larvae to neighboring reefs (Game et al. 2008, Maynard et al. 2015 & 2017, Storlazzi et al. 2017, Chung et al. 2018, Mcleod et al. 2019).

In these priority reef tracts, NFWF identified conservation outcomes that focus on multiple indicators associated with resilient coral reef ecosystems, such as high rates of herbivory and low proportional cover of turf and macroalgae. Focusing on a single indicator can obscure important trends, potentially leaving reefs vulnerable to disturbance events and hindering their ability to recover (Alvarez-Filip et al. 2013, Perry et al. 2014 & 2017, Januchowski-Hartley et al. 2017). A resilience-based approach helps to understand coral reef ecosystem services, integrity, and function using multiple indicators that recognize the dynamic nature of coral reefs (McClanahan et al. 2012, Lam et al. 2017, Ford et al. 2018).

The reduction of local stressors will allow corals to better recover from or withstand major climate-related stressors such as coral bleaching (McClanahan et al. 2012, Graham et al. 2013, Anthony et al. 2015). Effective watershed management from mauka to makai can help reduce sediment and nutrients from compromising coral health. A series of intermediate outcomes are required to document coral resilience, including improvements in upland condition by removing invasive ungulates and revegetation of denuded soils. In combination with other watershed improvements such as wetland restoration or fire risk reduction, these efforts reduce the amount of erosion from the watershed, trap sediment, and result in less sediment- and nutrient-laden runoff reaching nearshore waters. The improved water quality coupled with in-water conservation activities will help build coral reef resilience. In addition, upland improvements can restore functional habitat for native fauna such as pollinators that are vital for reproduction in many plant species. Fence protection and early successional plant establishment also provide the necessary conditions to support outplanting of Hawai‘i’s most endangered plant species managed by the Plant Extinction Prevention Program (PEPP).

Table 3. Business Plan Goals for Focal Coral Reef Tracts

Focal Coral Reefs	10-yr Business Plan Goals
Kawela Reef, Moloka‘i	Maintain high coral cover and build coral reef resilience to improve corals’ ability to complete for space on the Kawela reef by improving key measures of resilience: Increase in the proportion of reef building species[8] by 10%, from 2.15 to 2.4. Increase herbivore fish biomass[9] by 45%, from 20 to 29 g/m^2. In the event of a disturbance, such as a bleaching event(s), recover coral cover significantly faster than comparison sites. Improve water quality to support resilient coral reefs with reduced turf and macroalgal cover: Reduce sediment discharge to nearshore waters by 90%, from 1,840 to 200 tons/year at the Kawela Gulch streamgage. Support improvements in upland condition to establish native plant species, reduce soil loss, and decrease suspended sediment for improved water quality:

[8] Also known as the reef builder ratio, this metric is the proportion of calcifying organisms (hard coral and crustose coralline algae) relative to fleshy organisms (macroalgae and turf algae). Positive ratios indicate more corals and other calcifying organisms important for coral recruitment and is a measure of the benthos’ overall composition.
[9] Herbivorous fishes graze on turf and macroalgae, which can reduce competition on the reef and allow corals to thrive. Herbivore biomass is a measure of both the number and size of fish on the reef, which is a good indicator of the coral reefs ability to cope with and recover from large-scale stressors.

Focal Coral Reefs	10-yr Business Plan Goals
	Reduce signs of ungulate presence from over 50% to less than 5% at sampling locations within the Kawela Gulch fenced unit. Increase native plant cover by 40% at sampling locations within the Kawela Gulch fenced unit.
Kīhei Reef, Maui	Maintain high coral cover and build coral reef resilience to improve corals' ability to complete for space on the Kīhei reef by improving key measures of resilience: Increase in the proportion of reef building species[8] by 10%, from 1.9 to 2.1. Increase herbivore fish biomass[9] by 35%, from approximately 15 to 20 g/m^2. In the event of a disturbance, such as a bleaching event(s), recover coral cover significantly faster than comparison sites. Improve water quality and reduce polluted runoff to support resilient coral reefs with reduced turf and macroalgal cover: Decreased turbidity at nearshore water quality monitoring sites by 30%, from approximately 6 to 4 NTUs. Decreased total nitrogen at nearshore water quality monitoring sites by 30%, from approximately 73 to 48 mg/L.

Prospective Species and Sites

The following prospective focal species and sites require additional information and/or investment before NFWF can include them as species with measurable conservation goals in the business plan.

Table 4. Planned Actions for Prospective Watershed Forests, Bird Species, and Coral Reef Sites

Prospective Watershed Forests	Planned Actions
Pelekunu watershed, Molokaʻi Kahoma, Kauaula, Launiupoko, Olowalu watersheds, Maui Kīholo, Hawaiʻi Island	More information is needed to determine if these watershed forests should become a focal geography. NFWF will work with partners to identify the necessary management actions, timeline of management actions, funding needs, baseline habitat conditions, and expected quantitative improvement in native species before making the determination.

Prospective Bird Species	Planned Actions
puaiohi (small Kauaʻi thrush)	The Kauaʻi Forest Bird Recovery Project is studying the relationship of rat control to puaiohi survival, sex ratios and nest success on and off rat control grids. This 3-year project will provide data with the potential to support a reproductive success goal that links directly to the benefit and efficacy of rat control—an activity NFWF supports.
ʻalae ʻula (Hawaiian moorhen)	The State is finalizing the review and analysis of historical waterbird data. Future efforts to reintroduce this extirpated species to Maui Nui will arise from completion of the data synthesis and will require prioritization and planning prior to initiation of on–the-ground actions. Potential sites include wetlands on Maui and Molokaʻi; however, each site will require actions to improve wetland condition and reduce threats of predators prior to release. NFWF will explore a reintroduction goal for this species when the enabling conditions have been met.
Prospective Coral Reefs	**Planned Actions**
Keōmoku and Naha Reefs, Lānaʻi	Initial investments are underway in Lānaʻi, but more information is needed to set goals in this area; therefore, Lānaʻi will be considered a prospective coral reef geography until more information is known about the location of ungulate fencing activities and as sediment and coral reef monitoring is established.

Prospective Issues

Marine plastic waste, derelict fishing gear and other marine debris impact reef and terrestrial species survival and habitats across the Hawaiian archipelago. NFWF will explore strategies and opportunities to remove debris from key reef and island systems. Where NFWF is unable to directly reduce mortality, NFWF will explore strategies to build population resilience for impacted species through this business plan.

Geographic Focus

The geographic footprint of the Hawai‘i Conservation Business Plan encompasses priority areas for birds, coral reef, and watershed conservation on Hawai‘i Island, Maui, Lāna‘i, Moloka‘i, and O‘ahu (Figures 1-3). Additional priority areas will be added in the future as prospective avian species, coral reef sites, and watershed forests are included as focal targets in the business plan.

Watershed forest investments will prioritize Priority I and II areas (native wet and mesic areas, respectively) as identified by the State of Hawai‘i based on the watershed's ability to recharge underground aquifers and capture fog, thereby sustaining the state's freshwater resources. These priority watershed forest areas have a strong relationship to priority areas that the State has identified for biodiversity and freshwater conservation.

Bird conservation investments will be directed to habitats important for the Plan's focal bird species.

Coral reef investments will be targeted within two focal areas which encompass three watersheds adjacent to the Kīhei priority reef (Maui) and seven watersheds adjacent to the Kawela priority reef (Moloka‘i). Criteria that informed focal area selection for coral priorities included: 1) relative coral reef resilience and climate vulnerability, larval connectivity, and information about local stressors.

Figure 1. Hawai‘i Island focal areas.

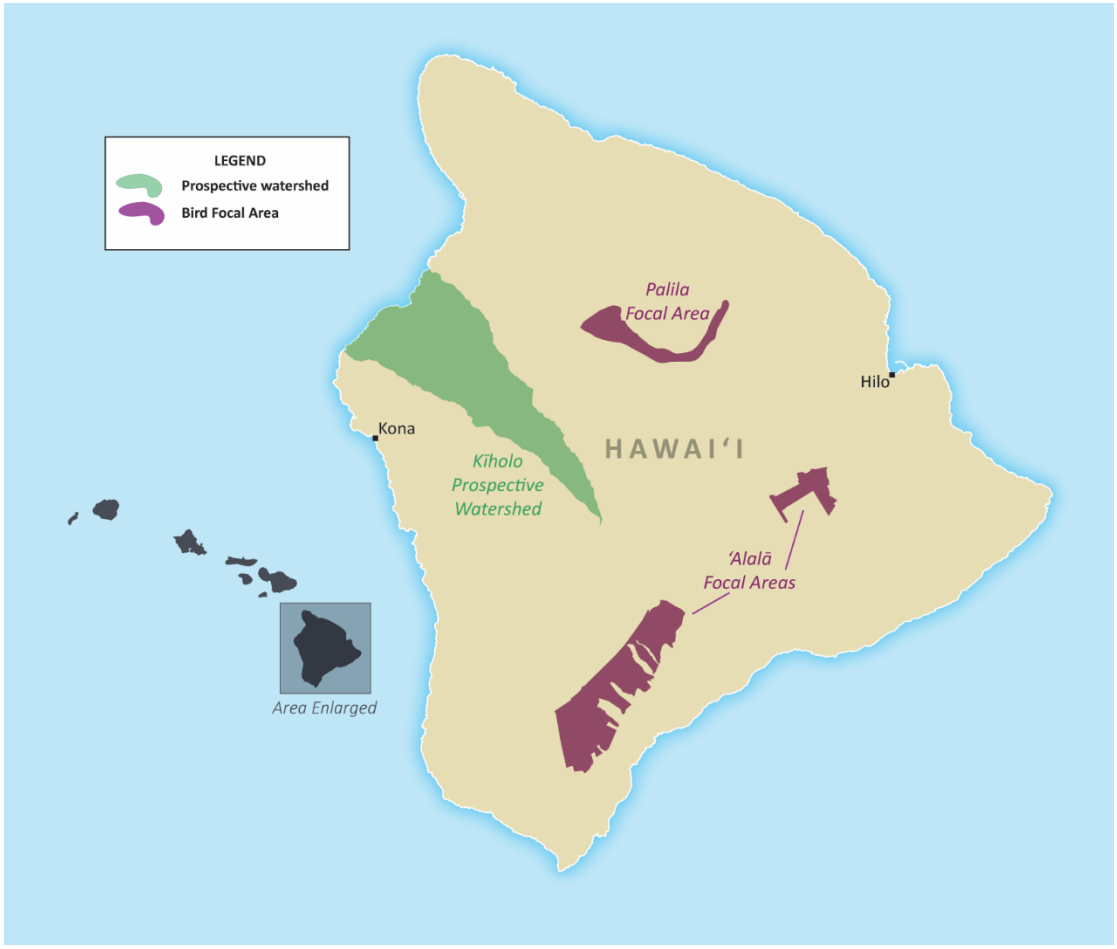


Figure 2. Maui Nui focal areas.

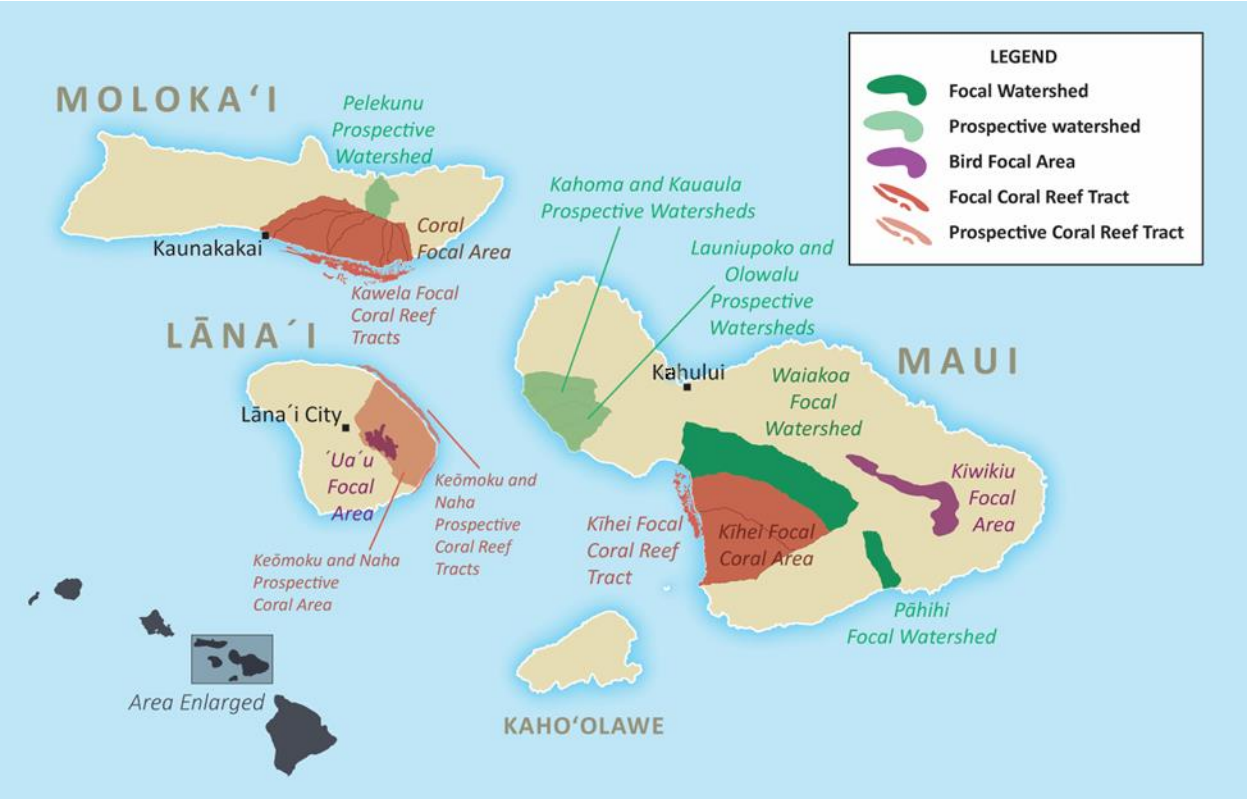


Figure 3. O'ahu focal areas.

Implementation Plan

NFWF will fund projects implementing the following strategies to support the overarching goal of reducing extinction risk and sustaining resilient populations of native species in Hawai'i. The results chains depict the collective strategies that are anticipated to contribute to the identified watershed forests and avian species conservation outcomes (Figure 4) and coral reefs conservation outcomes (Figure 5).

Strategy 1: Restore or improve native watershed function and biodiversity.

1.1 Watershed protection and enhancement – Support the State of Hawai'i's Sustainable Hawai'i Initiative and Hawai'i Association of Watershed Partnerships (HAWP) through targeted investments in priority watershed forests to preserve essential habitat for native species, replenish freshwater aquifers and streams, and improve water quality in nearshore marine environments to support resilient coral reefs.

1.1.1 Ungulate-proof fencing: Install and maintain ungulate-proof fences within priority watersheds that will contribute towards the State's commitment to protect 30% (253,000 acres) of Hawai'i's most important watershed forests by 2030. Priority actions include all phases of project development such as scoping, feasibility assessment, securing partnership agreements, community outreach, completion of environmental compliance review, pre-implementation ecological monitoring and research, project implementation, post-implementation monitoring, and fence maintenance.

1.1.2 Invasive ungulate removal: Control feral ungulates including pigs, goats, sheep, deer, and cattle to prevent essential habitat and watershed degradation. Priority actions may include development of management plans, removal through public and staff hunting and professional aerial shooting, community and hunter outreach, and monitoring.

1.1.3 Habitat restoration: Improve native species habitat and resiliency within priority watersheds by systematically removing invasive plants and weeds to promote growth of native species and increase vegetative cover. Where native seed banks are strong, simply removing grazing pressure from feral ungulates can allow native plant populations to recover. However, where passive restoration is insufficient, outplanting native plants is an alternative and effective restoration practice which may support the Plant Extinction Prevention Program that specifically targets Hawai'i's rarest plant species. Priority actions may include invasive weed control, invasive plant removal through herbicide treatment and physical removal, native seeds/plant propagation, outplanting, community engagement, post-removal/planting monitoring.

1.1.4 Wildfire prevention and management: Protect and suppress wildfire damage to priority watersheds. By removing invasive species and improving the health of native dry forest habitats through the activities outlined above, fire risk can be reduced. However, active fire management is needed to protect native dry forest habitat and Hawaiian communities, including strategic grazing, invasive weed/plant control, traditional/green fire breaks, native plant installation, development of management plans, community outreach, and monitoring.

1.1.5 Working lands management: Support best management practices of ranching and agricultural lands to address soil erosion, degraded water quality from sedimentation, and inadequate habitat for native wildlife. Implementation practices may include access control, brush management, weed control, and installation of riparian corridor ungulate fences to improve water quality by preventing feral ungulates from destabilizing streambanks and causing erosion.

1.1.6 Watershed Monitoring: Support or supplement existing monitoring programs in priority watershed forest fence units for in-field data collection such as vegetation plots and transect surveys, remote sensing to quantify vegetation/canopy cover, and any data analysis needed to track progress towards watershed outcomes.

1.2 Coastal habitat restoration – Improve and maintain coastal ecosystems to reduce flood risk, provide habitat for waterbirds, and trap sediments and nutrients to improve nearshore water quality for the protection of coral reef ecosystems.

1.2.1 Stormwater management: Reduce sediment export from uplands by maintaining vegetation and revegetating areas through the watershed protection objectives in Sections 2.1 and 2.2. Support low-impact designs such as treatment of wetlands on golf courses, vegetated swales, and buffer strips to reduce stormwater runoff. Impervious surfaces in urban areas transport significant volumes of sediment and nutrient-laden stormwater runoff to coastal waters. Other effective strategies to reduce sediment and nutrient runoff may include stream restoration and detention basins, among others.

1.2.2 Coastal wetlands restoration: Protect and restore existing wetlands to reduce sedimentation and nutrient runoff to nearshore waters and improve waterbird habitat, while safeguarding coastal communities by storing significant volumes of stormwater to reduce flood risk. In addition to direct restoration, the business plan will also consider investments in traditional agricultural and aquaculture practices such as fishpond (loko iʻa), seaweed (limu), and taro (kalo loʻi) cultivation.

Strategy 2: Support populations of endemic bird focal species to prevent extinction.

2.1 Habitat restoration and management – Protect endemic bird focal species by managing and restoring habitat, managing non-native invasive predators, safeguarding at-risk-species through captive rearing, translocation, social attraction, and reintroduction efforts and by monitoring species and habitat response to interventions.

2.1.1 Habitat restoration: Control non-native invasive vegetation including new invasions and established plants to improve forest function and health for forest birds. Plant native species to restore degraded habitats.

2.1.2 Habitat management: Repair, replace and maintain ungulate-proof fences, remove ungulates from fenced areas, control and remove non-native predators from bird habitat and conduct outreach to local stakeholder communities in support of habitat management activities.

a. Ungulate-proof fence maintenance: Support fence repair and maintenance to ensure ungulate free high-quality habitat.

b. Control ungulates: Support removal of ungulates following fence repair, as needed.

c. Control non-native predators: Control invasive predators including rats, mongoose and feral cats. Priority actions may include predator surveys, development of management plans, removal through trapping, and efficacy monitoring.

2.1.3 Community outreach: Support outreach to local stakeholder communities to build understanding and support of management for at risk Hawaiian birds.

2.2 Captive rearing, reintroduction, and translocation strategies – To reduce extinction risk for individual focal species a suite of tools including captive rearing, reintroduction, translocation, and social attraction may be necessary.

2.2.1 Captive rearing: Implement and support captive rearing programs for birds most at risk of extinction to increase captive populations. Activities may include locating and capturing individuals; captive husbandry; infrastructure support; captive species monitoring.

2.2.2 Reintroduction, release of captive birds: Reintroduce captive birds to appropriate locations that are sufficiently protected, maintained, and monitored to establish new populations.

2.2.3 Translocation (to suitable habitat): Translocate wild birds to appropriate locations that are sufficiently protected, maintained, and monitored to establish new populations.

2.2.4 Address knowledge gaps: Support new science to fill knowledge gaps leading to improvement in species-specific conservation activities.

2.2.5 Monitoring: Support bird surveys and analysis to inform conservation decisions and as part of conservation action efficacy monitoring.

2.3 Landscape-scale avian malaria control – Treat avian malaria through a science-driven, consensus-building process. At the direction of partners this could include the development and application of a trans-infected *C. quinquefasciatus* mosquito to be reared and released at a landscape-level to protect native forest birds. Support the development of alternative tools for long-term success, as appropriate.

2.3.1 Coordination: Coordinate the *Birds, Not Mosquitoes* steering committee. Coordinate sub-committee meetings and reporting towards ensuring that the enabling conditions are met for implementing landscape scale treatment to protect collapsing endemic bird populations. Activities may include developing and maintaining the overall project plan, coordinating meetings and internal (steering committee) and external (partner and public) communications.

2.3.2 Community outreach: Support sustained community engagement to key user groups. Activities may include educating communities on the technology and conservation need, incorporating local knowledge, and socializing the mosquito biopesticide implementation/release strategy.

2.3.3 Science development: Support the research and development of treatment methods, and aerial application tools for deployment at the landscape-level. R&D activities may include application drone trials.

2.3.4 Biopesticide application: Support research and testing of techniques for deploying mosquito biopesticide application at the landscape scale.

2.3.5 Mosquito-related monitoring: Collect data to inform prioritization of mosquito treatment locations relative to species' extinction risk. Post treatment(s) monitoring will be critical for determining if a reduction in mosquito presence has occurred in treatment sites, if mosquitoes are continuing to expand into endemic bird habitat, and the rate of transmission of avian

malaria. Types of monitoring include bird occupancy and number of individuals; invasive mosquito distribution, occurrence, density, and seasonality; avian malaria incidence rates.

Strategy 3: Promote resilient coral reef ecosystems at priority reef tracts.

3.1 Marine in-water management – Pursue in-water strategies to further promote coral reef resilience and bolster recovery from environmental-related stressors. While land-based strategies are expected to promote reef resilience by reducing sources of pollution, additional in-water strategies may be needed to see measurable changes in coral reef indicators over the business plan period.

3.1.1 Data collection and assessments: Improve decision making for fisheries management by supporting the collection of data and assessments, including fisheries stock assessments, coral reef baseline data collection, and surveys of fishing effort to identify herbivore biomass targets.

3.1.2 Community outreach: Support education and outreach, as new marine managed areas and regulations are identified, to ensure awareness and compliance. In addition and where relevant, support community-based fisheries management to help reduce take of herbivorous fishes and advance sustainable fishing practices.

3.1.3 Invasive macroalgae removal: Remove marine invasive species and reduce macroalgal cover to decrease benthic competition and support coral growth and recruitment. In addition to removal efforts, support assessment and monitoring to identify areas with dense concentration and to document changes in invasive algae where necessary.

3.2 Coral reef restoration – For the purposes of this business plan, as it relates to coral reefs, "restoration" refers to the establishment of corals derived from land-based or ocean nurseries that are directly transplanted to degraded reefs that are believed to support growth and reproduction. Live coral cover is one of the factors that is expected to improve resilience of reef systems following a disturbance and direct restoration through outplanting can be an effective strategy to increase live coral cover over a relatively short time. However, for coral restoration to be successful, localized stressors must be sufficiently reduced. As appropriate, the business plan will support restoration in priority sites as well as capacity building to implement coral restoration more broadly in the State by establishing coral nurseries or increasing the number of coral species and genotypes suitable for outplanting.

3.2.1 Capacity building research and development: Increase the number of species that can be outplanted and genotypes that have adaptation(s) to climate stressors through research and propagation technique development and by increasing coral nursery capacity.

3.2.2 Outplant nursery-grown corals: Where appropriate, actively restore coral reefs by outplanting key coral species to increase coral cover and recruitment potential.

3.3 Coral reef monitoring – Support or supplement existing monitoring programs in priority areas. Existing monitoring programs are robust and include regular benthic, fish, and water quality surveys. However, additional monitoring may be needed within priority areas including establishing sufficient coral reef monitoring in southern Molokaʻi and Lānaʻi. Additional assessment may include deploying sediment traps on reefs or measuring sediment depth to monitor changes in terrigenous sediment on the reef, evaluating sediment tolerance thresholds for corals, exploring additional benthic habitat indicators such as juvenile coral density, or assessing invasive algae distribution and density.

Figure 4. Results chain depicting the relationship of various strategies (yellow hexagons) within the business plan to each other, to the intermediate results (blue boxes) and ultimately to the target watershed forests and avian species (green ovals).

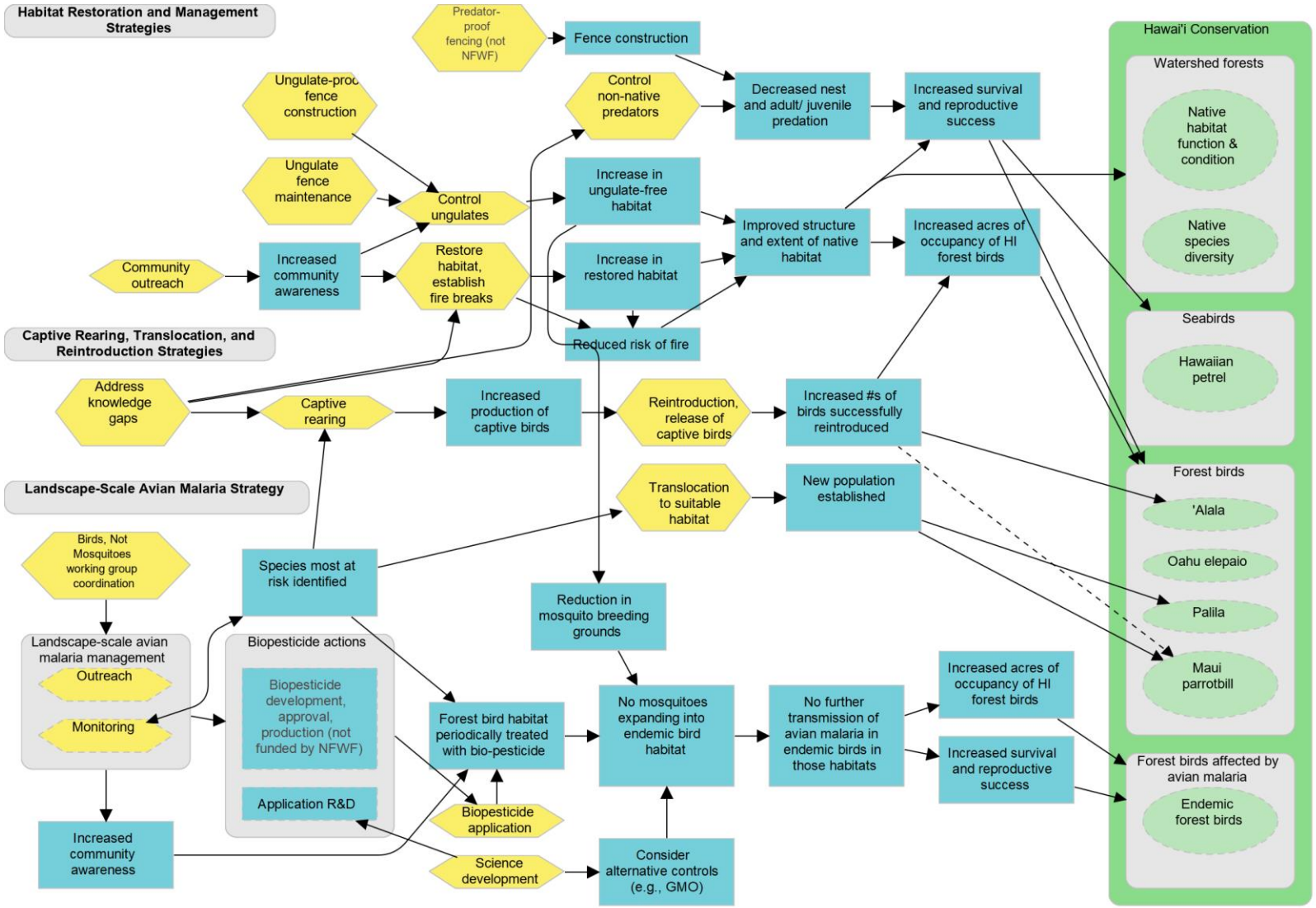
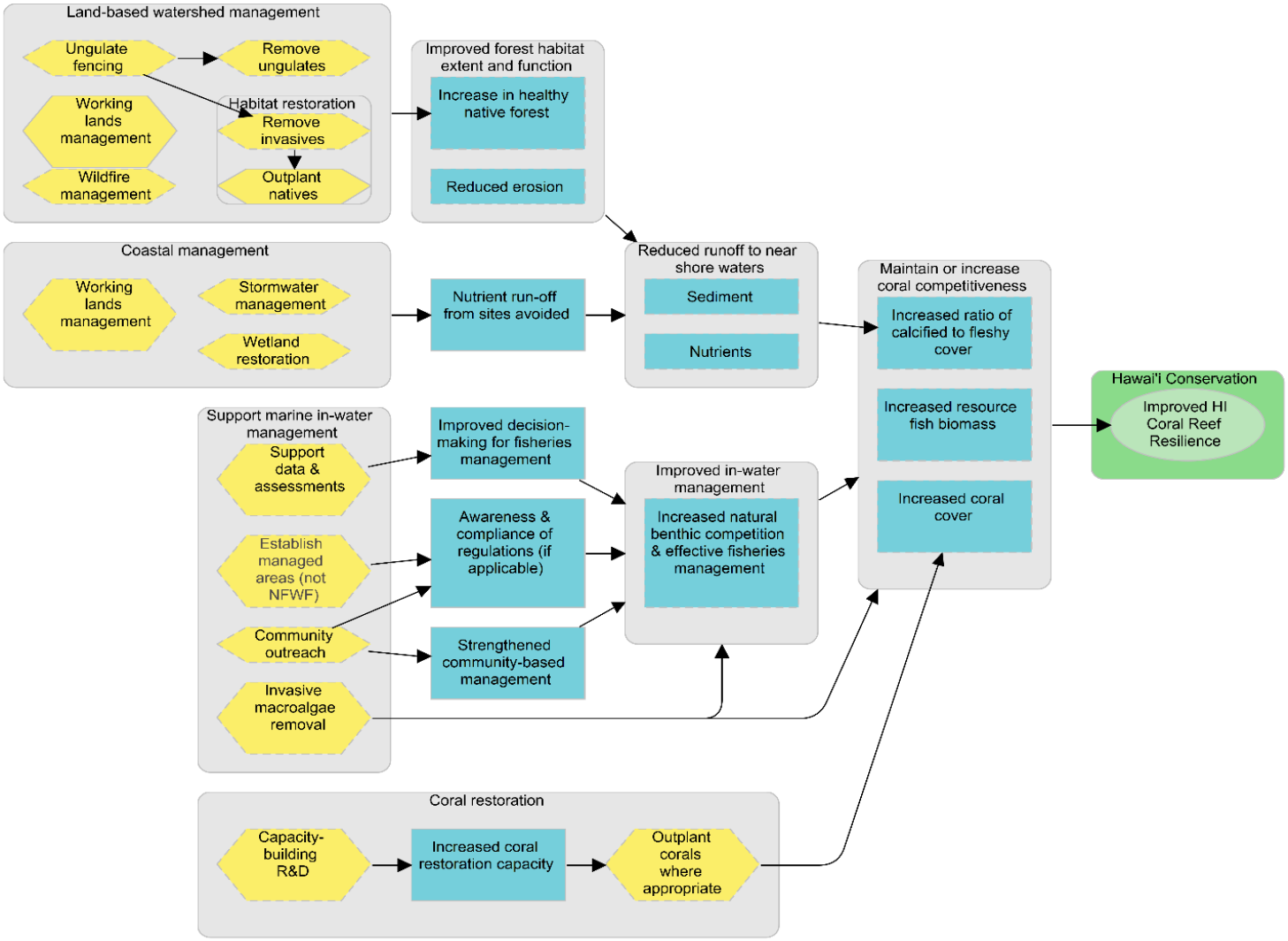


Figure 5. Results chain depicting the relationship of various strategies (yellow hexagons) within the business plan to each other, to the intermediate results (blue boxes) and ultimately to the target coral reefs (green ovals).



Risk Assessment

Risk is an uncertain event or condition which, if it occurs, could negatively affect a plan's outcomes. NFWF assessed seven risk categories to determine the extent to which they could impede progress towards our business plan strategies and goals over the next 10 years. Below, NFWF identified the primary risks to success to the avian and coral goals and describe strategies to minimize or avoid those risks, where applicable. In addition, NFWF has considered how the risk might affect the sustainability of the outcomes achieved up to 10 years after closure of the business plan (i.e., long-term sustainability).

Table 5: Hawai'i Conservation Business Plan Risk Assessment.

RISK CATEGORY	RATING	RISK DESCRIPTION	MITIGATING STRATEGIES	LONG-TERM SUSTAINABILITY
Economic Risks	Forests: N/A	*Not a risk area.*		
	Birds: N/A	*Not a risk area.*		
	Coral: Low	Unknown economic changes due to COVID (e.g., likely increase in subsistence fishing), which could affect priority sites.	NFWF will need to adapt as necessary to economic trends.	NFWF should continue to track trends and adapt as needed.
Environ-mental Risks	Forests: Moderate	Increased risk of drought and fires affecting dry forests. Rapid ʻŌhiʻa Death (ROD) could spread to additional islands.	Business plan strategies (fire breaks, habitat restoration, fencing) will reduce fire and ROD risk and impacts.	Potential for increased drought and fire poses risk to long-term sustainability.
	Birds: High	Warming temperatures increasing spread of mosquitoes and avian malaria to higher elevations. Rapid ʻŌhiʻa Death could precipitate wet mesic forest collapse.	Business plan goals assume warming temperatures continue.	Continued warming temperatures (and spread of avian malaria) poses risk to long-term sustainability.
	Coral: High	Climate change will impact coral, via bleaching, disease and ocean acidification. Invasive algae and fishes pose a risk to coral reefs.	Sites were selected based on potential resilience, and strategies are targeted to improving resilience.	Continued warming temperatures (and bleaching) poses risk to long-term sustainability.

RISK CATEGORY	RATING	RISK DESCRIPTION	MITIGATING STRATEGIES	LONG-TERM SUSTAINABILITY
Financial Risks	Forests: Low	Limited supply of galvanized steel could increase costs and delays for future fence projects. Funds for conservation affected by COVID-related impacts to state tourism and tax revenue.	NFWF may need to increase the budget for some conservation strategies.	Sustainability likely. Supply of steel likely to re-adjust over plan timeframe; State and USFWS have mandate to engage in conservation.
	Birds: High	Only 27% of business plan budget secured at this time. Funds for conservation affected by COVID-related lack of state tourism and Congressional State of the Birds funding.	Plan goals are based on anticipated funding.	Sustainability likely. State and USFWS have charge to engage in conservation; some NGOs have been working on HI bird conservation for years.
	Coral: High	Only 27% of business plan budget secured at this time. State funds for in-water strategies may be affected by COVID-related lack of tourism.	Plan goals are based on anticipated funding.	Long-term sustainability may be an issue if business plan sites are not prioritized by the State in their efforts.
Institu-tional Risks	Forests: Low	Limited capacity for fencing and native plant propagation, amplified by COVID restrictions, could delay activities.	Plan goals assume anticipated delays. Potential opportunity to expand fence building capacity through internships with partners.	NFWF should consider long-term capacity-building strategies.
	Birds: Low			
	Coral: Low	Limited capacity for ungulate fencing and native plant and coral propagation, amplified by COVID restrictions, can delay activities.	Business plan strategies will assist with capacity-building.	Institutional support/ capacity for ongoing maintenance needed for long-term sustainability.
Regulatory Risks	Forests: Low	Risk of permit delays due to required endangered species and cultural resource consultations. Limited funding for enforcement may increase risk of introduced pests and diseases.	NFWF will communicate with State and USFWS partners to encourage their involvement in mitigating delays.	Sustainability is likely because protection of freshwater resources is of high importance to the State. Regulatory processes are standard practice in forest conservation.
	Birds: High	Permitting requirements for the mosquito strategy and COVID-related restrictions could delay implementation.	NFWF will communicate with State and USFWS partners to encourage their involvement in mitigating delays.	Achievement of plan activities should promote sustainability.
	Coral: Low	Permitting can hinder coral restoration. Ability to do coral in-water management depends on whether State implements marine management areas at our priority sites.	Currently investing in addressing restoration permitting barriers. Plan goals don't assume State initiative work at our sites. If they do, it will be a bonus.	Sustainability should be likely because State is likely to have more, rather than less, long-term management.

RISK CATEGORY	RATING	RISK DESCRIPTION	MITIGATING STRATEGIES	LONG-TERM SUSTAINABILITY
Scientific Risks	Forests: N/A	Not a risk area.		
	Birds: Moderate	Several scientific unknowns, including rate of bird declines, palila recovery needs, and development of *Wolbachia*-carrying mosquito.	NFWF can seek to support filling knowledge gaps.	If NFWF obtains sufficient knowledge to achieve goals, long-term sustainability will be likely.
	Coral: Low	Coral reefs are extremely complex systems and limited scientific understanding could pose a risk to effective implementation and measuring our impact.	Business plan includes strategies for R&D capacity and restoration. Priority sites are not data deficient.	If NFWF obtains sufficient knowledge to achieve goals, long-term sustainability will be likely.
Social Risks	Forests: Low	Some community members purposefully sabotaging fence effectiveness, which can lead to reinvasion of ungulates.	Plan includes community outreach highlighting the impact of ungulates on native species and alternate locations for continued hunting.	Continued engagement efforts needed for long-term sustainability.
	Birds: Low	Some hunters purposefully cut fences, which can lead to reinvasion of ungulates. Anti-GMO sentiment in HI could affect landscape-scale mosquito strategy.	Plan includes outreach to (a) hunters highlighting the impact of ungulates on native species and alternate locations for continued hunting and (b) the public to raise awareness about the difference between GMO and non-GMO mosquitoes.	Continued engagement efforts needed for long-term sustainability.
	Coral: Low	Fishing community will need awareness of new coral regulations. Record number of people moving in and out of the State due to COVID, but impact on community engagement is unclear.	NFWF has already engaged in some efforts that we can transfer to other sites. Plan includes outreach to fishing communities to raise awareness of value of regulations to increase compliance.	Continued engagement efforts needed for long-term sustainability.

Monitoring & Evaluating Performance

Performance of the Hawai‘i Conservation Business Plan will be assessed at both project and program scales. At the project scale, individual grants will be required to track relevant metrics from Tables 6-8 for demonstrating progress on project activities and outputs and to report on them in their interim and final programmatic reports. At the program scale, broader habitat and species outcomes will be monitored through targeted grants, existing external data sources, and/or aggregated data from relevant grant projects, as appropriate. In addition, NFWF will conduct an internal assessment at a future stage of the business plan to determine outcomes and adaptively manage. In some cases, course corrections that require increased investment may be warranted. However, it is also possible that NFWF would reduce or eliminate support if periodic assessment indicates that further investments are unlikely to achieve intended outcomes.

Monitoring Watershed Forest Outcomes

The protection and restoration of the State of Hawai‘i’s Priority I and Priority II watershed forests provide habitat for threatened and endangered species, enhance watershed functions, and mitigate wildfire threats to prevent deforestation and loss of watershed ecosystem services. Native forest protection in Hawai‘i typically follows a two-pronged approach of protecting watershed forests by: 1) building ungulate-proof fencing and subsequently removing invasive ungulates, and 2) suppressing invasive plants and invasive predators, and outplanting native vegetation where appropriate. While successful watershed forest restoration and conservation strategies are site-specific, these primary actions are important for the protection of species unique to Hawai‘i. NFWF’s investments and progress on these metrics will contribute towards the State of Hawai‘i’s *Sustainable Hawai‘i Initiative* goal to protect 30% of priority watershed forests by 2030.

Table 6. Metrics for measuring progress towards priority watershed forest conservation goals.

Category	Fence Unit	Outcomes	Baseline (2020)	Goal (2031)	Data source(s)
Priority I and Priority II watershed forests within focal watersheds	Kamehamenui, Maui	Increase native plant cover to 35%	10%	35%	Grantees/ DoFAW
		Establish 5 critically endangered plant species	0	5	Grantees/ DoFAW
		Increase native species diversity from 0 to 5 species per acre	0	5	Grantees/ DoFAW
	Pāhihi Pūka‘i, Maui	Increase native plant cover to 30%	0	30%	Grantees/ DoFAW
		Increase native species diversity from 0 to 5 species per acre	0	5	Grantees/ DoFAW
	All Maui focal watershed forest fence units	Miles of ungulate fencing installed	0	13	Grantees/ DoFAW
		# of acres protected (by installing ungulate-proof fencing)	0	3,600	Grantees/ DoFAW
		# of acres restored (native plants planted)	0	1,200	Grantees/ DoFAW
		# of miles of fuelbreaks created	0	2.5	DoFAW

Monitoring Hawaiian Bird Outcomes

A long-term Hawai'i Forest Bird Survey was established in 1986 and in 1988 DOFAW instituted a program of resampling the original forest bird transects once every 5-years (Camp et al. 2009). The overarching objective of these surveys is to assess distribution, population size, population trend and density data for forest birds on Kaua'i, O'ahu, Maui, Moloka'i and Hawai'i Island. One species, palila, is surveyed annually and has been continuously monitored since 1980 (Camp et al. 2009, Genz et al. 2018).[10]

O'ahu elepaio population surveys occur less frequently (Vanderwerf et al. 2013), however localized monitoring is conducted in conjunction with predator reduction actions at specific sites across the island. 'Ua'u monitoring is conducted annually on Lāna'i to generate colony level estimates of reproductive success as well as more localized data on burrow occupancy and density. 'Alalā post-release monitoring includes tracking data from tags and nearly daily field surveys to monitor health and survival.

A suite of metrics has been proposed for a landscape-level mosquito control effort, including the number of acres of bird habitat treated with an effective landscape biocontrol; the number of acres of bird habitat treated with a biocontrol that are mosquito free, the pre- and post-biocontrol treatment rates of avian malaria and the pre- and post-biocontrol treatment estimates of bird populations. However, because the initial treatment location will not be determined for 3-5 years, acreage targets cannot be estimated at this time. In the short-term, NFWF will focus on application at the site level and recognize that a broader suite of metrics will be available in support of evaluating success of treatment following site selection. Overall, data will be available to NFWF to assess progress towards species' goals and strategy-level performance metrics.

Table 7. Metrics for measuring progress towards bird conservation goals.

Bird Species	Outcomes	Metrics	Baseline (2020)	Goal (2031)	Data source(s)
'alalā (Hawaiian crow)	Establish one or more populations[11] of 'alalā in native forest through captive releases of 5 or more individuals annually	Release 5 or more 'alalā annually in locations aligned with 'alalā working group priorities	0	≥50 (2025)	Grantees
		# of populations established	0	1	Grantees
palila (finch-billed Hawaiian honeycreeper)	Achieve a stable population trend	100 individuals +/- 10 detected during annual population surveys	100	100	Grantees

[10] In addition to this annual palila survey, the State collects a suite of dry forest metrics to evaluate the health of the mamane (*Sophora chrysophylla)*/naio (*Myoporum sandwicense*) dry forest, the primary habitat for palila. While these habitat metrics could provide a complementary data set to the annual palila population surveys, there are currently insufficient resources and assurance that this time intensive survey can be conducted every 5 years.

[11] A population is multiple individuals of 'alalā that become resident to the immediate and adjacent areas of their point of release, in which they show potential for establishing territories, such as pairing, territorial and/or breeding behaviors, and become self-sufficient on native wild food resources.

Bird Species	Outcomes	Metrics	Baseline (2020)	Goal (2031)	Data source(s)
kiwikiu (Maui parrotbill)	Establish at least one captive population to reduce species extinction risk	Capture a minimum of 30 kiwikiu for establishing captive population	0	30	Grantees
		# of captive populations established	0	1	Grantees
ʻuaʻu (Hawaiian petrel)	Maintain an average reproductive success of 0.7 chicks/pair/year on Lānaʻi	# of chicks fledged per pair	0.7	0.7	Grantees
Oʻahu elepaio (monarch flycatcher)	Increase Oʻahu elepaio occupancy 100% in the Koʻolau Mountains	Increase the number of occupied Oʻahu elepaio breeding territories 100%	31	62	Grantees
		# of chicks fledged per pair	.35	.7	Grantees
Habitat restoration	Improve forest health by restoring habitat for forest birds	# of acres restored (native plants planted)	0	500	Grantees
		# of acres restored (invasive plants removed)	0	150	Grantees
Habitat management	Improve management of forest birds through fencing and predator control	# of miles of fencing maintained	0	75	Grantees
		# of acres under improved management	0	20,000	Grantees
Monitoring and research	Monitoring and research to inform species trajectories and management	# of monitoring programs	0	40	Grantees
		# of studies to inform management	0	15	Grantees
Avian malaria control	Support implementation of effective mosquito control for reducing transmission of avian malaria to protect endemic Hawaiian forest birds[12].	# of islands where endemic bird habitat is treated with an effective mosquito control tool	0	1	Birds, Not Mosquitoes steering committee

Monitoring Coral Reef Outcomes

The Hawaiʻi Division of Aquatic Resources (DAR) has a robust coral reef monitoring program throughout much of Maui Nui. Since 2016, DAR has been conducting over 40 surveys at each of 10 reef tracts annually in both Maui and Lānaʻi, including the Business Plan's focal reef at Kīhei. These data include coral cover, reef builder ratio, and herbivore biomass and will be used to monitor coral reef outcomes at the Kīhei priority reef biennially. In addition, to assess the Kīhei reef's ability to recover more quickly, benthic and reef fish data will be collected from it and the remaining nine survey sites to support analysis of trends across the islands. If one or multiple bleaching events occur during the business plan period, it will be important to measure recovery at priority reef tracts relative to other impacted sites. On Molokaʻi, the coral reef tract is not monitored annually; however, recent surveys conducted in 2015–

[12] As noted previously, once the *Birds, Not Mosquitoes* steering committee decides the islands to apply landscape-level mosquito control (likely within 3-5 years), NFWF will identify targets for "acres treated" and "acres monitored post-treatment".

2016 provide estimates of benthic and reef fish composition. NFWF will develop a similar monitoring program for the Kawela priority reef on Molokaʻi to establish an updated 2020 baseline and to facilitate future monitoring. On Lānaʻi, coral reef surveys are currently underway and will be used to help set goals if Keōmoku or Naha become priority reef tracts. Monitoring programs on Lānaʻi and Molokaʻi will follow DAR's survey protocols to ensure consistency across priority reefs.

Monitoring Water Quality Outcomes for Coral Reefs

The Hawaiʻi Department of Health (DOH) and other entities have fixed water quality monitoring sites throughout the State where turbidity (an indicator of sediment and other particulate matter in the water), total nitrogen, and other pollutants are routinely monitored in nearshore waters. On Kīhei (Maui), the local non-profit Hui O Ka Wai Ola surveys five water quality monitoring sites multiple times throughout the year. The DOH established six monitoring sites in southern Molokaʻi in 2019 with the intention of monitoring the sites regularly. In addition, there is a USGS streamgage at the base of the Kawela Gulch, which is recognized as one of the largest sources of sediment to the reef tract in southern Molokaʻi (Takesue 2010). The streamgage measures suspended sediment concentration and discharge. In addition, numerous studies have documented sediment accumulation on the reef flat (Field et al. 2008) and suspension in the waters over the reef (Presto et al. 2006, Jokiel et al. 2014); these data can be used to facilitate assessments of changes in sediment on the Kawela reef. On Lānaʻi, USGS is conducting a notional sediment budget and establishing sediment trap to document sediment accumulation on the reef.

Monitoring Watershed Outcomes for Coral Reefs

Since 2006, The Nature Conservancy (TNC) has conducted systematic vegetation surveys on Molokaʻi to evaluate vegetation response to fence installations and other management actions. The Molokaʻi Understory Monitoring (MUM) survey was developed by local land managers and scientists to provide a robust and standardized approach to assess vegetation recovery. MUM provides a coarse look at forest health through the status and changes in a suite of site characteristics including ungulate disturbance, percentage of native cover, and plant species composition. Photos are also captured at consistent locations to visually depict changes in site characteristics over time. MUM data are collected every five years on established transects, and additional monitoring sites will be established within the Kawela Gulch fence unit to document dry forest and shrubland recovery before and after fence construction. These data, in tandem with information from the Kawela streamgage, will provide a holistic approach to document improvements in watershed health.

Table 8. Metrics for measuring progress towards coral conservation goals.

Category	Focal Reef Tract	Outcomes	Baseline (2020)	Goal (2031)	Data source(s)
Coral reef resilience	Kawela Reef, Molokaʻi	Increase reef builder ratio (unitless) by 10%	2.15	2.4	Grantees/ Contractors
		Increase reef fish biomass (g/m2) by 45%	20	29	Grantees/ Contractors
	Kīhei Reef, Maui	Increase reef builder ratio (unitless) by 10%	1.9	2.1	DAR
		Increase reef fish biomass (g/m2) by 35%	15	20	DAR
	All priority reefs	Marine acres under improved management	0	100	Grantees
		# of studies to inform management	0	12	Grantees
		# of monitoring programs	0	11	Grantees/ Contractors

Category	Focal Reef Tract	Outcomes	Baseline (2020)	Goal (2031)	Data source(s)
Improved water quality	Kawela Reef, Moloka‘i	Reduce sediment discharge (tons/day) by 90%	1,840	200	USGS Streamgage
	Kīhei Reef, Maui	Reduce nearshore turbidity (NTU) by 33%	6	4	DOH
		Reduce nearshore total nitrogen (µg/L) by 33%	73	48	DOH
	All priority watersheds	Acres with BMPs for sediment and nutrient reduction	0	1,470	Grantees
		Lbs of sediment avoided annually	0	13M	Grantees
		Lbs of N avoided annually	0	2,000	Grantees
Improve forest health and function	Kawela Reef Tract, Moloka‘i	Increase upland native plant cover by 40%[13]	0	40	TNC/EMoWP
		Reduce signs of ungulate presence to 5% or less	>50	<5	TNC/EmoWP
	All priority watersheds	Miles of ungulate fencing installed	0	24	Grantees
		# of acres protected (by installing ungulate-proof fencing)	0	10,600	Grantees
		# of acres restored (invasive plants removed)	0	300	Grantees
		# of native plants planted	0	10,000	Grantees
		# of PEPP species planted	0	3	Grantees
		# of miles of fuelbreaks created	0	13	Grantees
		Acres restored (wetland restoration)	0	35	Grantees

[13] Project baseline conditions will vary by site.

Budget

The following budget shows the estimated costs to implement the business plan activities. NFWF will have to raise funds to meet these costs; therefore, this budget reflects NFWF's anticipated engagement over the plan's period of performance and it is *not* an annual or even cumulative commitment by NFWF to invest. This budget assumes that current activities funded by others will, at a minimum, continue.

BUDGET CATEGORY	Yrs 1-5	Yrs 6-10	Total
Strategy 1. Restore or improve native watershed function and biodiversity.			
1.1.1 Ungulate-proof fencing	563,000	0	563,000
1.1.1 Invasive ungulate removal	100,000	0	100,000
1.1.3 Habitat restoration	125,000	625,000	750,000
1.1.4 Wildfire prevention and management	100,000	100,000	200,000
1.1.5 Working lands management	100,000	100,000	200,000
1.1.6 Watershed Monitoring	105,000	105,000	210,000
Strategy 1 Sub-Total:	**$1,093,000**	**$930,000**	**$2,023,000**
Strategy 2. Support populations of endemic bird focal species to prevent extinction.			
2.1.1 Habitat restoration	395,000	250,000	645,000
2.1.2 Habitat management	711,000	500,000	1,211,000
2.1.3 Community outreach	40,000	50,000	90,000
2.2 Captive rearing, translocation, and reintroduction strategies	648,000	650,000	1,298,000
2.2.5 Monitoring	333,000	350,000	683,000
2.3.1-2.3.2 Landscape-scale avian malaria control - coordination & community outreach	179,000	50,000	229,000
2.3.3 Landscape-scale avian malaria control - science development	100,000	150,000	250,000
2.3.4 Landscape-scale avian malaria control - biopesticide application	100,000	100,000	200,000
2.3.5 Landscape-scale avian malaria control - mosquito-related monitoring	223,000	300,000	523,000
Strategy 2 Sub-Total:	**$2,729,000**	**$2,400,000**	**$5,129,000**

BUDGET CATEGORY	Yrs 1-5	Yrs 6-10	Total
Strategy 3. Promote resilient coral reef ecosystems at priority reef tracts.			
1.1.1 Ungulate-proof fencing	2,975,000	0	2,975,000
1.1.2 Invasive ungulate removal	752,000	0	752,000
1.1.3 Habitat restoration	414,000	0	414,000
1.1.4 Wildfire prevention and management	60,000	0	60,000
1.1.5 Working lands management	0	500,000	500,000
1.2.1 Stormwater management	670,000	1,000,000	1,670,000
1.2.2 Coastal wetlands restoration	350,000	1,000,000	1,350,000
3.1.1 Data collection and assessments	100,000	200,000	300,000
3.1.2 Community outreach	100,000	100,000	200,000
3.1.3 Invasive macroalgae removal	100,000	100,000	200,000
3.2.1 Coral reef restoration - capacity building research and development	100,000	100,000	200,000
3.2.2 Coral reef restoration - outplant nursery-grown corals	100,000	100,000	200,000
3.3 Coral reef monitoring	231,000	100,000	331,000
Strategy 3 Sub-Total:	**$5,952,000**	**$3,200,000**	**$9,152,000**
TOTAL BUDGET	**$9,774,000**	**$6,530,000**	**$16,304,000**

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