Wake Atoll
Rat Eradication Program

Draft Environmental Assessment
July 2021

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Draft Environmental Assessment

Cooperating Agencies:
U.S. Air Force
U.S. Fish and Wildlife Service

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USDA-APHIS

July 2021

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Executive Summary

Wake Atoll is a small coral island in the Pacific Ocean that lies approximately 2,200 miles (3,540 km) west of the Hawaiian Islands. Wake Atoll consists of three islands: Wake, Wilkes, and Peale. These three islands collectively form a V-shaped figure with a shallow lagoon that is open to the Pacific Ocean. The island is managed by the U.S. Air Force (USAF) with the installation's day-to-day operations managed by a USAF Base Operations Support (BOS) contract. The shallow lagoon in the interior of the atoll and surrounding waters are managed by the U.S. Fish and Wildlife Service (USFWS) as a national wildlife refuge. The refuge is also part of the Pacific Remote Islands Marine National Monument (PRIMNM) that is cooperatively managed by the USFWS and the National Oceanic and Atmospheric Administration (NOAA). Wake Atoll is a National Historic Landmark (NHL) due to its military significance during World War II.

The U.S. Department of Agriculture Animal and Plant Health Service (USDA-APHIS) Wildlife Services (WS) is proposing to eradicate the invasive Pacific rat (*Rattus exulans*) from Wake Atoll. The proposed eradication is a cooperative effort between USDA-APHIS WS, USAF, USFWS, and Island Conservation to plan and implement the proposed action. The proposed eradication of the Pacific rat on Wake Atoll is the second attempt to eradicate invasive rodents from the island. An initial attempt in 2012 successfully removed the Asian rat (*Rattus tanezumi*) from Wake Atoll, and the Pacific rat from Peale Island; however, the Pacific rat was not eradicated from Wake Island and Wilkes Island. Pacific rat populations have rebounded since the 2012 eradication attempt and pose a threat to human health, island infrastructure and natural resources on Wake Atoll. A post-eradication analysis identified data gaps and uncertainties that contributed to the failed rat eradication. Additional studies and project reviews were conducted to address data gaps and uncertainties from the 2012 rat eradication. This information was used to determine the feasibility of a proposed second eradication attempt and prepare an operational workplan which is summarized in the proposed action described in this draft Environmental Assessment (EA).

This EA discusses the human health and environmental effects of the proposed action and the no action alternative. The proposed action to eradicate the Pacific rat from Wake Atoll will use ground and aerial broadcast applications of Brodifacoum-25W Conservation (B-25W). B-25W is a pelleted rodenticide bait registered by USDA-APHIS and is intended for conservation purposes for the control or eradication of invasive rodents on islands or abandoned vessels. Brodifacoum is the active ingredient in the B-25W formulation and has successfully been used in previous island rodent eradication projects. The B-25W formulation will be broadcast on Wake Atoll by hand or using a helicopter or unmanned aerial vehicle (UAV) on Wake Atoll. Areas of Wake Atoll where aerial or ground broadcast applications are not feasible, or not permitted, will use other ground application methods to ensure that all Pacific rats are exposed to the rodenticide or otherwise removed. Other ground application methods for rodenticides may include the use of stationary and floating bait stations, bait trays, burrow baiting, bait bolas or sachets, and canopy baiting. Trapping will also be used in areas where rodenticide use is not allowed or to supplement rodenticide applications. Post-eradication treatments to remove any remaining Pacific rats may include hand application of B-25W, alternative rodenticides, and trapping. The project is proposed for implementation in summer 2023. Summer is the preferred time of application since it is the dry time of the year on Wake Atoll, which reduces the chance of brodifacoum runoff into the marine environment and will maximize efficacy of the baits. Summer is also the time of year with a lower potential to impact nontarget birds, in particular migratory shorebirds on Wake Atoll.

The eradication of the Pacific rat will remove the risks to human health associated with rodent infestations. The proposed action will not result in adverse effects on people on Wake Atoll or workers involved with eradication and post-eradication activities. No contamination of food items and drinking water will occur from the proposed action. B-25W label requirements and program measures designed to reduce exposure will ensure minimal risk to workers who are part of the eradication. Additional mitigation measures proposed by the USAF will reduce the risk to military and civilian staff on the island.

The proposed action will also protect natural resources currently being negatively affected by the Pacific rat. Nesting seabirds and their eggs and chicks will be protected from predation by the Pacific rat. Other bird species and wildlife will also benefit where rats compete for resources such as food. The use of B-25W bait pellets does pose a risk to birds and other wildlife that consume the pellets or that consume prey that contain residues of brodifacoum. The risks to birds will be reduced by the implementation of protective measures designed to minimize exposure to brodifacoum and disturbance from the proposed action.

The proposed action will not result in significant adverse effects on the marine environment at Wake Atoll. Pesticide label restrictions and other program mitigation measures intended to protect marine resources will reduce incidental deposition of B-25W bait pellets into the marine environment during the proposed ground and aerial broadcast applications. The proposed window of rodenticide application during the dry season will also ensure that runoff into the marine environment will be minimized. Label restrictions and program measures to mitigate rodenticide contamination of the marine environment will minimize the risks to nontarget marine species.

USDA-APHIS has prepared this EA for planning and decision-making purposes and to allow public comment about the potential effects of the proposed actions. USDA-APHIS has determined that the proposed action described in this EA will not result in significant effects on human health and the environment.

Project	Wake Atoll Rat Eradication
Agency	U.S. Department of Agriculture (USDA) - Animal and Plant Health Inspection Service (APHIS) Wildlife Services (WS)
Cooperating Agencies	U.S. Air Force (USAF), U.S. Fish and Wildlife Service (USFWS)
Affected Location	Wake Atoll
Proposed Action	Eradication of the Pacific rat (*Rattus exulans*) from Wake Atoll
Island & Project Area	1,747 acres (707 hectares)
Required Permits & Approvals	• National Environmental Policy Act (NEPA) • Endangered Species Act (ESA) • Magnuson-Stevens Fishery Conservation and Management Act of 2006 • Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) supplemental Section 3 pesticide labels • Section 106, National Historic Preservation Act (NHPA) • Water Pollution Control Act of 1948, as amended - National Pollutant Discharge Elimination System (NPDES) Permit • National Wildlife Refuge System Administrative Act (NWRSA)
Anticipated Determination	No significant negative effects. Long-term beneficial effects on human health and safety, and natural resources on Wake Atoll.
Parties Consulted	• USAF • Island Conservation • USFWS - Wake Atoll National Wildlife Refuge • Pacific Remote Islands Marine National Monument • USFWS - Migratory Bird and Habitats Program • USFWS – Pacific Islands Ecological Services • National Oceanic Atmospheric Association (NOAA) - National Marine Fisheries Service (NMFS) • U.S. Environmental Protection Agency (USEPA) - Office of Pesticide Programs (OPP) • USEPA - Office of Water (OW) Region 9 • Alaska State Historic Preservation Office (SHPO)
Environmental Assessment Preparation	USDA-APHIS

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Acronyms and Abbreviations

Acronym	Phrase
ac	Acres
ai	Active ingredient
AFB	Air Force Base
APE	Area of Potential Effect
APHIS	Animal and Plant Health Inspection Service
B-25D	Brodifacoum-25 D Conservation
B-25W	Brodifacoum-25 W Conservation
BASH	Bird Aircraft Strike Hazard
BMDS	Ballistic Missile Defense System
BOS	Base Operating Support
°C	Degrees Centigrade
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, And Liability Act
CO	Carbon monoxide
CO_2	Carbon dioxide
CH	Critical Habitat
CSIRO	Commonwealth Scientific and Industrial Research Organizations
CWA	Clean Water Act
dBA	Decibel A Scale
D-50	Diphacinone-50
DGPS	Differential Geographic Positioning Systems
DIISE	Database of Island Invasive Species Eradications
DPS	Distinct Population Segment
ESA	Endangered Species Act
EA	Environmental Assessment
EC_{50}	Median Effective Concentration
EFH	Essential Fish Habitat
EO	Executive Order
°F	Degrees Fahrenheit
ft	Feet
FGAR	First-Generation Anticoagulant Rodenticides
FIFRA	Federal Insecticide Fungicide and Rodenticide Act
FONSI	Finding of No Significant Impact
FR	Federal Register
g	Grams
GPS	Geographic Positioning System
ha	Hectares
ICRMP	Integrated Cultural Resources Management Plan
INRMP	Integrated Natural Resources Management Plan
IPM	Integrated Pest Management
IC	Island Conservation
in	Inches
IUCN	International Union of Conservation Nature
kg	Kilograms
lb	Pounds
LC_{50}	Median Lethal Concentration Dose
LD_{50}	Median Lethal Oral Dose

MDA	Missile Defense Agency
m	Meters
mg/kg	Milligrams Per Kilogram
mg/L	Milligrams Per Liter
mph	Miles Per Hour
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MMPA	Marine Mammal Protection Act
MBTA	Migratory Bird Treaty Act
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollution Discharge Elimination System
NWRC	National Wildlife Research Center
PM	Particulate Matter
PPE	Personal Protection Equipment
RCRA	Resource Conservation and Recovery Act
RUP	Restricted Use Pesticide
SGAR	Second-Generation Anticoagulant Rodenticides
SHPO	State Historic Preservation Office
SO_2	Sulfur Dioxide
SPCC	Spill Prevention and Control Countermeasure
SWAA	Solid Waste Accumulation Area
µg/L	Micrograms Per Liter
U.S.	United States
USAF	U.S. Air Force
USDA	U.S. Department of Agriculture
USDOD	U.S. Department of Defense
USDOI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service
USEPA	U.S. Environmental Protection Agency
WIA	Wake Island Airfield
WS	Wildlife Services
w/w	Weight by Weight

Chapter 1 Purpose and Need

1.1 Introduction

This Environmental Assessment (EA) evaluates the potential environmental impacts from the proposed action to eradicate the invasive Pacific rat *(Rattus exulans*), also known as the Polynesian rat, from Wake Atoll. Wake Atoll is a small coral reef in the Pacific Ocean that lies approximately 2,200 miles (3,540 km) west of the Hawaiian Islands, 1,600 miles east of Guam, and 2,000 miles east of Japan. Wake Atoll consists of three islands: Wake, Wilkes, and Peale. These three islands collectively form a V-shaped figure with a shallow lagoon that is open to the Pacific Ocean toward the northwest (Figure 1). Wilkes Island is joined by a causeway to Wake Island. The north end of Wilkes Island is tidally separated from the rest of Wilkes at high tide. The total land area of Wake Atoll is 2.73 square miles (7.1 square kilometers (sq. km)). Approximately 1,747 acres (ac) (707 hectares (ha)) is dry land with 10 miles (16 km) of ocean shoreline and 6 miles of lagoon shoreline (USAF, 2009).

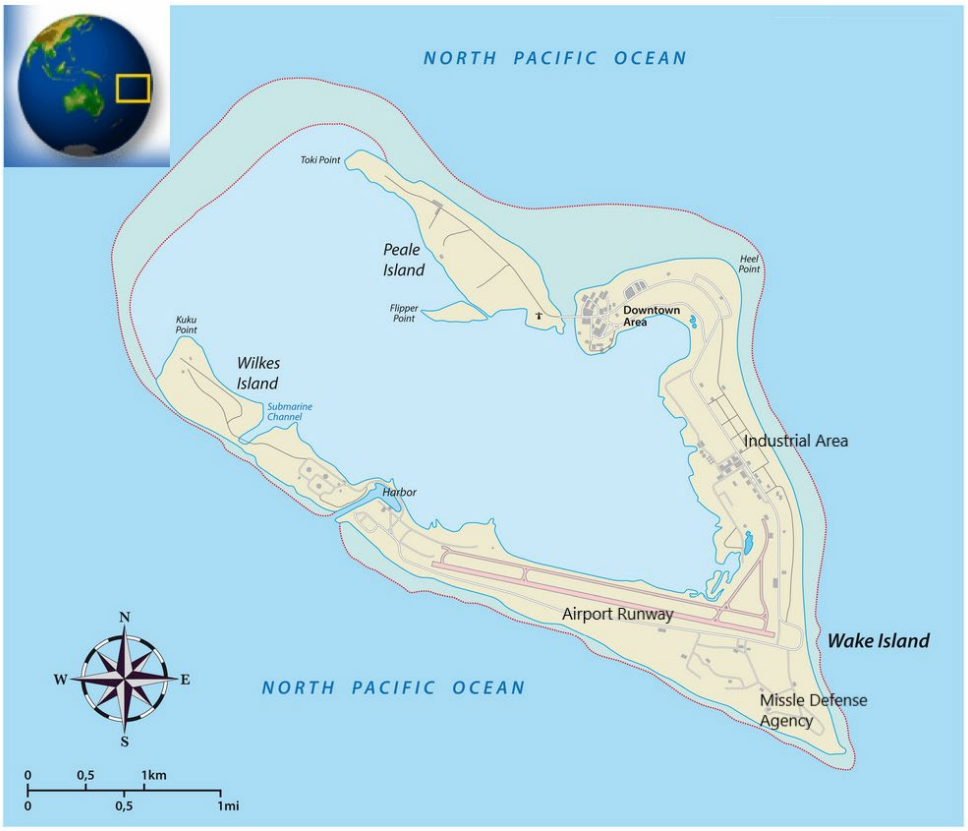


Figure 1. Location of Wake Atoll.

Wake Atoll is an unorganized, unincorporated territory of the United States, part of the United States Minor Outlying Islands, administered by the Office of Insular Affairs, U.S. Department of the Interior (USDOI). Access to the island is implemented under the U.S. Air Force (USAF) and the installation's day-to-day operations are managed by a USAF Base Operations Support (BOS) contract (USAF, 2009). The USAF assumed responsibility for management of the island in 1972 in a Memorandum of Agreement (MOA) between the USAF and U.S. Department of Interior (USDOI). Federal natural resource and wildlife

protection laws apply to Wake Atoll; however, due to its unique jurisdictional setting, no state, territorial, or commonwealth natural resource or wildlife protection laws apply (USAF, 2017). Wake Atoll was designated a National Historic Landmark in 1985 due to its military significance during World War II (USAF, 2017).

Developed areas on Wake Atoll are divided into four general areas of activity that include the airport, industrial area, downtown, and the Missile Defense Agency (MDA) area (USAF, 2017). In addition to these four general areas, there is a jet fuel depot on the southern portion of Wilkes Island and a harbor on the southwest end of Wake Island. The airport has a 9,850-foot runway with supporting taxiways and an airport terminal. The industrial area has supporting infrastructure (e.g., aircraft fueling support and airfield maintenance shop), fire and rescue, warehouse buildings, offices, and a water collection and distribution center. The downtown area provides a living area for staff on the island including housing and a cafeteria among other amenities. The MDA contains various testing equipment that is used to support their mission.

Wake Atoll has a tropical maritime climate with temperatures ranging from a minimum of 68 degrees Fahrenheit (°F) or 20 degrees Centigrade (°C) to a maximum of 95°F (35°C) (USAF, 2017). Rainfall on the island is light, averaging about 35 inches (in) or 889 millimeters (mm) per year. Precipitation is greatest during the months of July through October peaking in August with an average rainfall amount of 6.16 in or 156.5 mm. January is the driest month of the year with an average rainfall amount of 1.16 in or 29.46 mm (USAF, 2009).

Wake Atoll and the surrounding waters contain ecological habitats that support various fish and wildlife communities. The wildlife on Wake Atoll is dominated by a variety of bird species protected under the Migratory Bird Treaty Act (MBTA). Several species of seabirds occur on the island, all of which are populations of regional significance and may be affected by the Pacific rat (Table 1). Nesting areas for birds are found throughout the island but are at higher densities on Wilkes Island and Peale Island. Various shorebirds also occur on Wake Atoll including the bristle-thighed curlew, (*Numenius tahitiensis*) which is considered a near threatened species (IUCN, 2020). Birds and other native organisms can be found through the various habitats in and around Wake Atoll, including the varied plant communities (Appendix C).

Table 1. Seabirds observed on Wake Atoll.

Common Name	Scientific Name	Common Name	Scientific Name
Brown Noddy	*Anous stolidus*	Laysan Albatross	*Phoebastria immutabilis*
Black Noddy	*Anous minutus*	Black-footed Albatross	*Phoebastria nigripes*
White Tern	*Gygis alba*	Wedge-tailed Shearwater	*Ardenna pacifica*
Gray-backed Tern	*Onychoprion lunatus*	Great Frigatebird	*Fregata minor*
Sooty Tern	*Onychoprion fuscatus*	Masked Booby	*Sula dactylatra*
Red-tailed Tropicbird	*Phaethon rubricauda*	Red-footed Booby	*Sula sula*
White-tailed Tropicbird	*Phaethon lepturus*	Brown Booby	*Sula leucogaster*

The waters in and around the island are part of the Wake Atoll National Wildlife Refuge managed by the U.S. Fish and Wildlife Service (USFWS). The refuge includes 495,515 acres of submerged lands and waters surrounding Wake Atoll out to 12 nautical miles from the mean low water line of the island.

Wake Atoll is home to large populations of a diversity of marine fish species. Surveys indicate over 230 species with large populations of the Napoleon wrasse (*Cheilinus undulates*), various shark species, and

the humphead parrotfish (*Bolbometopon muricatum*). Wake Atoll is also home to various marine invertebrates including the giant clam (*Tridacna maxima*) and a variety of coral species, including some that are protected. The refuge is part of the Pacific Remote Islands Marine National Monument (PRIMNM), cooperatively managed by the USFWS and the National Oceanic and Atmospheric Administration (NOAA). The Wake unit of PRIMNM extends out to the seaward limit of the United States Economic Zone, which is 200 nautical miles from the mean low water line of the island. The PRIMNM contains the largest collection of coral reef, seabird, and shorebird protected habitats that are managed under a single jurisdiction (USAF, 2017).

1.2 Purpose of the Action

The purpose of the proposed action is to eradicate the invasive Pacific rat from Wake Atoll. The proposed eradication project is a cooperative effort between the U.S. Department of Agriculture Animal and Plant Health Service (USDA-APHIS) Wildlife Services (WS)[1], USAF, USFWS, and Island Conservation (IC). The eradication program at Wake Atoll will consist of a primary eradication effort followed by post-eradication activities that will increase the likelihood of eradication of the Pacific rat. The primary tool for eradication will be rodenticide(s) applied using various aerial and ground-based application methods that are designed to increase the likelihood of a successful eradication and minimize the risk to human health and the environment.

1.3 Need for the Action

1.3.1 History of Invasive Rats and Previous Eradication Efforts on Wake Atoll

The Pacific rat and Asian house rat (*Rattus tanezumi*) were the only two invasive rodent species known to occur on the atoll. The Pacific rat was thought to have been introduced by early Micronesian explorers, while the Asian house rat was introduced in the mid-1970's by Vietnamese refugees (USAF, 2017). Both species became abundant on Wake Atoll after their introduction.

In 2012, an attempt was made to eradicate the Pacific and Asian house rats from Wake Atoll. The eradication project was a joint effort between the USAF, USFWS, IC and USDA-APHIS. The eradication effort consisted of aerial and ground broadcast applications, and bait stations using a rodenticide containing the anti-coagulant brodifacoum. Post eradication monitoring showed that the eradication effort was successful for the Asian house rat on all three islands and the Pacific rat on Peale island, but was unsuccessful for the Pacific rat on Wilkes Island and Wake Island (USAF, 2017).

The Pacific rat population has rebounded since the 2012 eradication effort (USAF, 2017). Rats have been observed in natural and developed areas including housing areas, the runway, terminal buildings, and at high densities in the Wilkes Island bird colony. Currently, ongoing efforts to control rat populations using rodenticide bait stations in commensal areas (e.g., living quarters and food preparation areas) and the marina are being conducted (USAF, 2017). These localized control actions don't address rat populations in other areas on Wake Atoll. Rats can repopulate areas after localized treatments resulting in the need to continually use rodenticide bait stations to suppress populations in key areas.

[1] WS includes operational personnel from Guam and Hawaii and research personnel from the National Wildlife Research Center (NWRC).

1.3.2 Impacts of Invasive Rodents on Islands

The introduction of invasive rats and house mice (*Mus musculus*) on islands can have significant human health and ecological impacts. The three most common invasive rat species that have been introduced on islands are the brown or Norway rat (*Rattus norvegicus)*, the ship or black rat (*Rattus rattus),* and the Pacific rat (Harper and Bunbury, 2015). The presence of rats on islands and other areas of human habitation can result in negative health and safety and economic impacts to humans such as:

- Disease transmission
- Food contamination
- Agriculture and livestock impacts
- Damage to infrastructure

The ability of rats to serve as reservoirs for transmission of multiple human-related diseases is well documented (Banks and Hughes, 2012; Mazza et al., 2013; CABI, 2018). Losses to agriculture, contamination of food and damage to infrastructure have human health implications; and economic impacts such as the cost of controlling rats and repair to infrastructure, and economic losses related to reduced crop yields and food supplies.

Invasive species, and in particular rats, are recognized as the most significant threat to island biodiversity (PII, 2020). The ability of introduced rats to impact island ecosystems is due to several factors including a lack of natural predators, high reproduction rates, and a varied diet.

Ecological impacts related to the introduction of rats to island ecosystems have been summarized in various reviews (Harper and Bunbury, 2015; Shiels et al., 2014). These impacts have been noted for rat introductions to temperate and tropical island ecosystems. In some cases, rat introductions to islands have resulted in the extinction of native plant and wildlife species (Duncan and Blackburn, 2007; Bellard et al., 2016). Impacts can be direct, meaning primarily through depredation by rats on plants and animals, or indirect where rats may reduce food abundance for native wildlife or alter habitats resulting in trophic level effects. Ecological impacts related to the introduction of invasive rat species on islands include:

- Impacts to terrestrial plant communities,
- Impacts to terrestrial invertebrates (e.g., insects, snails, and crabs),
- Impacts to reptiles (e.g., lizards, tortoises, and sea turtles),
- Impacts to mammals (e.g., bats, and small rodents),
- Impacts to birds,
- Spread of invasive species,
- Disease transmission to native wildlife,
- Impacts to marine ecosystem productivity,
- Impacts to algal abundance and marine invertebrates, and
- Impacts to soil nutrients and pH.

Island ecosystems are especially vulnerable to the impacts of invasive species such as introduced rodents. Islands comprise less than 5.3% of the land area globally but support 20% of all bird, reptile, and mammal species. The Pacific islands are home to approximately 25% of the worlds globally threatened bird species. Invasive rodents are the primary threat to seabirds and island biodiversity when compared to other threats

such as habitat change and hunting (Jones et al., 2008; PII, 2020). Invasive rodents will feed on all bird life stages including eggs, chicks, and adults. The impact of invasive rodents on island bird populations has been demonstrated in the many island rodent eradication projects undertaken to date and the benefits realized during the post-eradication monitoring efforts (Thibault, 1995; Jouventin et al., 2003; Newton et al., 2016). Brooke et al. (2018) evaluated rat eradication impacts by measuring population growth rates of 181 seabird populations of 69 species post-eradication and found that population growth is more rapid in new colonies compared to those already established after successful eradication. This impact was more prevalent among gulls and terns. The benefits to birds from rodent eradication also extend to other plant and animal island species (Newton et al., 2016; Graham et al., 2018; USFWS, 2019;). The benefits to invertebrates, reptiles and plant communities from rodent removal have been documented on similar islands such as the Palmyra Atoll and other tropical islands (Harper and Banburry 2015; Wolf et al. 2018).

Negative impacts related to the introduction of the Pacific rat have been reported for several sea and land bird species on various islands, including Wake Atoll (Table 2). Predation events on sooty tern chicks were observed on Wake Atoll in previous bird surveys (Gilardi and Rauzon, 2015). Other species observed on the island such as the brown noddy, wedge-tailed shearwater, Laysan albatross, and red-tailed tropicbird have also been negatively impacted by the Pacific rat on other islands.

Table 2. Sea and land bird species reported to have been impacted by the Pacific rat (Rattus exulans).

Common Name	Scientific Name	Location	Source
Seabirds			
Brown Noddy	*Anous stolidus*	Kure Atoll	Woodward, 1972
Gray-backed Tern	*Onychoprion lunata*	Kure Atoll	Woodward, 1972
Sooty Tern	*Onychoprion fuscata*	Wake Atoll, Kure Atoll	Kepler, 1967; Woodward, 1972; Gilardi and Rauzon, 2015
Red-tailed Tropicbird	*Paethon rubricauda*	Kure Atoll	Fleet, 1972; Woodward, 1972
Bonin Petrel	*Pterodroma hypoleuca*	Kure Atoll	Kepler, 1967
Bulwer's Petrel	*Bulweria bulwerii*	Lehua, Hawaii	VanderWerf et al., 2007
Murphy's Petrel	*Pterodroma ultima*	Henderson Island	Brooke, 1995
Kermadec Petrel	*Pterodroma neglecta*	Henderson Island	Brooke, 1995
Pycroft Petrel	*Pterodroma pycrofti*	Lady Alice Island	Pierce, 2002
Little Shearwater	*Puffinus assimilis haurakiensis*	Lady Alice Island	Pierce, 2002
Wedge-tailed Shearwater	*Puffinus pacficus*	Kure Atoll	Wirtz, 1972
Laysan Albatross	*Phoebastria immutabilis*	Kure Atoll	Kepler, 1967
Black-footed Albatross	*Phoebastria nigripes*	Kure Atoll	Woodward, 1972
Land birds			
Tuamotu Sandpiper	*Prosobonia cancellate*	Tuamotos	Pierce and Blanvillain, 2004
Polynesian Ground Dove	*Callicolumbae rythroptera*	Tuamotos	Pierce and Blanvillain, 2004
Atoll Fruit Dove	*Ptilonopus coralensis*	Tuamotos	Pierce and Blanvillain, 2004

Common Name	Scientific Name	Location	Source
Seabirds			
Sandpiper	*Prosobonia* sp.	Henderson Island	Wragg and Weisler, 1994

The Pacific rat is the smallest of the three invasive rat species that most commonly occur on islands. Adults range from 4.5 to 6 inches (in) (11.4 to 15.2 centimeters (cm)) long from the tip of the nose to the base of the tail, and weigh between 1.5 and 3 ounces (oz) (28.3 and 85 grams (g)) (Figure 2). Reproduction success is dependent on food availability with up to six litters per adult female per year possible. Litter sizes range from six to eleven pups (GISD, 2015).

Figure 2. Adult Pacific rat.

The Pacific rat can live in a wide range of habitats and is limited primarily by food availability and shelter. They are good climbers but are not considered good swimmers, which generally limits their island incursions to human-assisted introductions. The Pacific rat has a generalist diet that includes plant and animals. They prey on various terrestrial invertebrate species and vertebrates such as reptiles and birds (e.g., eggs and chicks). The Pacific rat also feeds on a wide variety of plants and plant parts including seeds, stems, leaves, bark, flowers, fruits, and roots (GISD, 2015). Direct impacts to populations of these plants and animals can occur from the Pacific rat as well as indirect effects on wildlife that depend on native plants and animals on islands.

1.4 Wake Atoll Natural Resource Management Plan and Seabird Conservation Plan

1.4.1 Integrated Natural Resources Management Plan Wake Island Airfield, Wake Atoll, Kōke`e Air Force Station, Kaua`i, Hawai`i, Mt. Ka`ala Air Force Station, O`ahu, Hawai`i

The USAF prepared an extensive integrated natural resource management plan (INRMP) for Wake Atoll and other stations throughout the Pacific as part of its requirements under the Sikes Act (USAF, 2017). The preparation of the INRMP is consistent with AFMAN 32-7003, Environmental Conservation (USAF, 2020a). The INRMP was prepared in cooperation with the USFWS, NOAA and the Hawai`i Department of Land and Natural Resources (DLNR). The INRMP provides a description of resources on Wake Atoll and the other Pacific stations, and a list of management goals for natural resources on each island. The INRMP also presents a list of integrated pest management goals for managing invasive species. One of the management goals is the eradication of invasive rats from Wake Atoll (Table 3).

Table 3. Integrated pest management objective for rat eradication on Wake Atoll.

Objective IPM-3: Conduct follow-up rat eradication efforts based on lessons learned from the May 2012 eradication efforts and additional information obtained since the initial efforts.	
Tasks	Conduct necessary agency coordination and documentation required to implement the follow-up eradication effort.
	Develop a contingency plan to be implemented if live rats are found after the second eradication effort.
	Implement follow-up rat eradication efforts based on lessons learned from the May 2012 eradication efforts, additional information obtained since the initial effort and additional field research conducted by USDA-APHIS WS.
	Conduct surveys following the eradication effort to ensure that the effort was successful.
	Implement the contingency plan if live rats are found following the second eradication effort.
	Ensure that management practices and protocols presented in Nuisance and Non-Native Species Management-4 are implemented to minimize potential for re-introduction of rats onto Wake Atoll.

(USAF, 2017)

1.4.2 U.S. Fish and Wildlife Service Seabird Conservation Plan

The USFWS Pacific Region published a seabird conservation plan with the purpose of identifying the priorities for seabird management, research, outreach, planning and coordination (USFWS, 2005). The plan identifies seven bird colonies on islands that are a high priority for predator control, including Wake Atoll. The conservation plan proposes several management goals specific to protecting and managing seabird populations including, but not limited to:

- Coordinating with other federal and state agencies to protect important seabird colonies including those on military bases.
- Working with the U.S. Department of Defense (USDOD) and USDA to secure funds to implement the existing plan to eradicate rats from Wake.

1.5 Regulatory Considerations

USDA-APHIS is authorized to implement the proposed eradication program under the Acts of March 2, 1931, as amended, and December 22, 1987 (7 U.S.C. §§ 8351 – 8354), The Act of March 2, 1931 was amended in the Fiscal Year 2001 Agriculture Appropriation Bill, The Acts grant authority to USDA to eradicate or control injurious animals.

USDA-APHIS is preparing this EA to comply with the provisions of the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. §§ 4321 et seq.) as prescribed in implementing regulations adopted by the Council on Environmental Quality (CEQ) (40 CFR parts 1500-1508), USDA's NEPA regulations at 7 CFR part 1b, and USDA-APHIS NEPA implementing procedures (7 CFR part 372), and USAF's NEPA implementing procedures (32 CFR Part 989), for the purpose of evaluating the potential effects of the proposed action on the human environment (40 CFR § 1508.1(m)). The proposed action does not meet the criteria for actions normally requiring an environmental impact statement (7 CFR § 372.5(a)) based on the lack of significant impacts to the human environment associated with the implementation of the proposed eradication program.

This EA examines the environmental effects associated with the proposed alternatives. USDA-APHIS will use this EA for planning and decision-making, in addition to informing the public about the environmental effects of each action. This draft EA will be available for a 30-day public comment period. At the end of the public comment period, USDA-APHIS will review and address all substantive public comments in the final EA. After consideration of all comments, USDA-APHIS will determine if a finding of no significant impact (FONSI) is the appropriate decision and will publish the final EA and FONSI through a notice of availability to the public, or if an environmental impact statement will be prepared.

The proposed cooperative rat eradication project on Wake Atoll is being carried out with consideration of all applicable federal regulations and Executive orders (EO) (Table 4).

Table 4. Federal regulations, laws and Executive orders considered in the proposed Wake Atoll rat eradication project.

Federal regulations	Executive orders
• Acts of March 2, 1931, as amended, and December 22, 1987 • National Environmental Policy Act (NEPA) • Endangered Species Act (ESA) • Magnuson-Stevens Fishery Conservation and Management Act (MSA) and Essential Fish Habitat (EFH) • Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) • Marine Mammal Protection Act (MMPA) • Migratory Bird Treaty Act[1] (MBTA) • National Historic Preservation Act (NHPA) • National Wildlife Refuge System Administrative Act (NWRSA) • Water Pollution Control Act of 1948, as amended	• EO 13186 Responsibilities of Federal Agencies to Protect Migratory Birds (66 FR 3853, January 17, 2001) • EO 13089 Coral Reef Protection (June 11, 1998) • EO 13112 Invasive Species as amended 12/08/2016 by E0 13751

[1] The U.S. Department of the Interior Solicitor's Office issued a binding opinion (M-Opinion) on December 22, 2017 (Memorandum M-37050) that states that a permit is not required for incidental take of migratory birds. USDA-APHIS confirmed this is the status in correspondence with the USFWS dated October 20, 2020. The USFWS published a final rule on regulations governing take of migratory birds on January 7, 2021. The final rule was to be effective February 8, 2021 however the USFWS has invited public comment. USFWS is currently evaluating the final rule to determine if it still applies to incidental take. USDA-APHIS is working with USFWS, who is a cooperating agency in this project, to minimize impacts to migratory birds and adhere to responsibilities outlined in its MOU under EO 13186. USDA-APHIS will continue to communicate with the USFWS regarding any changes to the final rule and potential requirements for incidental take permits under the MBTA.

EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds, requires that each federal agency establish a Memorandum of Understanding (MOU) with the USFWS. The MOU between APHIS and USFWS provides a framework to work cooperatively to minimize impacts to migratory birds and to foster collaboration on the protection of migratory birds.

1.5.1 Previous NEPA Documentation Related to Rat Eradication Activities on Wake Atoll

The USAF prepared a final EA in 2009 for the 2012 rat eradication project conducted on Wake Atoll. The preferred alternative was the use of a brodifacoum bait, applied using aerial and hand broadcasting with some bait station use. This EA incorporates by reference the applicable information from the 2009 EA (USAF, 2009). A proposed second eradication effort, updated information regarding biological resources on the island, new pesticide registrations, and new technologies since the previous eradication effort warrant the preparation of a new EA.

1.6 Issues Considered in this EA

USDA-APHIS developed a list of topics for consideration in this EA based on issues identified in public comments submitted for other similar EAs, the scientific literature on island rodent eradication, and the use of pesticides. The following topics were identified as relevant to the scope of impacts analysis in this EA (40 CFR § 1501.2, and § 1501.3):

- human health and worker safety,
- cultural resources,
- physical environment: soil, water, and air quality,
- biological resources: animal and plant communities,
- potential impacts to threatened and endangered species,
- potential impacts to birds protected under the MBTA,
- potential impacts to marine mammals protected under the MMPA,
- potential impacts to trust resources managed by federal agencies, and
- compliance of the Agency's regulatory status decision with EOs, and environmental laws; and regulations to which the action is subject.

1.7 Project Participants

1.7.1 USDA-APHIS (Lead Agency)

The mission of USDA-APHIS WS is to provide federal leadership and expertise to resolve wildlife conflicts to allow people and wildlife to coexist. WS conducts program delivery, research, and other activities through Regional and State Offices, and the National Wildlife Research Center (NWRC) and its Field Stations, as well as through its National Programs. NWRC is the research unit of the USDA-APHIS WS program where scientists and staff find solutions to challenging wildlife damage management problems related to agriculture, natural resources, property, and human health and safety. This effort includes working in partnership with stakeholders to protect natural resources and critical infrastructure on islands that can be negatively impacted by invasive species.

1.7.2 USAF (Cooperating Agency)

Wake Atoll is under the administrative control of the Department of the Air Force, and under command authority of the Pacific Air Forces Regional Support Center, which is part of the 11th Air Force headquartered at Joint-Base Elmendorf-Richardson, Alaska. The USAF manages Wake Atoll, which serves as a critical trans-Pacific refueling station for military aircraft and supports MDA testing activities. The USAF, working collaboratively with the USFWS, is also responsible for managing and protecting the natural resources on the island.

1.7.3 USFWS (Cooperating Agency)

The USFWS is the primary federal government agency dedicated to conservation, protection, and enhancement of fish, wildlife and plants and their habitats. The USFWS is the only federal agency whose primary responsibility is the conservation and management of these natural resources. The mission of the USFWS is "to work with others to conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people." The Wake Atoll National Wildlife Refuge is part of the National Wildlife Refuge System, which is a network of lands and waters managed by the USFWS. These lands and waters are managed for conservation and restoration of fish, wildlife, and their supporting habitats. The Wake Atoll National Wildlife Refuge includes 495,515 acres of submerged lands and waters surrounding the island out to 12 nautical miles from the mean low water line of the atoll. The refuge is also part of the PRIMNM that is cooperatively managed by the USFWS and NOAA.

1.7.4 Island Conservation

Island Conservation (IC) is a non-government organization with a mission to "prevent extinctions by removing invasive species from islands." IC began in 1994 and became an international non-profit organization in 1997. Since that time, IC has worked with local communities, government agencies, and conservation organizations to prevent the extinction of globally threatened species. IC is a global leader in the development of comprehensive and humane plans for removing invasive species, conducting research, and implementing removal of invasive species that provide conservation benefits to island ecosystems. The work to date by IC and its partners has resulted in the restoration of 64 islands worldwide benefitting 1,195 populations of 487 species and subspecies.

1.7.5 MOU between USDA-APHIS WS, USFWS and Island Conservation

The purpose of this 2016 MOU is to "further wildlife conservation and ecosystem management interests and responsibilities for the islands, atolls and reefs under the jurisdiction of the United States." This includes restoration and protection efforts where invasive species such as rodents and other introduced species have had impacts on island ecosystems (Appendix D).

Chapter 2 Alternatives

This chapter describes the preferred alternative and the no action alternative, or baseline conditions, on Wake Atoll against which the preferred alternative will be compared to assess impacts to the human environment. NEPA regulations (40 C.F.R. § 1508.25) require the scope of analysis to include a no action alternative in comparison to other reasonable courses of action. Reasonable alternatives refer to those actions that are technically and economically feasible, meet the purpose and need of the proposed action, and where applicable, meet the goals of the agency. This chapter also describes the alternatives that were considered but not analyzed in the environmental consequences section of the EA. The alternatives not analyzed are not technically or economically feasible or do not meet the management goal of eradication of the Pacific rat from Wake Atoll.

2.1 Summary of Rodent Eradication Efforts on Island Ecosystems

Invasive mammal eradication projects have been completed in both temperate and tropical island ecosystems. To date, there have been 1,233 completed mammalian eradication attempts on islands (classified as whole island events, where data quality is good or satisfactory, and excluding domestic populations and reinvasion events), with an 88% success rate across 806 islands. More than 60 countries and territories have attempted mammalian eradications (DIISE, 2018). Globally, there have been 138 completed Pacific rat eradication projects on island ecosystems that used rodenticides, with an approximate 80% success rate (DIISE, 2018). Howald (2020) reports that approximately 90% of the reported successful rodent eradications to date used second-generation anticoagulants (SGAR), with approximately 72% using baits containing either 20, 25, or 50 parts per million (ppm) brodifacoum.

Lessons learned from previous eradication efforts have been used to develop principles and best management practices to increase the likelihood of successful eradications for future eradication projects. While each eradication project provides a unique set of challenges, there are basic principles that can be applied to all of them. Parkes (1993) identified three principles to address island invasive species eradication efforts:

- Every individual targeted must be put at risk with the proposed removal technique(s).
- The technique(s) must remove individuals at a rate faster than they can replace themselves (i.e., breed).
- Immigration must be zero, or effectively be managed to zero (i.e., identify and respond effectively to eliminate any introduction).

Howald et al. (2007) further refined these principles specific to rat and mice island eradication projects:

- Deliver a highly palatable bait containing a toxic rodenticide into every potential rodent territory.
- Ensure bait is available for long enough that every rodent has access to a lethal dose.
- Time the baiting operation to when the rodent population is most likely to consume the bait.
- Minimize the short-term risks and impacts to nontarget wildlife, people, and the environment from disturbance and the rodenticide wherever possible (i.e., the benefits of the eradication must outweigh the costs).

- Biosecurity procedures must be able to sustain the eradication with effective prevention, detection, and response to any incursion.

Eradication project planning and implementation continue to improve as lessons are learned from previous eradication efforts. The Pacific Invasives Initiative (PII) provides a toolkit for project managers and eradication team members based on previous experience with mammal eradication projects on islands in the Pacific (PII, 2020). The toolkit provides a five-step process to follow to ensure the likelihood of a successful eradication: project selection, feasibility study, project design, operational planning, and implementation. Common to all five stages is stakeholder engagement, monitoring and evaluation, and biosecurity. Additionally, best management practices have been developed that will further increase the likelihood of successful eradication of invasive rodents from island ecosystems (Keitt et al., 2015; Broome et al., 2017).

2.2 Feasibility of a Second Rat Eradication Project on Wake Atoll

The 2012 rat eradication attempt on Wake Atoll successfully removed the Asian rat, but the Pacific rat was only eradicated on Peale Island, and not Wake and Wilkes Islands. Reasons for rodent eradication failures fall into three broad categories: Category 1: the baiting component of the operation was not completed (removal efforts were incomplete), and therefore, not all individuals were exposed to the eradication method; Category 2: the operation was completed but not all individuals were removed despite exposure to the eradication method; and Category 3: the operation was completed, all existing target animals were removed, but rapid recolonization occurred (Kappes et al., 2019). Recolonization was eliminated as a cause of the failed eradication of the Pacific rat in the 2012 Wake Atoll project based on genetic analysis conducted on the remaining rat population (Griffiths et al., 2014; Hanson et al., 2020).

Follow up eradication attempts can achieve successful eradication with appropriate planning and recognition of measures that may have resulted in the initial failure to remove rodents. Samaniego et al. (2020a) reported that rodent eradication was achieved in 86% of the cases where a second eradication effort was required on islands.

Data gaps and uncertainties identified in the post-eradication analysis for Wake Atoll were highlighted by Brown et al. (2013) and Samaniego et al. (2020a). Many potential factors behind the failure to eradicate Pacific rats were identified in these reviews, but, the failure of the first eradication attempt was likely one or a combination of the five factors leading to Category 1 and Category 2 failures.

1. A poor understanding of Pacific rat use of habitats such as *Pemphis* (*Pemphis acidula*), commonly referred to as pemphis and underground and abandoned structures likely caused bait gaps or localized shortages in bait availability (Category 1 failure).

2. Inadequately designed baiting methodology in commensal and intertidal environments, and overly complicated combinations (and integration) of various baiting methodologies likely caused bait gaps or localized shortages in bait availability (Category 1 failure).

3. Low overall bait application rates with insufficient coverage and some known application errors or difficulties caused bait gaps or localized shortages in bait availability (Category 1 failure).

4. Rats breeding during the operation may have caused temporal or spatial unavailability of bait to juveniles emerging from natal nests after applications (Category 1 failure).

5. Speculation that there was behavioral avoidance of bait by a small percentage of breeding females (Category 2 failure). Samaniego et al. (2020b) found that this was not the case for the Pacific rat as rat breeding did not impact bait consumption.

6. A poor understanding of interactions between Asian and Pacific rats that might have resulted in inadequate bait accessibility for the Pacific rats (Category 1 failure).

Brown et al. (2013) provided several recommendations for a second eradication attempt.

1. Existing eradication best practice documents have been developed that could be used as a basis to develop specific tropical island versions of eradication best practices. These documents need to be used in the development of future operational plans and baiting strategies, and any deviations from such best practice principles need to be justified within the documents.

2. A thorough and connected planning process needs to be followed with attention to ensuring that all aspects of each step are addressed adequately. Vital components of the planning process need to address all the key issues and need to be critically reviewed by independent eradication experts.

3. Compliance with regulations and island manager-imposed conditions is a necessity; however, the acceptance of such restrictions where they may cause deviation from eradication of best practice principles should be acknowledged by operational planners and stakeholder agencies as potentially compromising the prospects for a successful outcome. Wherever federal or site-specific requirements compromise efficacy, they need to be identified early so that a special exemption can be sought, or the risks openly acknowledged by all parties.

4. Agreements on paper need to match the practicality of successful implementation on the ground.

5. Focus needs to be given to island residents and how they can be incentivized to help maximize the potential for successful eradication.

6. Prior project data and reviews of project documents, and methodology must be considered in planning the eradication.

7. Contingency planning is needed to ensure only the most essential operations occur during the brief window of active bait distribution. Thus, overriding priorities such as airfield operations need to be addressed prior to eradication efforts to optimize success.

8. A single project manager should lead the eradication process and be involved in the project from start to finish. The project manager should have a high degree of rat eradication expertise and should be allowed to operate relatively freely with some flexibility within the bounds of an operational plan that has been approved by all key stakeholders.

9. Key staff on the eradication team should have considerable familiarity with Wake Atoll, its inhabitants, and off-island managers.

10. Flexibility is required in the determination of bait rates, either by more detailed bait uptake monitoring or incorporating an appropriate margin of error in the bait rates. Allowances need to be permitted for adaptive situations, such as extra baiting levels in special treatment areas or supplemental applications where baiting has been deemed insufficient.

11. Stakeholders should be prepared to postpone the project if predetermined conditions are not met at predetermined times.

12. The feasibility study for the eradication project needs to identify all issues of concern, and subsequent work should attempt to resolve the issues before the operational planning commences. The entire feasibility assessment and subsequent planning process needs to be revisited and the key issues addressed more fully prior to implementing a second attempt to eradicate Pacific rats on Wake Atoll.

13. Resources should be allocated for post-operational monitoring. Options such as post-operational use of rodent detecting dogs to locate surviving rats should be evaluated. Any detection made could be followed up by pre-determined rapid response measures.

14. Bait palatability needs further research, especially where abundant alternative food resources occur, and during rat breeding. The possible effect of ant activity on bait palatability to rodents also warrants investigation. Preference trials could be conducted between ant-tainted and fresh-bait palatability to rats.

15. More data should be collected on rat population and breeding indices, in conjunction with plant phenology (especially known rat food sources) and year-to-year climate cycles and variation, to further refine the optimum times to undertake eradication on Wake Atoll and other tropical islands.

16. Immediate pre-drop monitoring should be completed on rat and crab densities to ensure to the extent possible that populations (or crab activity) are comparable to earlier data. Any increases in numbers should warrant re-evaluation of intended bait rates.

17. Staff scheduling should ensure all legal and critical staffing requirements (i.e., presence of authorized pesticide handlers and GIS personnel) are covered at all stages of the project. Potential replacements also need to be identified and on-call if required so not to compromise the project due to the loss of a key person.

In 2014, USAF began working with USDA-APHIS to address uncertainties and data gaps identified in the post-eradication reviews for Wake Atoll. This work along with additional efforts between USDA-APHIS, USAF, and IC have been used to determine the feasibility of a second eradication attempt (Table 5). A narrative version of this summary is available including tabulation of remedial efforts by eradication failure risk factor (Kappes et al., 2020b).

Table 5. Studies evaluating components of feasibility for a second rat eradication attempt on Wake Atoll.

Study	Objectives and Results	Documentation
Wake Island: Efficacy of rodenticide baits for control of Pacific rats (*Rattus exulans*), and Pacific seabird and shorebird surveys	Three-day, no-choice bait trials with Brodifacoum-25W Conservation (B-25W) and Diphacinone-50 Conservation (D-50) demonstrated both baits were highly palatable and efficacious (100% mortality). Rats generally preferred bait to locally harvested alternative foods in a three-day two-choice test, though no rats died from bait consumption because studies were terminated prior to observing mortality. The intent of the study was to determine if rats preferred bait over alternative food sources.	Shiels et al., 2015
Wake Atoll pemphis habitat rodenticide application strategy	Intertidal pemphis habitat was not adequately treated during the initial eradication due to concerns for rodenticide entering the marine environment. This study established that rats do regularly forage in this habitat and developed two strategies for treating the area while minimizing marine contamination.	Siers et al., 2017; Siers et al., 2018
Placebo bait uptake trial to test feasibility of Pacific rat eradication on Wake Atoll	This placebo trial evaluated uptake of nontoxic B-25W pellets applied at the label's standard broadcast application rates of 18 kilograms/hectare (kg/ha) for the first application followed by a second application of 9 kg/ha in mixed shrub/grassland, closed-canopy forest, and Solid Waste Accumulation Area (SWAA). Bait persistence was adequate at mixed and forest plots, but bait disappeared too rapidly at SWAA.	Niebuhr et al., 2020
Review of the 2013 Wake Atoll Post-Eradication Evaluation and Data Gap Analysis	This review followed Brown et al. (2013) to identify any data gaps remaining and to make recommendations for a second eradication attempt for Pacific rats.	Hanson et al., 2020
Relative acceptance of brodifacoum pellets and soft bait sachets by Pacific rats using commensal, solid waste aggregation, and natural areas on Wake Atoll	The two-choice bait trials evaluated whether Pacific rats captured from commensal areas on Wake Atoll were conditioned to softer food items, making hard pellets less palatable. Results from this study demonstrated that rats from commensal areas did not prefer the soft bait sachets compared to B-25W pellet bait. In addition, acceptance, and efficacy of the soft bait sachets in a subsequent no-choice bait trial was low.	Kappes et al., 2020a
Subterranean baiting strategies for eradication of Pacific rats from Wake Atoll	This study assessed strategies for deploying and rebaiting bait stations in commensal areas and subterranean rat habitats. Data from this study updated the existing GIS database for structures and subterranean habitats on Wake Atoll.	In prep
Wake Atoll SWAA supplemental biomarker trial for Pacific rat eradication	This study evaluated broadcast application rate(s) with non-toxic B-25W to ensure bait persistence in the SWAA.	In prep
Lessons learned from failed island rodent eradications redone successfully: Implications for the second rat eradication attempt on Wake Atoll	This review looked at past failed island rodent eradication projects where subsequent eradication attempts succeeded, and synthesized key factors for remediating causes of the initial failures. The lessons learned were then applied to the initial eradication failure on Wake Atoll to inform planning for a second eradication attempt for Pacific rats.	Samaniego et al., 2020a
Revised operational plan for eradication of Pacific rats from Wake Atoll	USDA-APHIS and IC incorporated the new knowledge and recommendations for a second eradication attempt for Pacific rats in the revised operational plan for Wake Atoll.	Appendix D
Eradication mobilization/demobilization cost analysis	USDA-APHIS WS NWRC prepared initial cost estimates for the second eradication effort on Wake Atoll.	In prep

Since the 2012 rat eradication project on Wake Atoll, additional recommendations or best management practices have been proposed to increase the likelihood of a successful rodent eradication (Keitt et al., 2015; Broome et al., 2017). Keitt et al. (2015) made the following recommendation for rat eradication efforts on tropical islands:

- Subsequent broadcast applications should be the same application rate as the first application.
- Bait broadcast application rates should target a minimum of 4 consecutive nights of bait availability (per application) across all habitats on the island.
- Increasing the time between the two bait applications
- Bait broadcast applications should use a 50% swath overlap to minimize risk of bait gaps.

Reviews of the initial rat eradication effort on Wake Atoll, and information gathered from studies conducted by USDA-APHIS WS NWRC and IC, were used to inform the preferred alternative for the proposed Pacific rat eradication attempt on Wake Atoll. Subject matter experts from USDA-APHIS WS, USDA-APHIS WS NWRC, IC, and USFWS formed a technical working group that developed the preferred alternative for the proposed eradication of the Pacific rat on Wake Atoll.

2.3 Preferred Alternative

The preferred alternative is the use of aerial and ground-based rodenticide applications on Wake Atoll, including Wake Island, Wilkes Island and Peale Island. Peale Island is considered rat-free however potential incursions to the island since the last survey require treatment to ensure rat eradication from all three islands. Wake Atoll has a variety of natural environments and man-made structures that require a variety of application methods. The method of application will depend on site-specific factors such as:

- Site type (enclosed/indoor or open/outdoors),
- Habitat or terrain type,
- Site use (e.g., food preparation, living quarters, and industrial areas),
- Site accessibility,
- Worker safety, and
- Proximity to environmentally sensitive areas.

Brodifacoum will be the primary toxicant used for the eradication; however, alternative rodenticides and mechanical control measures will be employed where appropriate. The eradication program at Wake Atoll will consist of a primary eradication effort followed by post-eradication activities that will increase the likelihood of eradication of the Pacific rat. In summary, the preferred alternative will include:

- Primary eradication effort:
    - Two aerial applications, supplemented with ground applications as needed, of Brodiacoum-25W Conservation (B-25W) pellets across the entire land area of Wake Atoll at up to 45 pounds per acre or 50 kg/ha per application, with an interval of approximately 21 days in between applications, and a possible third supplemental “middle” aerial broadcast up to 50 kg/ha in areas with high bait disappearance rates observed following the first application,

    - Trapping and hand baiting applications of B-25W pellets or brodifacoum all-weather blocks using some combination of the following, bait bolas/sachets, floating or elevated bait stations, bait trays, bait stations, burrow baiting, and/or canopy baiting, and
    - Implementation of mitigation measures to protect human health and environmentally sensitive areas.
- Post-eradication effort:
    - Hand baiting or ground broadcast applications of B-25W pellets up to 50 kg/ha in areas with continuing evidence of rat activity for a period of up to eight months,
    - Hand baiting applications of B-25W pellets or brodifacoum all-weather blocks using either bait bolas/sachets, floating or elevated bait stations, bait trays, bait stations, burrow baiting, or canopy baiting,
    - Trapping and alternative rodenticide product use in localized areas with continued rat activity and other high-risk areas in post-eradication treatments, and
    - Ensure continued implementation of the WIA biosecurity plan to ensure rodents are not reintroduced to Wake Atoll in the future (Appendix E).

A Commensal Manager will be stationed on Wake Atoll for a period of 13 months. The Commensal Manager will work with USAF personnel and civilian contractors strengthening engagement and supporting project objectives, ultimately increasing the potential for project success. This will include activities such as outreach to Wake Atoll residents to eliminate human based alternative food sources for the Pacific rat. The Commensal Manager will also assist with pre-eradication bait station deployment, pre-baiting, and conduct post-eradication activities in areas where rats may not have been fully removed in the initial B-25W application.

2.3.1 Bait Selection

The preferred toxicant formulation for the Wake Atoll eradication is B-25W, the same formulation that was used in the 2012 eradication operation. B-25W is formulated into a ½" pellet that contains 0.0025% w/w (weight per weight or weight concentration of a solution) brodifacoum as the active ingredient (ai). Brodifacoum was chosen as the primary active ingredient for the Wake Atoll rat eradication project due to its successful use in previous eradication efforts. Approximately 90% of the reported successful global rodent island eradications to date have used second-generation anticoagulants (SGAR), with approximately 72% using baits containing either 20, 25, or 50 ppm brodifacoum Howald (2020). Brodifacoum is also the preferred rodenticide used in U.S. island rodent eradication programs (Witmer et al., 2011). Brodifacoum is the preferred rodenticide for island eradications due to its high toxicity to rodents typically after just one feeding (Howald, 2020). The high efficacy and toxicity of brodifacoum to rodents also results in toxicity concerns for nontarget organisms. Mitigation measures have been developed to reduce and minimize the risk of brodifacoum to nontarget organisms while still resulting in successful rodent island eradications (Howald, 2020).

The pellet contains a blue dye intended to reduce nontarget bird exposure. Blue and green dyes added to pellets have been shown to deter or reduce bird consumption reducing the risk of rodenticide exposure (Hartley et al., 1999; Marples et al., 1998; Hartley et al., 2000; Weser and Ross, 2013).

USDA-APHIS currently maintains pesticide registrations with the U.S. Environmental Protection Agency (USEPA) for two brodifacoum products labelled for island conservation use:

- Brodifacoum-25W Conservation (EPA Reg. No. 56228-36) (Appendix F)
- Brodifacoum-25D Conservation (B-25D) (EPA Reg. No. 56228-37)

The B-25W formulation is designed for use in wet, tropical environments and the B-25D formulation is designed for use in dry environments. Both products are restricted use pesticides (RUP) due to the potential hazards to nontarget species and must be applied by certified pesticide applicators or persons under their direct supervision.

USDA-APHIS also currently maintains the registration of a supplemental label for B-25D (Accepted July 10, 2019) for a future house mouse eradication project on Midway Atoll National Wildlife Refuge's Sand Island.

USDA-APHIS has previously registered supplemental labels for previously completed rodent eradication projects on Palmyra Atoll (B-25W), Wake Atoll (B-25W), and Desecheo Island (B-25D). USDA-APHIS also currently maintains the registration of a supplemental label for B-25D (Accepted July 10, 2019) for a future house mouse (*Mus musculus*) eradication project on Midway Atoll National Wildlife Refuge's Sand Island.

USDA-APHIS will submit a supplemental label application to USEPA in early 2021 for the proposed use of B-25W on Wake Atoll. The maximum broadcast application rates proposed on the B-25W supplemental label for Wake Atoll is up to 45 pounds per acre or 50 kg/ha per application which are lower than the maximum broadcast application rates approved by USEPA in 2019 for both the Midway Atoll and the Palmyra Atoll supplemental labels.

USDA-APHIS is also working with another registrant, Bell Laboratories, Inc., to submit a supplemental label application to USEPA for a brodifacoum block product (FORMUS® All-Weather Blox™; EPA Reg. No. 12455-108) for hand baiting applications on Wake Atoll (Appendix F). The product is a reddish-brown, weather-resistant block that contains 0.0025% w/w brodifacoum.

2.3.2 Aerial Broadcast Applications

Aerial broadcast applications of B-25W will be made using either a helicopter or an Unmanned Aerial Vehicle (UAV). The use of either a helicopter or UAV carrying a bait hopper to distribute bait over the targeted area will depend on site-specific conditions on Wake Atoll at the time of application including weather conditions, habitat type, and helicopter pilot safety. The operation of the helicopter or UAV will be approved by USAF and USDA-APHIS WS and accomplished under professional guidance and coordination with the onsite safety manager. USDA-APHIS will follow all applicable agency guidelines regarding the safe use of helicopters and will comply with USAF, including AFMAN 32-1053, and applicable Federal Aviation Administration (FAA) requirements during aerial bait applications (USAF, 2019).

Aerial bait applications require adequate bait coverage at a pre-determined rate to ensure success. To ensure that the aerial bait applications are carried out successfully, the following measures will be implemented:

- Pilots will fly a predetermined application path. The application path will be monitored onboard the helicopter (or remotely when using a UAV) using a Differential Geographic Positioning System

(DGPS). The DGPS will provided the guidance needed to ensure bait application gap and overlap avoidance.

- The application rate will be calculated using the quantity of bait broadcast and area covered, with overlaps in the bait swaths recorded by the DGPS tracking system.
- Adjustments in bait flow rates, helicopter/UAV speeds, and flight lines will be made as necessary to meet intended application rates and ensure maximum application rates are not exceeded.

To make bait available to all possible rat home ranges on the island, bait will be applied across the entire land area of Wake Atoll with every reasonable effort made to prevent bait spread into the marine environment. The baiting regime will follow the common practice of flying parallel, overlapping swaths across the island. On the coastal perimeter, a deflector attached to the hopper will be used to prevent bait spread into the marine environment. An additional full swath coastal buffer will be flown at a 40-m distance from the coastline to fill any potential gaps at the end of the interior parallel flight lines.

Helicopter flight width swaths are the uniform distance of bait broadcast from the hopper, ranging from 164 to 246 ft (50 to 75 m) in length. Flight swaths will be flown in a parallel pattern, with subsequent flight swaths overlapping the previous swath by approximately 50 percent (all parallel flight lines will have 50% overlap to achieve a consistent bait rate) to ensure no gaps in bait coverage. Narrow swath or trickle baiting may also be used adjacent to sensitive habitats. Trickle baiting uses a 1-2 m swath width allowing for more precise application of bait pellets to the target site

The typical swath width for UAV bait applications is 131 to 197 ft (40 to 60 m) but will vary depending on bait size and width. Deflectors for directional swath applications on either side of the UAV can be used for coastal perimeters and around sensitive habitats. Narrow swath baiting can also be used around sensitive habitats or narrow application sites.

Any gaps in treatment coverage that are identified during aerial applications using helicopter or UAV are typically treated on the same day to ensure bait availability for a minimum of four consecutive nights. Gap treatments would typically be done at the end of the day or immediately the next day depending on weather conditions.

2.3.2.1 Helicopter

Helicopter models considered for the aerial broadcast operations will include the Bell 206B Jet Ranger, Bell 206L4 Long Ranger, or other small- to medium-sized aircraft, guided by onboard DGPS and computer. The bait will be applied from a specialized bait hopper slung approximately 19.7 to 29.5 feet (ft) or 6 to 9 meters (m) below the helicopter (Figure 3). These hoppers are composed of a bait storage compartment, a remotely triggered, adjustable outflow gate to regulate bait flow out of the storage compartment, and a motor-driven broadcast device that can be turned on and off remotely and independently of the outflow gate. Helicopter operations for the bait application require low altitude overflights covering the entire land area of Wake Atoll. The helicopter will fly at a speed ranging from 25 to 50 nautical miles per hour (knots) (46 to 93 km per hour or 29 to 58 miles per hour) at an average altitude of approximately 164 ft (50 m) above ground level (USAF, 2009).

Figure 3. Helicopter rodenticide application using a bait hopper.

The aerial baiting helicopter will have a differential Tracmap GPS unit installed that is designed for agricultural use. The software on the GPS will load the island map and create flight lines for treatment at the 50% overlap and track coverage for the full swath, narrow swath, and directional half-swath applications. The GPS unit will map the flight path with buffers but does not calculate bait density from overlap. The track map data is downloaded onto a USB thumb drive and collected by the project aerial GIS person each time the helicopter sets down to re-fuel. Ground personnel will create bait coverage and bait density maps and can determine where gaps in coverage exist. Flight line data is downloaded from the aircraft throughout the day during re-fueling or battery swaps and is analyzed in real time to adjust the application rate and identify gaps in coverage. The pilot can track coverage in real time and retreat large gaps. However, a fine scale analysis is still required to identify smaller gaps and areas with low bait density.

2.3.2.2 UAV

A UAV (Unmanned Aerial Vehicle) is an aircraft that can fly a pre-set course with the help of an autopilot and Geographic Positioning System (GPS) coordinates. UAV use in agriculture, including pesticide applications, has become more common and expanded as the technology has progressed. UAVs offer several advantages compared to conventional aerial pesticide applications using planes and helicopters. UAVs are easier and more cost-effective to deploy and operate, reduce operator exposure to pesticides, eliminate pilot hazards, and allow for more precise pesticide applications. Typically, UAVs are accurate to within 1-m of a GPS coordinate and the dispersal system is automated reducing the risk from either over-bating of baiting gaps. In the case of applications for island rodent eradication, UAVs may be less disturbing to birds, have a lower risk of bird air strikes due to their size, and have no helicopter pilot risk. Two gasoline multi-copter vertical take-off and landing UAVs capable of 50 kg payload each could be used for the Wake Atoll rat eradication (Figure 4).

Figure 4. UAV proposed for aerial application use on Wake Atoll.

Staging areas for UAV use will be near the baiting area, where practical. During application the UAV pilot will use two data feeds from the UAV in real-time. One is a live video which provides quality control for the bait spreader to ensure no bridging or malfunctions, as well as reviewing the UAV flight path. Bridging occurs when the bait pellets inside the hopper form a "bridge" preventing the bait from exiting the hopper. This can occur with UAV or helicopter applications. The second is a flight log and telemetry data that can be used to review the GPS location of the UAV from the ground control station to confirm that it stays on its pre-programmed flight path. After the flight mission, the flight log will be downloaded and reviewed to ensure all treatment areas are baited appropriately without gaps.

2.3.3 Ground Applications

Ground-based brodifacoum applications (pellet and block products), as well as some alternative rodenticides, will be made using various methods (Table 6). A variety of ground application methods is required due to the varied habitats and man-made structures present on Wake Atoll.

Table 6. Ground application methods for rodenticide bait products on Wake Atoll.

Ground application Method	Description
Hand broadcast	Rodenticide is broadcast or scattered across the application area by hand or ground-based application equipment. Hand broadcast will be used for areas that will not be treated using aerial broadcast, were missed during an aerial broadcast application, or for post-eradication applications in areas with continued rat activity.
Bait sachets/blocks	Bait sachets are small bags of pellets made with rodent accessible materials. Bait sachets/blocks will be thrown into areas that are inaccessible or unsafe for applicators to enter. Devices, such as slingshots, t-shirt cannons, or UAVs, may be used to apply baits in these areas.
Bait stations and bait trays	Bait stations can be any type of tube or bait box with a lid. Bait trays have an open top but must keep the bait off the ground. Bait trays are particularly useful for rats that will not enter enclosed bait stations.
Floating bait stations	Bait stations are typically T-shaped (inverted) plastic bait stations attached on top of a piece of foam and tethered to a stationary object in a way that allows them to rise vertically. Floating bait stations are spaced on a grid within intertidal areas that are periodically inundated with water. Elevated bait stations and canopy baiting will be used for ocean-facing shores because floating bait stations would be overly vulnerable to being compromised by wind and waves.
Canopy baiting	Enclosed bait stations, sachets, or blocks are attached to the branches or trunks of trees or shrubs. Sachets or blocks can also be tied at intervals along a continuous line or string (e.g., daisy chain) that extends through the canopy or shrubs. Canopy baiting is useful for exposing rats that can climb vegetation such as the Pacific rat.
Burrow baiting	This type of ground application involves placing bait within the entrance of an active rat burrow. Burrows are flagged, monitored for activity, and bait reapplied if the bait is removed.

2.3.4 Alternative Rodenticide Use for Post-Eradication Activities

Brodifacoum (pellet or block products) will be the primary rodenticide active ingredient used during the eradication on Wake Atoll and will continue to be used during post-eradication activities to remove any surviving rats. However, alternative rodenticides targeting localized sites such as commensal areas, the SWAA and other areas may be needed to ensure the removal of any rats that may not be susceptible to the brodifacoum baits. These alternative products could be used, in addition to or instead of the aforementioned brodifacoum products, by trained project staff to remove remaining Pacific rats (if any) for up to eight months post the primary broadcast applications referred to hereafter as post-eradication. These products are meant to provide the project staff the greatest flexibility to address Pacific rats that may not have received a lethal dose during applications of B-25W or brodifacoum blocks. Pacific rats may not receive a lethal dose of brodifacoum due to neophobia, unlearned food avoidance and learned food aversions (O'Connor and Eason, 2000).

Table 7. Alternative rodenticide products proposed for use on Wake Atoll.

Product Name	Active Ingredient (% w/w)
DITRAC® D-50 Pellets (EPA Reg. No. 12455-147)	Diphacinone (0.005)
ZP® Tracking Powder (EPA Reg. No. 12455-16)[1]	Zinc phosphide (10)
Bromethalin-100 Conservation Place Packs and Bromethalin-100 Conservation Blocks (registration applications in review)	Bromethalin (0.01)

[1] ZP Tracking Powder can be used during the primary eradication and post-eradication effort.

DITRAC D-50 Pellets is currently registered by Bell Laboratories for island conservation use and will not require a supplemental label for the proposed use (Appendix G). DITRAC D-50 Pellets could be locally applied by hand as allowed on the label including hand broadcast, as well as use in bait stations, burrow baiting, and canopy baiting. DITRAC D-50 Pellets would be used for Pacific rats that survive the primary bait application and appear to be avoiding the brodifacoum pellets and blocks (Siers et al., 2017).

USDA-APHIS is working with Bell Laboratories to submit a supplemental label application for ZP® Tracking Powder (EPA Reg. No. 12455-16; 10% w/w zinc phosphide; Appendix G). ZP Tracking Powder could be used in cases where rats will not consume baits and would be hand applied outside of man-made structures or into structural voids. It may be sprinkled onto areas of dry ground or on open trays placed within constricted areas where rat trails are present, forcing them to traverse through the product. ZP Tracking Powder exposure occurs when the rats walk through the powder and then lick the product off their fur and skin.

USDA-APHIS has two new island conservation registration applications, Bromethalin-100 Conservation Place Packs and Bromethalin-100 Conservation Blocks, in review with USEPA. These submissions are a repackaging of two F-Trac® bait products commercially available from Bell Laboratories. Bromethalin baits have successfully been used for island eradication projects in the past to target rodents that survived or were not susceptible to the primary bait applications. Bromethalin baits have been used in rodent eradication and control efforts on Rose Atoll, Palmyra Atoll, Kure Atoll, Maritime National Wildlife Refuge, Midway Atoll Spit and Eastern Islands, HI (USDA, 1993; USEPA, 2004; USEPA, 1995; Witmer et al., 2011).

If registered and needed on Wake Atoll, the bromethalin baits could be used in bait stations, burrow, or subterranean baiting, or used in canopy baiting or floating bait station applications.

No alternative rodenticides will be used on Wake Atoll without a USEPA-approved label for the intended uses.

2.3.5 Mechanical Trapping

In any areas where baiting or tracking powder is not allowed or to supplement rodenticide applications, a combination of live traps, snap or other body gripping traps, glue traps, or Goodnature A24 traps will be used. Traps may also be used throughout the project site to monitor rat captures so as to better inform further trapping and baiting efforts.

2.3.6 Use Sites and Application Methods for Brodifacoum 25-W

Wake Atoll has a variety of man-made and natural features that warrant a variety of application methods. These methods will increase the likelihood that all Pacific rats are exposed to a lethal dose of rodenticide. Table 8 provides a summary of the use sites and brodifacoum application methods that are proposed for the Pacific rat eradication project on Wake Atoll.

Table 8. Site specific factors and proposed application methods for the primary brodifacoum bait application on Wake Atoll.

Use Site	Proposed Application Methods[1]
Outdoor, terrestrial areas	Aerial or hand broadcast, bait sachets or blocks, canopy baiting, bait stations and bait trays, and burrow baiting may be used in all outdoor, terrestrial areas.
Freshwater wells and water tanks	Aerial or hand broadcast may be used over freshwater wells and tanks if they are covered or drained. Hand broadcast, bait stations, and bait trays may be used around uncovered, freshwater wells and tanks.
Inland bodies of water	Aerial or hand broadcast may be used over covered, inland water bodies. Aerial or hand broadcast may be used around uncovered, inland saltwater or brackish waterbodies or wetlands, but must be made above the mean high tide line using a bait hopper or bucket equipped with a deflector (helicopter) or directional spreader (UAV) that directs bait away from the water, or a narrow swath bucket (helicopter or UAV). Aerial or hand broadcast may be used around uncovered, inland, freshwater pools and ponds, but not within 3.3 ft (1 m) of the water's edge.
Coastal shoreline	Coastal shoreline areas may be treated above the mean high tide line using a bait hopper or bucket equipped with a deflector (helicopter) or directional spreader (UAV) that directs bait away from the water, or a narrow swath bucket (helicopter or UAV). Complex rocky outcroppings with periodically inundated tidal sloughs may be hand broadcast or aerially baited using a trickle bucket (UAV). Dropping bait into the water will be avoided. Canopies of coconut trees (*Cocos nucifera*) growing out over open water or wetlands may be canopy baited. Most of the coastal intertidal mosaic of emergent land and tidal sloughs with impenetrable stands of pemphis vegetation is found in the southeast lagoon-side of Wake Island. These areas cannot be aerially baited without dropping substantial amounts of bait into the marine environment. Therefore, floating bait stations, elevated bait stations, and canopy baiting will be used in combination for the lagoon of Wake Island. To avoid having bait accidently enter the water, this area will be baited with a combination of floating and elevated stations as well as where practical with canopy baiting

[1] All rodenticide application methods and use sites will be limited to what is allowed by USEPA on the pesticide label(s) and by USAF.

Use Site	Proposed Application Methods[1]
Inside and around the outside of non-residential and non-food use, inhabited, man-made structures	Aerial or hand broadcast may be used around and over the exteriors of non-residential and non-food use, inhabited, man-made structures. Bait stations, bait trays, and bait sachets may be used inside and around non-residential and non-food use, inhabited buildings and other man-made structures. Bait stations and bait trays that are outdoors may be elevated to prevent nontarget species access, as appropriate.
Inside and around the outside of uninhabited or abandoned, man-made structures	Aerial or hand broadcast may be used around and over the exteriors of uninhabited or abandoned, man-made structures. Hand broadcast, bait stations, bait trays, and bait sachets and blocks may be used in uninhabited or abandoned, man-made structures.
Around the outside and on top of residential structures and food use areas	Aerial or hand broadcast may be used over and around the exteriors of residential structures, food use structures, covered food-producing trees, and covered garden plots and pots. Hand broadcast may be used around uncovered, food-producing trees outside of the drip line, and around uncovered garden plots and pots. Bait stations and bait trays may be used inside the drip line of food-producing trees.
Inside residential and food use structures	Bait stations may be used inside residential and food use structures.
Subterranean structures and spaces	Aerial or hand broadcast may be used over the exterior of subterranean structures and spaces. Hand broadcast, bait stations, bait trays, and bait sachets and blocks may be used inside subterranean structures and spaces. Elevated or floating bait stations should be used where subterranean spaces may be periodically inundated by water during the baiting period.
Airfield	Aerial or hand broadcast may be used around and over the airfield and associated paved areas. Sweepers or blowers may be used to remove or sweep bait to the sides of all runway, taxiway, ramps, and parking areas following broadcast applications.

[1] All rodenticide application methods and use sites will be limited to what is allowed by USEPA on the pesticide label(s) and by USAF.

2.3.7 Protection Measures for Human Health and the Environment

2.3.7.1 Human Health Protection Measures

Rodenticide applications will adhere to label requirements including the use of personal protective equipment (PPE) to protect applicators and other personnel during treatment. Pesticide use, disposal, storage, and recordkeeping will also follow the USDA-APHIS WS Directive 2.401. Pesticide Use. Any inadvertent spills or accidental discharge of pesticides will be managed under the Wake Atoll Spill Prevention Control and Countermeasure Plan (SPCC) (USAF, 2017). The SPCC is designed to protect human health and the environment in the event of an inadvertent release of hazardous materials.

Measures to protect military staff and contractors who reside on Wake Atoll and are not part of the eradication effort are similar to those described for the 2012 eradication and summarized below (USAF, 2009). The operation of the helicopter and use of a bait hopper would be accomplished under the supervision of trained and certified pilots and would be coordinated with the onsite safety officer. The safe application of brodifacoum and any of the alternative rodenticides, which may be utilized for this project are regulated by USEPA. All personnel on Wake Atoll will be informed regarding the use of these pesticides and any potential risk associated with their use. The following actions will be taken during the project to assist with ensuring safe and effective implementation of project activities:

- WIA personnel will be informed of the project activities including rodenticide use and risks, the planned application methods, potential pathways of the toxins, and requirements for reporting incidents during and after the application process that might have deviated from the application plan (e.g., bait spillage),
- Pre- and post-testing of water sources and marine food sources to determine any risks to staff,
- Posting of warning signs before, during, and after bait application,
- WIA medical staff will be equipped and trained (as needed) to assess prothrombin and other potential indices of anticoagulant poisoning,
- Recommend three-month consumption prohibition for fish caught in the lagoon, and
- Incineration of recovered rat carcasses, where feasible.

The Wake Island Airfield (WIA) is a Foreign Object Debris (FOD) free zone. Bait pellets dropped on the runway, taxiway, ramps, and parking areas qualify as FOD. Any pellets found on the taxiway, ramp, and parking areas directly following an aerial or hand application will be removed immediately.

2.3.7.2 Aquatic

All rodenticide applications will be made in a manner that will reduce the likelihood of pesticide deposition into aquatic areas such as isolated waterbodies, the lagoon, and the outer coastline at Wake Atoll. The following measures will be implemented during the proposed eradication effort to reduce the potential for brodifacoum deposition in aquatic systems:

- No broadcast bait applications over uncovered, inland waterbodies or over the lagoon,
- No rodenticide applications below the mean high tide water line except for floating and elevated bait stations, which can be placed between the mean low tide and mean high tide water lines in areas with no predictable wave action,

- No broadcast applications within 3.3 ft (1 m) of the water's edge for uncovered, inland, freshwater bodies,
- Use of a deflector shield (helicopter), directional spreader (UAV), or narrow swath bucket (helicopter or UAV) for aerial broadcast applications adjacent to waterbodies or along the coastal shoreline,
- Use of hand broadcast or narrow baiting by helicopter or UAVs for aerial broadcast for applications adjacent to waterbodies, where feasible,
- Limit aerial and most ground broadcast applications to the dry season, reducing offsite runoff to waterbodies,
- Restrict aerial broadcast applications to when wind speeds are below 35 mph, reducing the likelihood of off-site deposition of pellets, and
- Cover wells and water tanks during aerial broadcast applications. Alternately, hand broadcast applications, bait stations, bait trays, and bait sachets can be used around wells and water tanks.

2.3.7.3 Birds

Birds are the primary ecological resource most at risk on Wake Atoll from the proposed aerial and ground broadcast applications of B-25W. To minimize disturbance and the potential impacts from the use of B-25W, the following measures will be implemented, where feasible.

- Color and size of the rodenticide baits were selected to minimize attractiveness of the bait to birds,
- Use of UAVs in areas of high bird activity may be used to reduce disturbance and the probability of bird strikes,
- Animal carcasses that could potentially be a source of secondary poisoning will be removed for analysis or incineration,
- Special measures to prevent bait from entering the water and contaminating food sources resulting in bioaccumulation in bird prey items include hand broadcast applications or the use of deflector shield, directional spreader, or trickle bucket for aerial applications,
- Broadcast applications will be conducted when seasonal bird activities, including nesting, are minimal, and
- Minimize ground disturbance of birds, nests, and chicks during field operations.

The proposed start of aerial and ground broadcast rodenticide applications on Wake Atoll is planned for late May or early June during the dry season (Table 9) (USAF, 2009). Aerial applications will occur over an approximate three to four-week period dependent on weather conditions. Applications are proposed during the dry season toreduce the risk of brodifacoum pellet degradation, potentially reducing efficacy, and increasing runoff into aquatic habitats after rain events. This time period also reduces the risk of brodifacoum exposure to shorebirds that are typically present in lower numbers during the spring and summer. Shorebirds are especially at risk to brodifacoum exposure from the consumption of prey items that may contain brodifacoum residues and from ingestion of bait pellets. Seabirds are at less risk from these types of exposures since their diet consists primarily of prey items from the ocean that would not contain significant residues of brodifacoum.

Table 9. Calendar of approximate operational constraints.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Shorebirds present in greater numbers (approximately)	X	X	X							X	X	X
Sooty tern breeding (approximately)	X	X				X	X	X	X		X	X
Wet Season							X	X	X	X	X	X

Modified from USAF, 2009.

2.3.8 Efficacy and Environmental Monitoring

USDA-APHIS will implement a monitoring program that will evaluate the efficacy of the proposed eradication as well as monitor for potential nontarget species impacts. Monitoring protocols will follow those used in the 2012 Wake Atoll eradication project and are summarized in appendix G. In summary, USDA-APHIS will monitor bait availability, bait degradation, and target species mortality to evaluate the effectiveness of the proposed Pacific rat eradication on Wake Atoll. In addition, USDA-APHIS will have a Commensal Manager on site for eight months following the main baiting efforts, who will monitor for rats and make efforts to remove any rats that may be detected.

USDA-APHIS will also collect nontarget species carcasses that are observed during and after the eradication program, where feasible. Depending on the age and condition of the carcasses, they may be necropsied to determine cause of death and submitted for analysis to determine brodifacoum residue levels. Environmental samples including soil, water, and biological samples of relevant ecological compartments will also be collected to determine potential brodifacoum residues after application. All environmental samples will be collected under a research and monitoring special use permit issued by the USFWS.

2.4 No Action

The no action alternative would include continuation of current on-going rodent management efforts, which consist of localized rodenticide treatments to suppress rodent populations using bait stations in populated areas and in and around the SWAA. These rodenticide treatments are primarily focused on commensal areas and the marina, with no treatments in natural areas or other developed parts of the island. Currently registered rodenticides that are used in bait stations on the atoll include bromadiolone baits. Additionally, a biosecurity plan is in place for Wake Atoll that provides operational measures to support prevention, detection, and respond to pest incursions (Appendix E). The 2015 Wake Island biosecurity management plan is currently being reviewed and an updated plan is anticipated.

2.5 Alternatives Considered but not Analyzed in the EA

2.5.1 Genetic Biocontrol Technology

Genetically engineered (GE) organisms for use in biocontrol are a developing technology that includes the use of gene drives. Research has occurred with gene drives, a natural phenomenon whereby the inheritance of a particular gene or set of genes is favorably biased so that offspring inherit the gene at rates

higher than 50% until all members of a population possess the gene (Lyttle, 1991). GE technology allows certain genes to be selected and rapidly propagated in a population and can be used to spread genes that can have negative impacts to the target population. GE technology has the potential for use in controlling invasive species, including invasive rodents on islands (Campbell et al., 2015). USDA-APHIS in partnership with IC, Commonwealth Scientific and Industrial Research Organizations (CSIRO), Texas A&M University, North Carolina State University, Adelaide University and Landscape Research have formed a partnership to determine the feasibility of using GE modified rodents and other organisms for eradication of invasive rodent species on islands (GBIRd - Genetic Biocontrol of Invasive Rodents). The goal of the GBIRd is to evaluate the scientific, ecological, social, and ethical considerations, and to assess the risks of using GE modified organisms in conservation programs on islands (Campbell et al., 2019). The application of GE modified rodents in conservation biology holds promise; however, the technology is not yet developed, and research is needed to determine its effectiveness in rodent island eradication projects. Currently, genetic biocontrol technology is not a technically feasible alternative for the proposed eradication on Wake Atoll and will not be considered further in this analysis.

2.5.2 Fertility Control

Fertility control includes the use of chemical or botanical sterilants, immunocontraceptives, or other type of contraceptive chemical that renders one or both sexes of the target organism temporarily or permanently infertile. USDA-APHIS holds USEPA pesticide registrations for the immunocontraceptive chemical GonaCon that are used for controlling reproduction in large mammals including white-tailed deer (*Odocoileus virginianus*) (EPA Reg. No 56228-40) and wild and feral horses (*Equus ferus*) and burros (*E. asinus*) (EPA Reg. No. 56228-41). These chemicals are delivered through darting or hand injection of individual animals. USDA-APHIS WS NWRC is also evaluating the use of alternative contraceptive chemicals, such as Contrapest®, for use in rodent control (Witmer et al., 2017; Siers et al., 2020b). These products may have use in future island eradication projects as a component of an eradication program in conjunction with rodenticide use. However, currently there is not a formulation available that could be used effectively for eradication purposes. Fertility control chemicals are a component of an integrated pest management (IPM) approach to control populations of mammals, including rodents, but are not considered an eradication tool on their own. Control does not meet the goal of eradication of the Pacific rat from Wake Atoll. Therefore, this alternative will not be considered further in this analysis.

2.5.3 Aerial-Only Rodenticide Applications

Wake Atoll has approximately 301 man-made structures with 228 that are in use and 73 that are not in use. The interior of these structures likely harbor rats and cannot be effectively treated using aerial applications only and will require various ground application methods. Wake Atoll also contains man-made subterranean structures that likely harbor rats and require ground application methods. Additionally, the island has natural features such as environmentally sensitive habitats and rat burrows that could not be treated using aerial applications only. Aerial-only applications of rodenticides on Wake Atoll would not allow the project to meet its goal of eradication and will not be considered further in this analysis.

2.5.4 Ground-Only Rodenticide Applications

Ground-only applications refer to all ground application methods described under the preferred alternative. USFWS (2019) estimated that 200 worker days would be required to make a single hand broadcast application on Sand Island at Midway Atoll. Sand Island is slightly larger than Wake Atoll at 1,117 acres;

however, a similar effort would be required to make a single ground-only application on Wake Atoll. Two applications are proposed on Wake Atoll roughly doubling the number of hours needed for Sand Island to complete on Wake Atoll. The USFWS also estimated that a crew of 40 individuals would take more than 2 months to complete a single hand broadcast application on Sand Island. The estimate did not include baiting in and around structures. The logistics and costs associated with a ground-only application preclude its selection as an alternative that could be implemented to eradicate the Pacific rat from Wake Atoll. In addition, there is the potential for increased disturbance to nontarget species using ground-only rodenticide applications. This alternative will not be considered further in this analysis due to the limitations in meeting the goal of eradication.

2.5.5 Use of Alternative Rodenticides for Aerial and Ground Broadcast Applications

Currently there are 14 active ingredients registered in the United States by USEPA for use as rodenticides, but not all are currently registered for use for Pacific rats. The largest group by mode of action are the anticoagulant rodenticides, which are divided into first-generation anticoagulant rodenticides (FGARs) and second-generation anticoagulant rodenticides (SGARs). FGARs include diphacinone, diphacinone sodium salt, chlorophacinone, and warfarin. FGARS usually require rodents to feed on the bait for several days to receive a lethal dose. SGARs include brodifacoum, bromadiolone, difethialone, and difenacoum. SGARs usually only require a single feeding for rodents to receive a lethal dose. SGARs have a higher acute toxicity to rodents and potentially exposed nontarget species when compared to the FGARs (USEPA, 2020b; 2020d). Other rodenticides that are not anticoagulants include zinc phosphide, strychnine, bromethalin, cholecalciferol, alpha-chloralose, and alpha-chlorohydrin.

Approximately 90% of the reported successful island rodent eradications to date have used SGARs, with 72% using a brodifacoum-containing bait (Howald, 2020). Therefore, brodifacoum is a proven rodenticide for rodent eradication projects on islands and has proven efficacy against the Pacific rat. B-25W is formulated to allow aerial applications from a helicopter or UAV with the use of a bait hopper or bucket. Many of the other currently registered rodenticides are unproven against the Pacific rat and are not available in bait formulation types that are able to be effectively applied aerially or proven resistant to the environmental conditions present on tropical islands. Cholecalciferol is currently registered for use on Midway Atoll for control against mice, but its use on larger islands against Pacific rats is unproven (Howald et al., 2007; USFWS, 2019). Diphacinone has been used in previous rodent eradication efforts on islands (USAF, 2009). There are two diphacinone pellet formulations currently registered for broadcast applications on islands, as well as other hand baiting application methods. However, diphacinone requires multiple feedings for lethality due to its lower acute toxicity when compared to brodifacoum. The requirement for multiple feedings reduces the likelihood of a successful eradication on Wake Atoll given the various complexities related to treating all use sites on the island

The history of successful use of brodifacoum-containing baits for island rodent eradication projects, its ability to be broadcast spread aerially, its proven effectiveness with the target species and the lack of equally effective alternative rodenticides for aerial broadcast applications for the Pacific rat eliminate extensive use of alternative rodenticides from further consideration in this analysis

Chapter 3 Environmental Consequences

This chapter of the EA summarizes the affected environment and potential effects that may occur to human health and the environment under the preferred alternative and the no action alternative. This chapter discusses the existing conditions, or the environmental baseline, which is a summary of the current human and biological resources on Wake Atoll. The USAF INRMP is the primary source used for the discussion about existing conditions of resources on Wake Atoll (USAF, 2017). The INRMP is used for management and stewardship of natural resources present on Wake Atoll while ensuring the successful accomplishment of the military mission.

3.1 Scope of Analysis

3.1.1 Evaluation of the Potential Impacts of Agency Action

An impact is any change, beneficial or adverse, from existing (baseline) conditions described for the affected environment. Thus, impacts mean changes to the human environment, including human health and ecological resources that could result from the operations and the eradication of invasive Pacific rats from Wake Atoll.

Pursuant to CEQ regulations (40 CFR § 1508.1(g)), impacts or effects considered are those that are reasonably foreseeable and have a reasonably close causal relationship to the proposed alternative action. Impacts may occur soon after the field action or occur later in time. Potential impacts include ecological (such as the effects on natural resources and the components and functioning of affected ecosystems), historic, aesthetic, cultural, social, or effects on public health. Effects may include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial (40 CFR § 1508.1(g)).

In considering whether the effects of the proposed action are significant, agencies analyze the potentially affected environment, and degree of the effects of the action in relation to the affected environment (40 CFR § 1501.3). Agencies must also consider connected actions consistent with 40 CFR§ 1501.9(e)(1). The potentially affected environment is defined by the area(s) potentially impacted by the proposed action (e.g., national, regional, or local), and associated resources (e.g., natural, cultural). In considering the degree of the effects, agencies are to consider the following, as appropriate to the proposed action:

- Short- and long-term effects,
- Beneficial and adverse effects,
- Effects on public health and safety, and
- Effects that would violate federal, state, tribal, or local laws protecting the environment.

USDA-APHIS focused its analysis of potential effects on human health and the environment to the use of rodenticides and disturbance related to the proposed eradication project on Wake Atoll. Disturbance can be defined as any noise or physical disturbance on Wake Atoll during and after the proposed eradication. This chapter also summarizes the human health and environmental impacts of proposed rodenticides used during and after the eradication project. Brodifacoum is the preferred rodenticide to achieve the goal of eradication of the Pacific rat from Wake Atoll. Applications of brodifacoum will occur using aerial and

ground broadcast applications of B-25W, resulting in the greatest potential for exposure to staff who work and live on Wake Atoll as well as workers involved with the eradication.

Aerial and ground broadcast applications of B-25W bait pellets will also have the greatest potential to impact environmental and ecological resources. Due to the persistence of brodifacoum in the environment, the exposure and risk to nontarget species can be primary, secondary, or tertiary.

- Primary risk is exposure to nontarget species from the direct consumption of rodenticide.
- Secondary risk is exposure to nontarget species from the consumption of prey (e.g., invertebrates, vertebrates) that contain residues of rodenticide.
- Tertiary risk is exposure to nontarget species from the consumption of prey that has consumed secondary-contaminated prey.

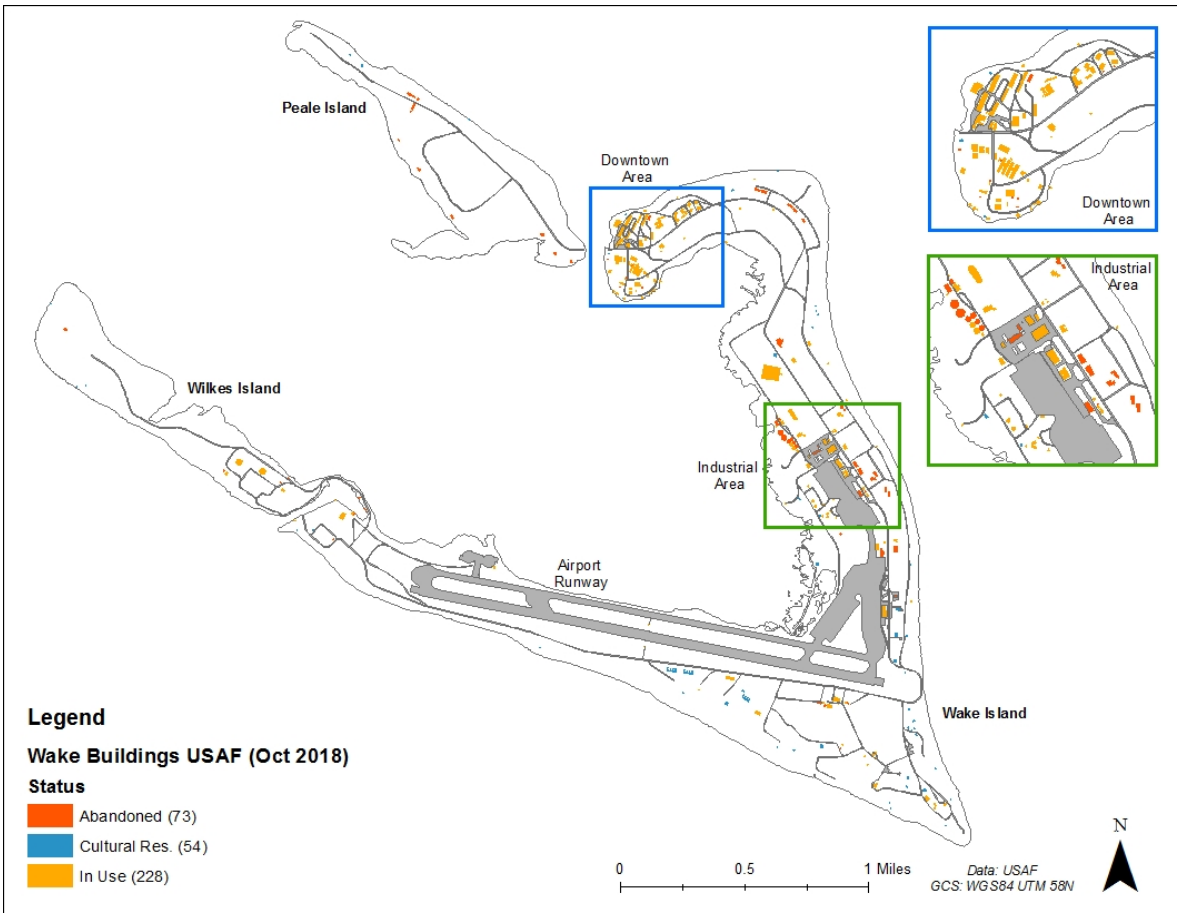
The rodenticides brodifacoum, diphacinone, bromethalin, and zinc phosphide have recently been evaluated by USEPA as part of registration review under FIFRA. Draft human health and ecological risk assessments were prepared by USEPA and submitted for public comment. The risk assessments for brodifacoum, diphacinone, and bromethalin are incorporated by reference into this EA (USEPA, 2020a; 2020b; 2020c; 2020d). The draft human health and ecological risk assessments prepared by USEPA and USDA-APHIS WS for zinc phosphide are also incorporated by reference into this EA (USEPA, 2020e; 2020f; USDA-APHIS, 2020).

USDA-APHIS recognizes that the proposed action will occur in addition to other activities that are occurring on Wake Atoll with a potential for effects to human health and ecological resources. Pesticide use on the island under the proposed alternative will increase in relation to current pesticide use and there will be more additional noise and physical disturbance due to the eradication effort during the operational window. These types of cumulative impacts are expected to be short-term and minor due to the short duration of the project, and program mitigation measures designed to reduce the risk to human health and ecological resources on Wake Atoll.

3.2 Resources Not Evaluated in this Analysis

3.2.1 Land Use and Infrastructure

Wake Island is the largest and currently the most developed of the three islands which make up the atoll. All three islands have had historical development primarily related to activities that started during the 1930's with additional development during and after World War II (USFA, 2017). Wake Island includes three main areas of development: the airport, the industrial area, and the downtown area (Figure 5). The airport consists of a 9,850-ft runway, supporting taxiways, tarmacs, various navigational aids, and vacant areas between active and non-active facilities. The industrial area includes aviation and airfield maintenance shops, fire and rescue, aircraft fueling support facilities, civil engineering, and supply and warehouse buildings. Other industrial facilities in the area include shops, water collection, and distribution structures. The downtown area supports a library, dining hall, medical facility, and laundry facility. It also supports a fire station, a gym, recreation buildings, single-family housing, and billeting. Wilkes Island contains a bulk fuel storage facility and Peale Island has no facilities. The Missile Defense Agency (MDA) utilizes Wake Atoll in a non-permanent capacity. The MDA was established to manage and integrate all missile defense programs and technologies into one Ballistic Missile Defense System (BMDS). MDA is responsible for developing and testing conceptual BMDS (USAF, 2017).



Credit: Island Conservation

Figure 5. Location of buildings and cultural resources on Wake Atoll.

The proposed eradication of the Pacific rat will not alter the current or future land uses on Wake Atoll and, therefore, are not evaluated further in this EA.

3.2.2 Air Quality

The Clean Air Act (CAA) is the primary Federal law that protects the Nation's air quality for the purposes of public health and welfare. The CAA requires the USEPA to establish National Ambient Air Quality Standards (NAAQS) for specific pollutants. These pollutants are known as criteria pollutants, and include ozone, particulate matter, carbon monoxide (CO), nitrogen dioxide, sulfur dioxide (SO_2), and lead. The NAAQS are intended to represent the maximum concentration of a specific pollutant in the ambient air that will not adversely impact public health or welfare. The stringency of air pollution regulations in a specific area is based upon whether that area is in attainment (e.g., compliance) or nonattainment (e.g., not in compliance) with the NAAQS. Greenhouse gases impact air quality; these gases include carbon dioxide (CO_2), methane, nitrous oxide, and fluorinated gases.

Air pollution levels on Wake Atoll are low due to its small size, isolated location, and meteorological conditions. Although, air pollutants are released on Wake Atoll that are associated with the activities on the island and air traffic, the releases are negligible in relation to its location in the Pacific Ocean. Similar

pollutants will be released during the proposed eradication however these will be short-term and will not result in significant impacts to air quality. Trade winds cause a continuous breeze that readily dilutes and disperses any air pollutants generated on the atoll out over the Pacific Ocean. The atoll's small size means limited opportunities exist for locally generated air pollutants to accumulate or recirculate before being transported offshore and away from the islands. There are no neighboring islands and, therefore, transport of criteria pollutants is not an issue (USAF, 2009). The lack of impacts to air quality precludes its analysis in this EA.

3.3.2 Socioeconomic and Environmental Justice Considerations

There are no minority or low-income socioeconomic populations present on Wake Atoll. The island is staffed with approximately 100 civilian and military personnel, so there is no established demographic structure. The lack of any population groups that could be disproportionally impacted by the proposed actions described in this EA precludes its analysis.

3.3 Resources Evaluated in this Analysis

3.3.1 Human Health and Safety

3.3.1.1 Baseline Conditions

The local population at Wake Island resides in a combination of billeting dorms, duplexes, and single-family homes. The primary billeting area is located downtown within proximity to most quality of life and community facilities. At full capacity, the billeting facilities (MDA and USAF civilians, contractors, and active duty) can accommodate approximately 300 personnel (USAF, 2017). Currently there are approximately 100 personnel on Wake Island and no children are present. Drinking water for those on Wake Atoll is derived from a reverse osmosis filtration system.

3.3.1.2 Potential Impacts: No Action

The current on-going rodent management activities such as periodic use of bait stations in commensal areas and the SWAA does not result in significant exposure to pesticides for the residents on the island. No rodenticide treatments are made to food items and there is no risk to drinking water resources. The greatest risk from rodenticide exposure is to applicators who are managing the bait stations. The risk to the applicators is low when baits are used in accordance with the label requirements, including appropriate PPE. The continued presence of the Pacific rat under the no action alternative may result in rodent contaminated food items and the potential for disease transmission. Additionally, there are costs associated with maintaining the current control program and repairing infrastructure damaged by the Pacific rat.

3.3.1.3 Potential Impacts: Preferred Alternative

The proposed eradication will result in low risk to the local population on Wake Atoll based on mitigation measures proposed for this eradication (see Section 2.3.7.1) and adherence to label requirements, including directions for protecting workers who work with pesticides during the eradication treatments. Brodifacoum is highly toxic to mammals, including humans, but the probability of significant exposure is low with a resulting low risk of adverse effects. All proposed uses of brodifacoum are to non-crop areas or other use sites that would not result in brodifacoum human dietary residues. Citrus trees on the island that may be fruit bearing will have the fruits removed and will be pruned prior to the beginning of pesticide

applications. In addition, trees will be covered during aerial broadcast applications, and no hand broadcast brodifacoum applications will be made within the dripline of any pruned trees. Prior to aerial broadcast applications all other outdoor active food producing areas will be decommissioned or covered to eliminate the potential for brodifacoum entry. Hand baiting applications in these areas will be restricted to bait stations or bait trays, and bait sachets or bolas on the perimeter of food producing areas.

As part of the mitigation measures proposed by USAF, there is a recommendation for a fish consumption ban for fish caught in the lagoon for three months after treatment. This will mitigate the potential for consumption of marine life by the local population that could contain residues of brodifacoum. Previous eradication efforts have shown the potential for low level brodifacoum residues in some marine fish species (Pitt et al., 2015; Siers et al., 2020a). Musashino Keisoku Ltd. (2012) reported no brodifacoum residues in 2 eel species (species not reported), 11 bonefish (*Albula glossodonta*), 16 milkfish (*Chanos chanos*), 1 goat fish (species not reported) or 6 land crabs (species not reported) collected after the 2012 Wake Atoll rat eradication attempt. One out of 8 bluefin trevally (*Cranax* sp.) and 4 out of 4 blacktail snapper *(Lutjanus fulvus*) collected within the lagoon had low but detectable brodifacoum residues.

Alternative rodenticides such as zinc phosphide, bromethalin, or diphacinone would be used on an as-needed basis in localized areas. Bromethalin and diphacinone would be limited to post-eradication applications. All three rodenticides are toxic to mammals; however, the proposed use patterns for each product demonstrate a low risk to the local population on Wake Atoll and the applicators who would be making treatments (USEPA, 2020a; 2020b, 2020f; USDA-APHIS, 2020).

Operational risks related to the use and operation of aerial or ground application equipment will be minimized by following all USAF and USDA-APHIS requirements on Wake Atoll. USDA-APHIS WS has a WS Aviation Safety Program and WS Aviation Safety Services that are both designed to ensure safe operation of all aerial aircraft, which have been analyzed in a risk assessment (USDA-APHIS, 2019). All aerial aircraft utilized for this project will have been assessed under these programs. USDA-APHIS will follow all applicable agency guidelines regarding the safe use of helicopters and will comply with USAF and applicable Federal Aviation Administration (FAA) requirements during aerial bait applications.

Birds are a concern for aircraft landings and take-offs from Wake Atoll. Wake Atoll has adopted a Bird Aircraft Strike Hazard (BASH) Program that includes methods to reduce the risk of BASH using harass techniques and pyrotechnics under a USFWS permit from the USFWS Division of Migratory Bird and Habitat Program. Wake Air Force Base (AFB) has a designated on-site BASH Officer.

The eradication of the Pacific rat will result in carcasses that will decay with resulting odors and flies that will be a nuisance to people living on Wake Atoll. While some carcasses may be removed it is not feasible to collect all of them so there will be a short-term nuisance impact to people on Wake Atoll during and after the eradication.

Eradication of the Pacific rat from Wake Atoll will protect key infrastructure from further rodent damage such as wiring, critical mission cables, facilities, supplies, and the possibility of foreign object debris on and around the airfield that could pose risks to residents on the island. Damage from rats to arresting cables on the airport runway have previously been reported (USAF, 2009).

3.3.2 Cultural Resources

3.3.2.1 Baseline Conditions

Wake Atoll is registered as a National Historic Landmark due to its military and strategic importance during World War II. Cultural resources on Wake Atoll include pre-occupation shipwrecks and features related to trans-Pacific aviation, the World War II Battle of Wake Island and post-war civilian and military use, and artifacts (Figure 5) (USAF, 2020b). Military structures include both American and Japanese cultural resources. The Area of Potential Effect (APE) as defined by the NHPA includes the entirety of Wake Atoll. Therefore, any considerations of impacts to cultural resources must include an evaluation of the entire island. In the first rat eradication attempt, Wake Atoll was under jurisdiction of the Advisory Council for Historic Preservation. Wake Atoll is an unorganized, unincorporated island, and in the past was not managed by any State Historic Preservation Office (SHPO). Since the first rat eradication attempt, the state of Alaska has assumed responsibility for cultural resource management on Wake Atoll. Alaska is also where the Pacific Air Force Regional Support Center is located and manages activities on Wake Atoll (USAF, 2020b).

3.3.2.2 Potential Impacts: No Action

The current rodent management plan will have no adverse effects on cultural resources that are present on Wake Atoll. No ground disturbance will occur and the bait stations that are used for rodenticide applications are not placed in commensal areas that would alter the characteristics of cultural resources. The presence of the Pacific rat on Wake Atoll is not anticipated to have any impacts to cultural resources.

3.3.2.3 Potential Impacts: Preferred Alternative

The eradication of the Pacific rat will not have an adverse effect on cultural resources present on Wake Atoll. No ground disturbance will occur under the preferred alternative. The use of bait pellets and the proposed methods of application will not result in any effects that would alter the characteristics of the cultural resources present on Wake Atoll. No staining or physical damage from baits and their application will occur to any of the cultural resources present on Wake Atoll. Dead rats will be present in and around cultural resources after the eradication, but their presence will be short term.

3.3.3 Noise

3.3.3.1 Baseline Conditions

Ambient noise levels around Wake Atoll are similar to a slightly busy commercial area with low population, and have been estimated to be approximately 60 to 65 dBA during the daytime and 45 dBA during the nighttime (USAF, 2009). Periodic construction activities requiring the use of heavy equipment may increase noise levels. These types of activities are intermittent and confined mostly to Wake Island. Light vehicles are used daily to move around the atoll, heavier vehicles are utilized less frequently Periodic aircraft operations raise the noise levels temporarily. The sound level produced by aircraft is dependent upon the airspeed, power setting, meteorological conditions, and altitude at which the aircraft is operating (USAF, 2009).

3.3.3.2 Potential Impacts: No Action

There will be short-term noise associated with light vehicles transporting applicators to treatment sites but is negligible compared with other activities. Therefore, no impacts to noise beyond the baseline conditions are associated with the current rodent management activities on Wake Atoll.

3.3.3.3 Potential Impacts: Preferred Alternative

Impacts from noise associated with the preferred alternative will primarily be associated with aerial applications of bait using helicopters and UAVs. Noise associated with helicopters will be greater compared to UAVs due to the difference in size and motor types between the two aerial application methods. Noise impacts will be short-term and restricted to the time frame during aerial applications. Any aerial applications over the industrial and housing area and airport would be made with approval of the USAF and notification to military and contract personnel living on Wake Island prior to treatment. There would also be increased light vehicle transportation associated with the eradication; however, this would be short-term and restricted to normal daylight hours. Rodenticide applicators, handlers and loaders associated with aerial bait applications will have proper hearing protection to mitigate the potential for hearing loss. Only workers associated with the rat eradication project will be allowed access to areas where aircraft would be staged and departing to make rodenticide applications. There would also be short-term light traffic noise associated with implementing the monitoring plan and biosecurity plan.

Noise disturbance effects on natural resources on Wake Atoll would be mostly to birds present during aerial applications. Noise levels associated with helicopters and UAVs may result in birds taking flight with the resulting use of energy reserves and temporary abandonment of nest sites. Wake Atoll has an active runway with air traffic routinely landing and taking off. Birds that would be disturbed by noise from aerial rodenticide applications would likely return to the treated areas once aerial treatments are completed. UAV applications may be employed in areas of high bird density, such as Peale Island, to minimize disturbance to nesting and foraging birds present on Wake Atoll.

3.3.4 Hazardous Materials and Waste

3.3.4.1 Baseline Conditions

Wake Atoll is a federal facility and has several hazardous materials, waste transfer, and storage areas. As a federal facility, it complies with all applicable federal laws. Hazardous material is defined by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) and the Toxic Substances Control Act (TSCA), as any substance with physical properties of ignitability, corrosivity, reactivity, or toxicity that might cause an increase in mortality, serious irreversible illness, incapacitating reversible illness, or pose a substantial threat to human health or the environment. Hazardous waste is defined by the Resource Conservation and Recovery Act (RCRA), which was further amended by the Hazardous and Solid Waste Amendments, as any solid, liquid, contained gaseous, or semisolid waste, or any combination of wastes that poses a substantial present or potential hazard to human health or the environment. In general, hazardous materials and hazardous wastes include substances that, because of their quantity, concentration, physical, chemical, or infectious characteristics, might present substantial danger to public health or welfare or the environment when released or otherwise improperly managed (USAF, 2009).
Hazardous material and wastes on Wake Atoll consist of fuels for transportation vehicles and any oils or

lubricants required to maintain such vehicles. Operations using hazardous materials at Wake are limited to aircraft flight and maintenance activities, base operations and infrastructure support activities, and infrequent missile launches. Jet fuel is the hazardous material used in the greatest quantity at Wake. In addition to jet fuel, small quantities of lubricants and motor fuel (gasoline) are stored in bulk for base operations and infrastructure support. These materials are delivered to Wake via ship and are transferred to storage facilities (MDA, 2015). Most of these materials are consumed in ongoing activities, and any spills are addressed under the Wake Atoll spill prevention control and countermeasure plans (SPCC) (USAF, 2015a) .

Small quantities of other hazardous materials, including some solvents, paints, cleaning fluids, pesticides, chlorine, and other materials, are also used for infrastructure support and aircraft maintenance activities. These materials arrive via ship or cargo aircraft. Remaining quantities of these materials, which are not consumed in operations, are collected as hazardous waste. Current pesticide use is limited to some rodenticide applications using bromadiolone in commensal areas and near the marina. Other pesticide use includes herbicide applications for weed control in developed areas on Wake Atoll and to remove invasive plant species in natural areas. Any insecticide use is limited to insect pests in and around buildings.

3.3.4.2 Potential Impacts: No Action

The current rodent management activities will not affect the use and handling of hazardous materials on Wake Atoll. Rodenticide use, handling, and storage will follow all applicable Federal laws and USAF SPCC plans for Wake Atoll.

3.3.4.3 Potential Impacts: Preferred Alternative

Under the preferred alternative there would be additional hazardous materials on Wake Atoll prior to and during eradication applications. This material would consist primarily of the B-25W formulation and, to a lesser amount, alternative rodenticides that could be used in post-eradication treatments. During the project implementation, staff would follow all pertinent requirements regarding hazardous materials and waste, including for refueling vehicles, disposing of hazardous wastes, and managing hazardous materials. Any accidental spills would be cleaned up according to the requirements of the facility emergency response plans such as the SPCC and Hazardous Material Emergency Planning and Response Plan. Bait would be applied in accordance with all applicable Federal regulations, including FIFRA. These regulations will set limits on the application rate, areas to be avoided, and required PPE for operations staff. All bait applications will be conducted under the supervision of a certified pesticide applicator (USAF, 2009).

3.3.5 Environmental Resources

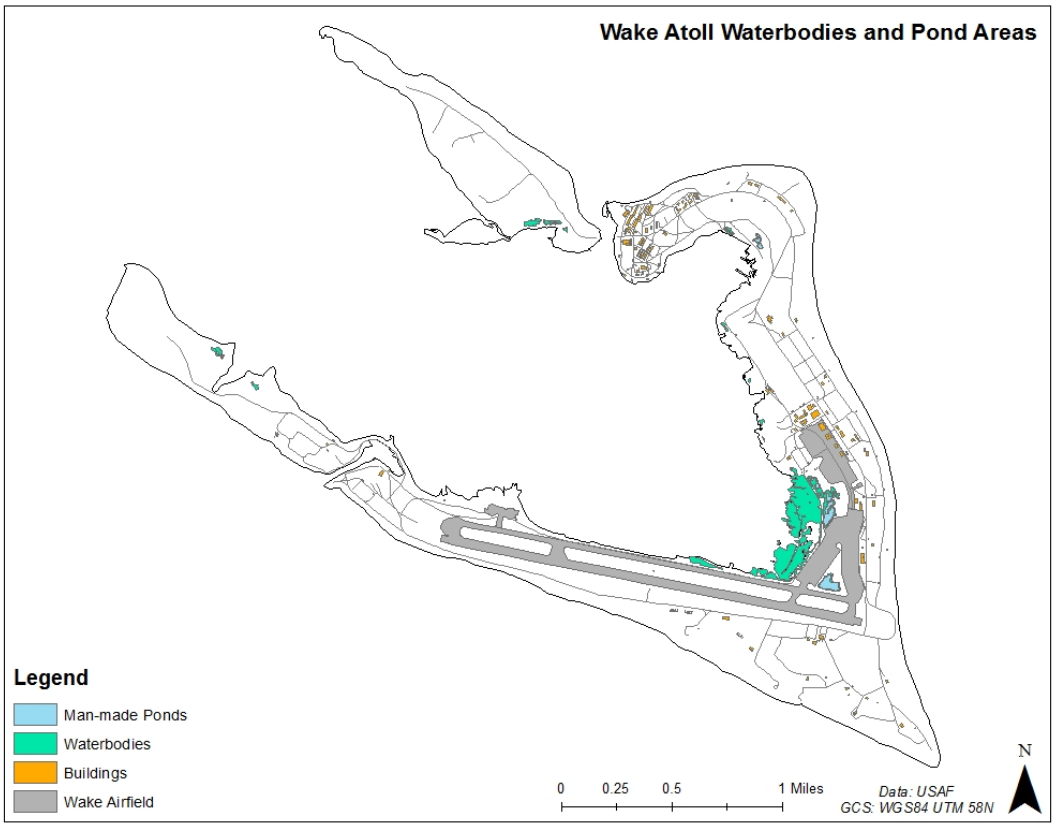
3.3.5.1 Water Quality

3.3.5.1.1 Baseline Conditions

Groundwater resources are limited on Wake Atoll due to the small area of the island and substrate permeability. Shallow, brackish, non-potable groundwater lenses do occur on the island. There are 12 brackish groundwater wells located on Wake Island. Four of the wells are at the power plant and provide cooling water. Three wells are located at the water plant, but only one is in use. Two wells are located at the water booster stations. The remaining wells are abandoned or not in use due to typhoon damage (USAF, 2017).

Surface water resources are dominated by the Pacific Ocean that surrounds the atoll. The lagoon within the atoll is shallow and averages 10 ft in depth but ranges from 1 to 12 ft in depth depending on tidal conditions. Depths at the mouth of the lagoon are around 15 ft. Water in the lagoon is often turbid due to tidal changes resulting in disturbance of the sand bottom, which is a large component of the lagoon along with some coral and rock formations.

In the interior portion of Wake Atoll, there are approximately 58 ac of brackish-water isolated waterbodies ranging in size from 0.11 to 42.3 ac (Figure 6). The largest wetland is located near the airport runway. The isolated waterbodies and pond areas on Wake Atoll are mostly a result of man-made ground disturbance activities.



Credit: Island Conservation

Figure 6. Location of isolated waterbodies on Wake Atoll.

3.3.5.1.2 Potential Impacts: No Action

Current rodent management practices will not impact water quality on Wake Atoll. Rodenticide use is limited to the use of bromadiolone in bait stations in commensal areas and near the marina. Bait stations eliminate any runoff potential and are not placed where tidal fluctuations could carry the bait stations into the surrounding marine environment.

3.3.5.1.3 Potential Impacts: Preferred Alternative

The application of B-25W using aerial broadcast applications may result in some of the pellets bouncing or being dropped accidentally into aquatic habitats on and surrounding Wake Atoll. Aquatic resources such as open wells or tanks will be covered to prevent accidental entry of pesticide during aerial applications or drained during aerial applications to eliminate the potential for pesticide accidentally entering water resources. In addition, the project may utilize ground-based bait application methods for any instances where covering or draining open wells and tanks is not feasible. Aquatic mitigation measures will be put in place beyond the label requirements for B-25W applications during the project activity periods. These measures are covered more fully in Section 2.3.7.1 and will reduce the potential for offsite deposition of brodifacoum into the water resources at Wake Atoll. Incidental deposition of brodifacoum into water resources may occur through drift or runoff from broadcast applications; however, the expected levels in waterbodies and the surrounding ocean would be negligible (Fisher et al., 2010). Bait applications are planned to occur during the dry season, to further reduce the potential for brodifacoum runoff entering aquatic resources due to rain events.

During the Palmyra rat eradication, where the documented bait application was high, 75.6 lbs./ac. (84.8 kg/ha) for the 1st application and 71.5 lbs./ac. (80.1 kg/ha) for the second application, the average density of bait entering the water was as high as 40 lbs./ac. (44.7 kg/ha) during the first application and 41 lbs./ac. (46.3 kg/ha) during the second (Engeman et al., 2013). A variety of factors are thought to have contributed to the high quantity of bait entering the marine environment at Palmyra, which included an irregular coastline, dozens of small islets that were difficult to aerially bait, baits drifting in the wind, pilot difficulty locating the shoreline due to overhanging palm trees, and an ineffective and broken bait hopper deflector. Conditions on Wake Atoll are different from those on Palmyra Atoll. At Wake Atoll there are only three islands and the shorelines are mostly linear. In addition, there are very few areas where tall canopy overhangs the shoreline. As a result, it is expected that shoreline applications will be more accurate than what occurred during the Palmyra eradication. Every effort will be made to ensure that all equipment is functioning at optimal conditions during aerial applications on Wake Atoll. In addition, where allowed and approved the use of UAVs next to sensitive marine habitats would further reduce the chance of bait pellet deposition into the marine environment. Any brodifacoum that would enter the water will do so as a pellet that would become saturated and sink to the bottom sediment where it would rapidly degrade. Pellet baits have been shown to degrade within minutes to less than five hours in previous eradication efforts (Empson and Miskelly, 1999; Howald et al., 2009; Samaniego-Herrera et al., 2014). Additionally, any pellets that are discharged into the ocean side of the islands would degrade even more rapidly through the mechanical forces of wave action.

Brodifacoum has low water solubility, 0.24 milligrams/liter (mg/L) at a pH of 7.4, and environmental fate properties that suggest that residues in water would bind to suspended solids and sediment, further reducing the probability of any impacts to water quality. Its low solubility and high binding affinity for soil also reduces the likelihood of leaching into any groundwater resources on Wake Atoll (D'Alessio et al., 2018). Drinking water is produced from a reverse osmosis filtration system. Drinking water will be monitored through pre-and post-eradication testing of raw water entering the reverse osmosis membrane and filtered water entering the distribution system. No effects on drinking water sources are expected on Wake Atoll from the proposed project.

Trapping activities will have no effects on water quality. The use of zinc phosphide as a tracking powder is unlikely to have negative effects on water quality. It's limited use in structural voids and outdoor constricted

areas where rats travel would not result in significant runoff from rain events. Any zinc phosphide that would be present in runoff after a rain event would rapidly dissipate resulting in phosphine that would volatilize into the air and zinc ions that would sorb to soil. Project activities are proposed to occur during the dry season where runoff from rain events are less likely to occur.

Post-eradication activities such as the use of alternative rodenticides would likely have no effects on water quality due to their limited use in localized areas with ongoing rat activity. Diphacinone may be hand broadcast in limited terrestrial outdoor and uninhabited areas and is not likely to enter water bodies. Diphacinone and bromethalin may be used in canopy baiting in vegetation near water resources but these uses will be minor with no expected effect on water quality. Bromethalin may be used in elevated or floating baits stations in habitat periodically inundated with water but uses would be minor with no expected effect on water quality. The environmental monitoring and biosecurity plan activities would have no effects on water quality. Water samples may be collected from inland wetland habitats, the lagoon, and surrounding coastline to further ensure that water resources are not being impacted by project activities.

3.3.5.2 Soil Quality

3.3.5.2.1 Baseline Conditions

Soil formation on Wake Atoll is minimal due to high winds and inundation of salt water. The resulting lack of organic matter and nutrients results in low fertility for the development of plant communities. The substrate on the island is highly permeable and composed primarily of sand, coral, shells, and limestone. Soils and substrate on the island have also been physically altered due to historic and current activities related to the strategic importance of the island as a military base (USAF, 2017). Lack of significant soil formation, including organic matter and nutrients, suggests that soil-borne microorganisms and invertebrates critical to maintaining adequate soil quality are nominal.

3.3.5.2.2 Potential Impacts: No Action

Current rodent management practices on Wake Atoll is not likely to result in significant impacts to soil quality. Periodic rodenticide use is restricted to commensal areas and the marina using bait stations where contact with soil is minimized.

3.3.5.2.3 Potential Impacts: Preferred Alternative

Broadcast applications of B-25W may result in residues of brodifacoum in soil if bait pellets or blocks are left on the soil surface and degrade over time. Previous eradication projects that have used brodifacoum have shown soil residues after application (Fisher et al., 2010; Alifano et al., 2012); however, these residues will degrade over time (Pitt et al, 2015). The presence of brodifacoum residues in soil is related to removal rates of pellets by the target pest and nontarget wildlife, and environmental conditions during and immediately following the bait application the eradication that can affect bait pellet degradation. There is a greater likelihood of brodifacoum soil residues to occur on rat-free Peale Island since bait removal rates will likely be lower than on Wilkes Island and Wake Island which have higher densities of the Pacific rat. Any brodifacoum present in soil will degrade slowly over time. Degradation half-lives for brodifacoum in soil are approximately 157 days (EPA, 2020d). Residues of brodifacoum that may occur in soil are not anticipated to result in long term effects on soil quality due to bait removal and degradation of brodifacoum Trapping activities will have no effects on soil quality. The use of alternative rodenticides such as

diphacinone, zinc phosphide, or bromethalin use on soil would be limited to localized areas. Diphacinone and zinc phosphide are expected to be less persistent than brodifacoum in soil. Bromethalin applications that could potentially affect soil quality would be largely limited to burrow baiting and subterranean areas, or unsafe areas where applicators cannot enter. None of these uses are anticipated to result in long term effects on soil quality due to their limited use.

Environmental monitoring and the biosecurity plan would have no negative effects on soil quality. Soil samples may be collected pre- and post-eradication to determine residues of brodifacoum; however, the number of samples collected would be small resulting in negligible disturbance.

3.3.6 Biological Resources

3.3.6.1 Terrestrial Mammals

3.3.6.1.1 Baseline Conditions

There are no native wild mammals or domestic terrestrial mammals present on Wake Atoll. The only terrestrial mammal present are the nonnative, invasive Pacific rat.

3.3.6.1.2 Potential Impacts: No Action

Current rodent management activities will continue to suppress rat populations in areas where treatments occur. Pacific rat populations will still exist on Wake Island and Wilkes Island and will not meet the objective of eradication. Over time, it is expected that the Pacific rat will reinvade Peale Island.

3.3.6.1.3 Potential Impacts: Preferred Alternative

Implementation of the preferred alternative will likely result in the eradication of the Pacific rat from Wake Atoll. The primary rodenticide that will be used for the eradication is brodifacoum, an SGAR. Brodifacoum is very highly toxic to mammals with the rat median lethal oral dose (LD50) for technical brodifacoum ranging from 0.42 to 0.57 milligrams per kilogram (mg/kg) body weight. The median lethal oral dose is defined as the concentration of a toxicant that is expected to result in the mortality of 50% of a population of test animals when administered in a single acute oral dose. The alternative rodenticides are also acutely toxic to mammals. Post-eradication rodenticide treatments and trapping will likely ensure removal of any Pacific rats that survived the initial eradication applications. Monitoring will assess the success of the eradication to determine if additional treatments are required. Continued implementation of appropriate biosecurity measures will reduce the risk of rodent species re-invading and establishing on Wake Atoll.

3.3.6.2 Birds

3.3.6.2.1 Baseline Conditions

Wildlife on Wake Atoll is dominated by various seabirds and other bird species (Table 1; Appendix C). Several species of seabirds use Wake Atoll for nesting. Nesting sites occur on various parts of Wake Atoll; however, Wilkes Island and Peale Island have the largest sites likely due to the lack of human activity or development on both islands.

Sooty terns are the most abundant seabirds that nest on Wake Atoll. Recent bird surveys from June 2020 counted 106,000 sooty tern nests on Wilkes Island (Gilardi, 2020) (Figure 7). Chicks had just begun to hatch during the June 2020 survey. Sooty terns feed over schools of predatory fishes, consuming goatfish, flying fish, and squid (USAF, 2009). Other nesting seabird species on Wake Atoll occur in much smaller numbers. The next most common seabird species observed nesting on Wake Atoll is the red-footed booby, which had 354 nests observed on Wilkes Island in December 2019. The Laysan albatross occurs in low numbers with a small number of nests. The black-footed albatross has not been observed in recent surveys. Additional bird survey and nesting data for other species on Wake Atoll is summarized in the 2020 Wake Island Quarterly Bird Survey (Appendix I).

Credit: John Gilardi

Figure 7. Sooty tern colony

The USFWS Seabird Conservation Plan and International Union for Conservation of Nature (IUCN) provides information about the distribution, ecology, and status of the sooty tern and the other seabird species reported on Wake Atoll (USFWS, 2005). Breeding cycles vary for seabirds that use Wake Atoll (Figure 8). Some species such as the brown booby and brown noddy are synchronous breeders. Other seabirds are asynchronous such as the black noddy. Other species such as the white tern are year-round breeders on Wake Atoll.

Various shorebird species use Wake Atoll to winter. They may occur at other times during the year on Wake Atoll, but their numbers typically increase during the winter months (Gilardi, 2020). The most abundant shorebird species observed during the winter months on Wake Atoll is the Pacific golden plover followed by the ruddy turnstone, tattlers, and the bristle-thighed curlew, which is classified as near threatened by the IUCN (IUCN, 2020). The bristle-thighed curlew does not nest on Wake Atoll but has been observed repeatedly on Peale Island in small numbers. The diet of the curlew is variable consuming intertidal and terrestrial invertebrates, seabird eggs and hatchlings, carrion, lizards, rodents, and fruit.

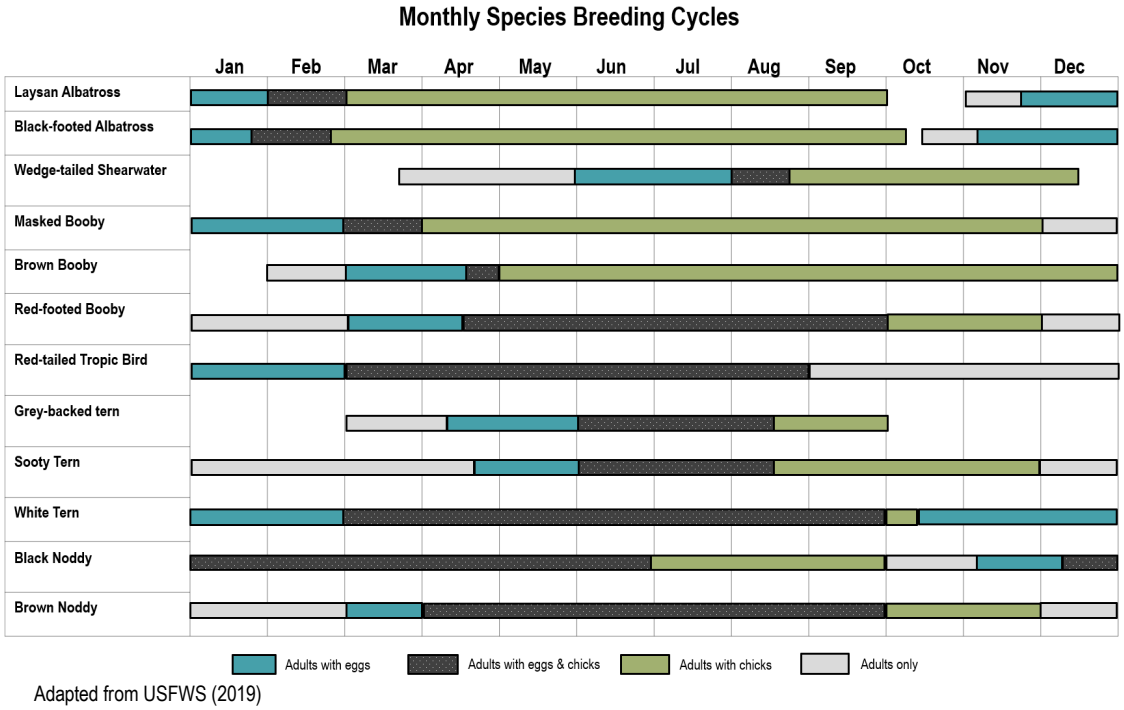


Figure 8. Seabird breeding cycles on Wake Atoll

3.3.6.2.2 Potential Impacts: No Action

The current rodent management activities on Wake Atoll will not directly affect bird populations on Wake Atoll. Rodenticide use is limited to commensal areas and involves the use of bait stations that would not pose a direct risk to birds since they would not be able to access the bait stations. Any dead rats from these treatments are not likely to be scavenged by most bird species that are common on Wake Atoll. The diet of the great frigatebird is composed mostly of marine prey items, but they may also scavenge and prey on other food sources (Schreiber et al., 1976). There is the potential for brodifacoum exposure to the frigatebird from scavenging dead rats, but the current rodent management activities are localized and not expected to result in significant risk to the great frigatebird.

The continued presence of the Pacific rat will result in short-term and long-term negative effects on birds that use Wake Atoll. The impacts of rodents to birds on islands has been well documented. Many of the bird species that nest and forage on Wake Atoll have been impacted by invasive rodents, including the Pacific rat (Table 2). Direct negative effects on birds that nest on Wake Atoll would occur from rat predation of bird eggs and chicks. Previous and current bird survey work on Wake Atoll has noted rat predation to nesting birds, which will continue without eradication of the Pacific rat. Competition by rats for food sources used by birds will also result in short-term and long-term indirect negative effects on birds on Wake Atoll.

3.3.6.2.3 Potential Impacts: Preferred Alternative

The implementation of the preferred alternative to eradicate the Pacific rat will have beneficial short-term and long-term effects on bird populations at Wake Atoll. These effects would be direct (reduced Pacific rat

predation of bird eggs and chicks) and indirect (increase in bird food items such as invertebrates and plant materials). Long-term positive effects of the eradication of the Pacific rat will likely include increased numbers of birds that nest and forage on Wake Atoll. This would particularly be the case for seabird species predated by rats, primarily eggs and chicks (Figure 8). Numerous rodent eradication projects on islands have documented the positive impacts on various bird populations post-eradication (Pierce, 2002; Nelson et al., 2016).

However, there are risks to birds from the proposed broadcast applications of B-25W. Brodifacoum is very highly toxic to bird species. The lowest reported LD_{50} for birds is 0.26 mg/kg-body weight for the mallard (*Anas platyrhynchos*) and the lowest reported subacute median lethality dietary concentration (LC_{50}) for birds is 0.8 mg/kg-diet for the northern bobwhite (*Colinus virginianus*) (EPA, 2020b). Birds exposed to sublethal concentrations exhibit various symptoms such as hemorrhaging, weight loss, decreased activity levels, wing droop, loss of equilibrium, lethargy, and other sublethal effects. Birds that ingest bait pellets containing brodifacoum (primary risk), or prey items that contain brodifacoum (secondary risk), are at risk from acute and chronic exposure.

USFWS evaluated the primary and secondary acute risk to seabirds and shorebirds on Sand Island at Midway Atoll from B-25W applications (USFWS, 2019). Many species that occur on Midway Atoll also occur on Wake Atoll. USFWS estimated the acute poisoning risk to seabirds and shorebirds using acute lethality data and estimating food intake values for birds that are present on Midway Atoll. Estimates of acute risk from direct ingestion of pellets or ingesting prey containing brodifacoum were made by estimating the percentage of daily food needed to receive a lethal dose of brodifacoum. USFWS categorized the primary and secondary poisoning risk from brodifacoum exposure using these toxicity estimates and feeding habits for seabirds and shorebirds (Table 10).

Table 10. Risk summary for seabirds and shorebirds on Wake Atoll from rat eradication activities

Species	Poisoning Risk		Disturbance Risk		BASH Risk
	Primary	Secondary	Ground	Air	
Laysan Albatross (adult)	Low	Low	Low	Low	Medium
Black-footed Albatross	Low	Low	Low	Low	Medium
Albatross (chicks all spp.)	Low	Low	Low	Low	Medium
Wedge-tailed Shearwater	Low	Low	High	Low	Low
Christmas Shearwater	Low	Low	High	Low	Low
Great Frigatebird	Low	Medium	Medium	Low	Medium
White-tailed Tropicbird	Low	Low	Medium	Low	High
Red-tailed Tropicbird	Low	Low	Medium	Low	High
Masked Booby	Low	Low	Low	Low	Low
Brown Booby	Low	Low	Low	Low	Low
Red-footed Booby	Low	Low	Low	Low	Low

Species	Poisoning Risk		Disturbance Risk		BASH Risk
	Primary	Secondary	Ground	Air	
Black Noddy	Low	Low	Low	Low	Medium
Brown Noddy	Low	Low	Low	Low	Medium
White Tern	Low	Medium	Low	Low	High
Sooty Tern	Low	Low	Low	Low	Low
Gray-back Tern	Low	Low	Low	Low	Low
Pacific Golden Plover	High	High	Low	Low	Low
Ruddy Turnstone	High	High	Low	Low	Low
Wandering Tattler	High	High	Low	Low	Low
Gray-tailed Tattler	High	High	Low	Low	Low
Sanderling	High	High	Low	Low	Low
Dunlin	High	High	Low	Low	Low
Sharp-tailed Sandpiper	High	High	Low	Low	Low
Bristle-thighed Curlew	High	High	Low	Low	Low

UFWS (2019).

Poisoning risk from brodifacoum is highest for shorebirds since they are more likely to consume bait (primary risk) or consume prey items such as crabs and other invertebrates and vertebrates that consumed bait pellets and contain brodifacoum residues (secondary and tertiary risk). The risk from ingesting bait will be short-term due to bait removal by the Pacific rat and invertebrates, and degradation of the bait pellet. The risk will be greater for shorebirds on Peale Island since the baits are expected to be present for a longer period because of expected lower rat densities. There is also a greater likelihood of secondary and tertiary risk to birds on Peale Island since crabs and other invertebrates as well as vertebrates, such as skinks and geckos, will consume bait pellets not removed by the Pacific rat. Brodifacoum residues may persist in lizards and geckos resulting in prolonged secondary risk to bird species that consume them as prey (Rueda et al., 2016; Rueda et al., 2019). These risks will decrease over time as brodifacoum residues decrease in the environment.

The primary and secondary risks of brodifacoum exposure to seabirds is low due to their feeding habits that consists mostly of marine prey items. The sooty tern which is the most common nesting seabird on Wake Atoll will have a low risk of primary or secondary exposure to brodifacoum based on their diet. In addition, chicks that may be present during applications have a low risk of brodifacoum exposure. Sztukowski and Kelser (2012) demonstrated that sooty tern chicks on Wake Atoll did not preferentially consume placebo bait pellets suggesting a low risk of exposure to chicks.

Secondary poisoning risks to birds are short-term and long-term; however, brodifacoum residues in bird prey items such as invertebrates, lizards, and marine fish will decline over time. Wegmann et al. (2019) reported no brodifacoum residues in mullet (*Moolgarda engeli*), cockroaches (*Periplaneta* sp.), geckos (*Lepidodactylus lugubris*), hermit crabs (*Coenobita perlatus*), and fiddler crabs (*Uca tetragonon*) three years post-eradication on Palmyra Atoll. Siers et al. (2020) reported no brodifacoum residues in fish samples collected within the lagoon at Wake Atoll, or within near-shore waters outside the lagoon, three years after

the 2012 eradication. Low concentrations of brodifacoum were detected in 2 out of 20 blacktail snapper (*Lutjanus fulvus*) fish samples that were collected in an intermittent land-locked pond in an area that received significant brodifacoum baiting. Although at levels too low to quantify, the study demonstrated that brodifacoum can persist in aquatic environments, especially smaller isolated water bodies.

In addition to the risks posed by brodifacoum to birds, there are operational risks to birds during the proposed eradication. There is a risk of bird strikes associated with aerial broadcast applications of brodifacoum. Pitt et al (2015) documented sooty tern and red-footed booby bird strike mortalities that occurred during aerial rodenticide applications on Palmyra Atoll. Wake Atoll has a BASH program that includes methods to reduce the risk of bird strikes using harassment techniques and pyrotechnics during landings and takeoffs. This would minimize the potential for bird strikes during landings and takeoffs, but there would still be a risk of bird strikes during aerial applications (Table 10). The amount of disturbance would be greater for helicopters compared to UAVs. These impacts would be temporary and negligible if birds are not nesting. Impacts would be temporary, but not necessarily negligible if boobies and terns are flushed from their nests during the heat of the day exposing eggs and chicks. To reduce any such risk, flyovers of a nesting seabird colony would be conducted later in the afternoon, as it gets cool. If any sooty terns are nesting during the operation, a hand-broadcast application through the sooty tern colony during the late afternoon would be conducted if the helicopter pilot deemed it unsafe to fly over (USAF, 2009). UAVs may also be used in these circumstances to reduce bird disturbance and minimize the potential for bird strikes.

Physical disturbance of bird nests and chicks during ground applications of B-25W will result in temporary negative effects but will be minimized by avoiding trampling of nests and burrows to protect nesting adults, eggs, and chicks during monitoring or hand broadcast activities. Disturbance of nesting adults can also cause nest abandonment resulting in heat exposure to eggs and impacts to chicks that can become disoriented and lost after leaving the nest. The implementation of bird mitigation measures in the 2012 rat eradication on Wake Atoll which was conducted during May and June resulted in a very low number of bird mortalities. Two birds, a Pacific golden plover and ruddy turnstone, were the only reported bird mortalities (USAF, 2017). However, the number of actual bird mortalities was likely higher due to the difficulty in finding and recovering all birds that may have exposed to brodifacoum (Vyas, 1999). However, the low mortality observed during the 2012 eradication shows that the mitigation measures used to protect birds during the rat eradication were effective in reducing effects.

The use of alternative rodenticides and trapping will likely not result in negative effects on birds on Wake Atoll. Alternative rodenticide use will be localized rather than island wide. Zinc phosphide use would be limited to constricted areas within rats' paths of movement. Use of diphacinone aboveground and outside of bait stations could include localized hand broadcast and canopy baiting. Diphacinone is less toxic to birds than the other proposed rodenticides. Use of bromethalin aboveground and outside of structures and bait stations could include canopy baiting. Bromethalin is more toxic to birds, but this use will be minor, and birds would not likely be exposed to any primary or secondary risks from bromethalin use. The use of alternative rodenticides will be short term lasting no more than eight months after the primary B-25W broadcast applications. Monitoring may result in short term negative effects on birds due to disturbance, but bird nesting areas will be avoided, where feasible, to ensure that these areas are not disturbed. Implementation of the biosecurity plan will have beneficial long-term effects by reducing the chance of rodent and other invasive species introductions on Wake Atoll.

3.3.6.3 Terrestrial Herpetofauna

3.3.6.3.1 Baseline Conditions

One species of skink and two species of geckos have been identified on Wake Atoll in recent surveys. The mourning gecko (*Lepidodactylus lugubris*) and common house gecko (*Hemidactylus frenatus*) occur in a variety of natural habitats on Wake Atoll, and in and around abandoned and occupied structures. The azure-tailed skink (*Emoia cyanura)* is also a common inhabitant of Wake Atoll, occurring in a variety of natural and man-made habitats (USAF, 2017). The stump-toed gecko (*Gehyra mutilata*) and the snake-eyed skink (*Cryptoblepharus boutonii*) have been reported in historical surveys on Wake Atoll but have not been seen in recent surveys (USAF, 2017).

3.3.6.3.2 Potential Impacts: No Action

Current rodent management strategies are not expected to have any short- or long-term effects on reptile populations on Wake Atoll, but the Pacific rat will inflict negative long-term effects. Reptiles, such as lizards and skinks have been shown to be adversely affected by the presence of invasive rodents on tropical islands (Harper and Bunbury, 2015). In some cases, reptiles, such as skinks, may be one of the primary food sources for invasive rats (Gaiotto et al., 2020). The continued presence of Pacific rats on Wake Atoll would suppress skink and gecko populations directly through consumption as prey and indirectly through competition for food sources. These effects would be short-term and long-term.

3.3.6.3.3 Potential Impacts: Preferred Alternative

Geckos and lizards on Wake Atoll are not expected to be negatively affected using brodifacoum. Weir et al. (2016) reported a LD_{50} value of greater than 1,750 mg/kg in a 14-day study using the western fence lizard (*Sceloporus occidentalis)*. This study demonstrates low toxicity of brodifacoum to lizards when compared to mammals and birds. Mauldin et al. (2020) dosed green iguanas (*Iguana iguana*) and giant ameivas (*Ameiva ameiva*) twice over a seven-day period and monitored for acute and sublethal impacts for 14 days. Three ameivas died in the low dose brodifacoum treatment level with one mortality in the high dose. One iguana in the low brodifacoum treatment level died; however, no mortality was observed in the high brodifacoum dose level. Iguanas at low and high doses following treatment showed markedly dark coloration that is frequently considered a sign of stress. There was no change in coloration noted in the control animals. Several treated ameivas were notably lethargic or unresponsive following dosing, which was not observed in the controls.

Gecko and skink species observed on Wake Atoll are primarily insectivores but may feed on baits accumulating residues. Brodifacoum residues may accumulate in invertebrates that feed on cereal baits. The result would be secondary exposure to skinks and geckos that consume prey items containing brodifacoum residues. Residue analysis for brodifacoum after rat eradication treatments have demonstrated residues in various lizard and skink species (Rueda et al., 2016). The short- and long-term impacts of sublethal brodifacoum residues in these species is unknown; however, the risk is expected to diminish over time. The short-term and long-term effects on reptiles from eradication of the Pacific rat will be an increase in reptile and skink populations. Towns (1991) reported that lizard populations on islands were positively impacted by the removal of the Pacific rat from the Mercury Islands in New Zealand. The elimination of the Pacific rat removes direct predation by rats of skink and geckos and removes competition for food resources. The use of alternative rodenticides and trapping will have similar long-term positive

effects on skinks and geckos on Wake Atoll. The immediate risk of exposure to alternative rodenticides will be less since their outdoor use will largely be limited to areas where remaining rats need to be eliminated. A risk of trampling skinks and geckos on Wake Atoll while making ground-based applications of brodifacoum or one of the alternative rodenticides is possible. Trampling may also occur while personnel are conducting monitoring activities or implementing the biosecurity plan. These risks will be short-term and are expected to be minimal. Workers will avoid stepping directly on any geckoes and skinks during these activities.

3.3.6.4 Invertebrates

3.3.6.4.1 Baseline Conditions

The invertebrate community on Wake Atoll is dominated by various crab species that can occur on land and in tidal pools (table 11). The most common crab species is the Strawberry hermit crab (*Coenobita perlata*), which occurs in natural habitats on the island and in developed areas.

Table 11 Crab species identified on Wake Atoll.

Common name	Scientific Name	Habitats
Strawberry Hermit Crab	*Coenobita perlata*	Widely distributed in most habitats
Dwarf Zebra Hermit Crab	*Calcinus laevimanus*	Shore and associated tidal pools
Electric Blue Hermit Crab	*Calcinus elegans*	Shore and associated tidal pools
Yellow-tip Hermit Crab	*Clibinarius virescens*	Shore and associated tidal pools
Yellow Nippers	*Geograpsus crinipes.*	Ironwood and tournefortia forests
Horned Ghost Crab	*Ocypode ceratophtala*	Intertidal zone
Fiddler Crabs	*Uca* sp.	Pemphis, seaside purslane isolated waterbodies
Thin-shelled Rock Crab	*Grapsus tenuicrustatus*	Intertidal zone
Flat Rock Crab	*Percnon planissimum*	Not reported
Red-eyed Crab	*Eriphia sebana*	Not reported
Xanthid Crab	*Leptodius exaratus*	Not reported
Hawaiian Crab	*Leptodius sanguineus*	Not Reported
Marine Crab	*Lydia annulipes*	Marine, near shore
Aerolated Xanthid Crab	*Pilodius aerolatus*	Not reported
Pilumid Hairy Crab	*Pilumnus longicornis*	Not reported
Pseudozid Crab	*Pseudozius caystrus*,	Intertidal zone
Sponge Crab	*Dromia personata*	Not reported

Additional invertebrates have also been identified in various habitats on Wake Atoll. In 2009 *Pisonia grandis* (grand devil's-claw) and *Cordia subcordata* (beach cordia) forests, *Tournefortia argentea* (velvetleaf soldierbush), *Pemphis acidula* (pemphis) wetland, seabird breeding colony, grassland and *Casuarina equisetifolia* (ironwood) habitats were sampled to determine invertebrate diversity in each habitat type. Approximately 148 arthropod species were collected from the various habitats. Beetles, moths, spiders, fruit flies, midges, wasps, scorpions, and tropical crickets were some of the arthropods collected during the study. Four invasive ant species also occur on the island including the fire ant (*Solenopsis geminate*),

bigheaded ant (*Pheidole megacephala*), *Paratrechina* spp. (possibly the longhorn crazy ant (*P. longicornis)* the only species widely introduced to tropical islands), and the yellow crazy or long-legged ant (*Anoplolepis gracilipes*) (USAF, 2017).

3.3.6.4.2 Potential Impacts: No Action

Current rodent management practices will not result in significant negative impacts to crab populations on Wake Atoll. Rodenticide use is currently restricted to commensal areas and the marina using bait stations. Some invertebrates may access bait stations and be exposed to bait; however, this type of exposure would be incidental and limited to the areas where bait stations are in use. Impacts to terrestrial invertebrates on islands where rats have been introduced have been noted for various rat species. including the Pacific rat (Chiba, 2010; St Clair, 2011). The diet of the Pacific rat is equally split between plant material and arthropods (Shiels et al., 2013; Shiels et al., 2014). A continued presence of the Pacific rat on Wake Atoll would result in negative short- and long-term effects on terrestrial invertebrates that serve as prey (St. Clair et al., 2011).

3.3.6.4.3 Potential Impacts: Preferred Alternative

The eradication of the Pacific rat will have positive short- and long-term effects on terrestrial invertebrates that are a part of the diet of rats that are present on Wake Atoll. Rats are general feeders and will feed on crabs and other terrestrial invertebrates. There is a low risk to terrestrial arthropods that are exposed to brodifacoum pellets and blocks. Spurr and Drew (1999) reported that terrestrial invertebrates like crickets, beetles, and ants are attracted to cereal baits used in rat eradication programs in New Zealand. Terrestrial invertebrates may also scavenge dead rats that have been exposed to brodifacoum. Based on available toxicity data, the risk to this group of nontarget species is expected to be low. Effects data are limited for terrestrial invertebrates but earthworm, snail and crab exposures show low toxicity after exposure to high concentrations of brodifacoum in laboratory toxicity testing (Booth et al., 2003). Pain et al. (2000) also demonstrated low brodifacoum toxicity to the hare-lipped land crab (*Johngarthia* (*Gecarcinus) lagostoma*). However, on Palmyra Atoll, some fiddler crabs may have died from brodifacoum poisoning in conjunction with the rat eradication (Pitt et al. 2015). Applications on Palmyra Atoll were higher than those proposed for Wake Atoll. USEPA (2020b) pesticide incident reporting suggests a low number of crab mortalities associated with SGAR use. There is the potential for brodifacoum residues to occur in terrestrial invertebrates that consume brodifacoum pellets or blocks (Howald et al., 2010). The sublethal impacts of these residues to terrestrial invertebrates is unknown but population increases of crabs and other invertebrate populations post-eradication suggest that the impacts are minimal and transient. The presence of brodifacoum residues in terrestrial invertebrates does pose a secondary risk for those nontarget species that rely on terrestrial invertebrates as a food source.

The use of zinc phosphide or the other alternative rodenticides in post-eradication treatments will likely have negligible short-term or long-term risks to terrestrial invertebrates. Any outdoor applications will be limited in scope and short duration. The environmental monitoring plan may include the collection of some terrestrial invertebrates for tissue residue analysis; however, the number of invertebrates collected will be low and will not result in any short-term or long-term effects. Implementation of the biosecurity plan will also not result in effects on invertebrate populations. The biosecurity plan will have long-term beneficial effects to terrestrial invertebrates by reducing the potential for future invasive species introductions on Wake Atoll and providing a response when these types of incursions occur

3.3.6.5 Terrestrial Plants

3.3.6.5.1 Baseline Conditions

Frequent natural and manmade disturbance on Wake Atoll have resulted in plant communities that are early successional or dominated by invasive terrestrial plant species (Figure 9; Appendix J).

Credit: Island Conservation

Figure 9. Plant communities on Wake Atoll

Pemphis is the predominant native plant species on Wake Atoll. Pemphis is a tightly branched, halophyte shrub that occurs on saturated sandy substrates, around brackish ponds, and dry sandy flats. Pemphis also occurs along the lagoon margin of all three islands and on the ocean side of the islands in spotty linear strands in areas above the mean high tide mark. Pemphis is also the dominant species lining the open brackish ponds on the golf course, behind the petroleum, oil, and lubricant area in the industrial area, and the detention basin at the northeastern end of the flightline (USAF, 2017).

The most common tree on Wake Atoll is velvetleaf soldierbush, *Heliotropium foertherianum*, or tournefortia. These native trees rarely reach a height of 20 ft (6.1m) and occur in the least fertile and dry areas on the island. Along the beach they appear as rounded shrubs between 3 to 6 ft in height. In inland sheltered areas tournefortia form pure stands, especially on Peale Island. Along the northeastern coastline tournefortia occurs with beach naupaka (*Scaevola taccada*). Tournefortia is also found in association with a variety of introduced species including ironwood (*Casuarina equisetifolia*), coconut (*Cocus nucifera*), and ornamental shrubs and native species such as pemphis and naupaka (USAF, 2009).

Casuarina, or ironwood, is the third most common plant vegetation type on Wake Atoll. Ironwood are small trees that were introduced in the 1970's as ornamental plantings and can be aggressive invaders of natural habitats. Ironwood can form thick stands that shade out native understory plants and have allelopathic properties that prevent germination of other plant species. Ironwood stands occur in the former housing and industrial areas, SWAA and MDA on Wake Island. Ironwood have been eradicated from Peale Island and are nearly eradicated from Wilkes Island. Ironwood prevents ground nesting species such as sooty terns and gray-backed terns, as well as sea turtles, from establishing nests in habitats types predominated by this invasive plant (USAF, 2017).

Ruderal vegetation is found in disturbed or altered habitats that typically receive occasional mowing or other disturbance. Since disturbance and habitat alteration characterize all areas of the island, the frequency of ground maintenance and mowing activities is the key factor. Ruderal areas support mostly introduced or weedy plant species and are found primarily on Wake Island on semi-improved grounds with. typically, greater than 50% bare substrate of shell, coral, or sand (USAF, 2017).

No federally protected plant species occur on Wake Atoll, but a rare Marshalls bunchgrass (*Lepturus gasparricensis*), endemic to Bokak and Wake Atolls, occurs in the bird nesting area on Wilkes Island (MDA, 2015).

Approximately 34 invasive plants have been noted on Wake Atoll. Several of these species are on the Federal Noxious Weed List, the Hawaii Noxious Weed List, and the Hawaii DLNR Invasive Plant List (USAF, 2015b).

3.3.6.5.2 Potential Impacts: No Action

Current rodent management practices will not have a negative impact on plant communities on Wake Atoll. Rodenticide use is restricted to bait stations in commensal areas and near the marina. There may be some physical disturbance to vegetation from foot traffic, but this will be localized and short-term.

3.3.6.5.3 Potential Impacts: Preferred Alternative

The proposed aerial and ground broadcast applications using B-25W will not result in direct negative effects on native and introduced plants on Wake Atoll. Brodifacoum binds to soil and is not considered systemic in plants (WHO, 1995). However, in a recent study dosing soil with brodifacoum at 100 g/m^2 or 500 g/m^2 resulted in residues in wheat ranging from 0.012 mg/kg to 0.0436 mg/kg (Miňo et al., 2019). For the study, bait pellets were incorporated into the soil and allowed to degrade releasing brodifacoum into the soil. The removal of bait by Pacific rats and other nontarget species suggests that long term exposure of plants to brodifacoum in soil is unlikely. Brodifacoum residues in soil that could result in plant uptake are more likely to occur on Peale Island because bait removal is likely to be less than Wilkes Island and Wake Island. The use of a weather-resistant pellet formulation, removal of pellets by Pacific rats, and the anticoagulant mode of action of brodifacoum suggests no direct effects on terrestrial plants will occur. Outdoor use of alternative rodenticides would be highly localized and unlikely to cause negative short- or long-term effects on plants.

In areas where ground broadcast applications are made there will be minor physical effects on plant ground cover due to foot traffic by workers making applications or by driving vehicles off established roads; however, these effects will be short-term. Similarly, the potential for physical disturbance from post-eradication activities such as alternative rodenticide use, monitoring. and implementation of the biosecurity monitoring plan will be minor, with potential localized and short-term effects to the plant communities on Wake Atoll. The biosecurity plan will have long-term beneficial effects to terrestrial plant communities by reducing the potential for future invasive species introductions on Wake Atoll and providing a response when these types of incursions occur.

The eradication of the Pacific rat from Wake Atoll would be expected to benefit native plant communities in the long-term by reducing herbivory and benefit efforts to remove invasive plant species on Wake Atoll. Wolf et al. (2018) demonstrated increases in native and non-native plant recruitment after a rat eradication project to remove the black rat. Increases in invasive plants post- eradication may require active management of those plant species to fully realize the benefits to native species.

The USAF is currently removing the invasive ironwood from Wake Atoll. The management plan for invasive plant removal on Wake Atoll notes that the Pacific rat consumes fruit from ironwood (USAF, 2015b). Dispersal of seed from the fruits would hinder invasive plant management activities by the USAF. Dispersal of other invasive plant species by the Pacific rat on Wake Atoll would also cease after successful eradication. Reductions in seed dispersal due to the Pacific rat would facilitate invasive plant removal by the USAF and strengthen any native plant restoration efforts.

3.3.6.6 Marine Mammals

3.3.6.6.1 Baseline Conditions

Several marine mammal species may occur nearshore or offshore at Wake Atoll that are protected under the Marine Mammal Protection Act (MMPA) (Table 12). Although not considered a marine mammal for Wake Atoll, the Hawaiian monk seal (*Monachus schauinslandi*), an endangered species, was reported on a beach once. The range of this species is the Hawaiian Islands and Johnston Atoll and its appearance at Wake Atoll is considered an anomaly. None have been seen for more than several decades and are not expected to be present near Wake Atoll.

Populations of the common bottlenose dolphin are considered vulnerable by the IUCN. The common bottlenose dolphin occurs in both offshore and coastal waters, including harbors, bays, gulfs, and estuaries of temperate and tropical waters. The other species have stable populations and typically occur offshore in deeper waters. Population assessments, distribution data and information about life history of marine mammals protected under the MMPA and ESA can be viewed at the NOAA site (Find a Species | NOAA Fisheries).

Table 12. Nearshore marine mammals that may occur at Wake Atoll.

Common name	Scientific Name	IUCN[1] Red List
Common Bottlenose Dolphin	*Tursiops truncatus*	Vulnerable
Common Minke Whale	*Balaenotera acutorostrata*	Least Concern
Bryde's Whale	*Balaenoptera brydei*	Least Concern
Short-finned Pilot Whale	*Globicephala macrohymchus*	Least Concern
Risso's Dolphin	*Grampus griseus*	Least Concern

Common name	Scientific Name	IUCN[1] Red List
Pantropical Spotted Dolphin	*Stenella attenuata*	Least Concern
Spinner Dolphin	*Stenella longirostris*	Least Concern
Dwarf Sperm Whale	*Kogia sima*	Least Concern
Cuvier's Beaked Whale	*Ziphius cavirostris*	Least Concern

[1] International Union for Conservation of Nature

There are also marine mammals that may occur well offshore from Wake Atoll and are protected under the MMPA and ESA (Table 13). The primary threats to these whale species are vessel strikes, entanglement in fishing gear, and ocean noise. Other threats include climate change, marine debris, and environmental contaminants.

Table 13. Offshore marine mammals protected under the Endangered Species Act.

Common name	Scientific Name	IUCN[1] Red List/ESA listing
North Pacific Right Whale	*Eubalaena japonica*	Endangered/Endangered
Sei Whale	*Balaenoptera borealis*	Endangered/Endangered
Blue Whale	*Balaenoptera musculus*	Endangered/Endangered
Fin Whale	*Balaenoptera physalus*	Vulnerable/Endangered
False Killer Whale[2]	*Pseudorca crassidens*	Near Threatened/Endangered
Sperm Whale	*Physeter macrocephalus*	Vulnerable/Endangered

[1] International Union for Conservation of Nature
[2] Main Hawaiian Island Insular

3.3.6.6.2 Potential Impacts: No Action

Current rodent management activities will not result in negative effects on marine mammals that are protected under the MMPA and ESA. All applications are made using bait stations on Wake Atoll in localized areas with no possibility of rodenticide reaching the marine environment.

3.3.6.6.3 Potential Impacts: Preferred Alternative

Implementation of the proposed alternative will not result significant effects on marine mammals, including those protected under the MMPA and ESA. Brodifacoum-containing pellets that enter the marine environment break down rapidly with remaining brodifacoum residues being diluted and mixed by wave action in the ocean. Brodifacoum will also partition to suspended solids and sediment where it will slowly degrade. The amount of brodifacoum that would reach the marine habitats of whales offshore from Wake Atoll would be negligible based on the application sites proposed for treatment and mitigation measures designed to protect marine environments (Section 2.3.7.1). Secondary exposure to brodifacoum from consumption of food items would also not result in short-term or long-term adverse effects.

The use of post-eradication treatments such as trapping and alternative rodenticides will have no short-term or long-term effects on marine mammals that occur near shore or offshore at Wake Atoll. Their use will be localized and would not occur in proximity to marine environments that could result in runoff of rodenticides in significant quantities. Bromethalin may be used in elevated or floating baits stations in lagoon habitats periodically inundated with water but uses would be minor with no expected effect on marine mammals. The implementation of the monitoring plan and biosecurity plan will also not result in any risk to marine mammals.

There is a very low risk of vessel strike to marine mammals from the proposed eradication. Equipment and supplies for the eradication may be delivered by an ocean-going vessel to Wake Atoll. The ship may encounter marine mammals during the trip. Strike avoidance measures would be in place to avoid the risk of vessel strikes to marine mammals. NOAA provides guidance on minimizing the potential for vessel strikes of marine life (Understanding Vessel Strikes | NOAA Fisheries). During the transportation of supplies and materials, vessels should monitor and adjust speeds to no more than 10 knots in the presence of protected marine species and ship captains should maintain at least a 100-yard (yd) (91.4 m) buffer around species encountered at sea.

3.3.6.7 Sea Turtles

3.3.6.7.1 Baseline Conditions

Five sea turtle species, all of which are protected under the ESA may occur at Wake Atoll. The threatened green sea turtle (*Chelonia mydas*) is regularly observed in the nearshore ocean, lagoon and near the marina on Wake Atoll. The lagoon and the channel between Peale Island and Wake Island are considered sensitive habitat for the green sea turtle due to the frequency of activity observed in the area. NMFS has also identified the endangered hawksbill sea turtle (*Eretmochelys imbricate*), loggerhead sea turtle (*Caretta caretta*), the South Pacific Distinct Population Segment (DPS), leatherback sea turtle (*Dermochelys coriacea*), and the threatened olive ridley sea turtle (*Lepidochelys olivacea*) as species that could be found at Wake Atoll. These four species have not been observed in recent surveys and none of the five species are known to nest on Wake Atoll (USAF, 2017). An old turtle crawl was noted on Wake Atoll in 2015 on the beach in an area associated with ironwood. Crawls happen when nesting females come onto a beach and leave tracks. Roots and vegetation associated with ironwood make this beach habitat unsuitable for turtle nesting.

3.3.6.7.2 Potential Impacts: No Action

Current rodent management activities would not impact sea turtles since the use of bait stations is localized and no applications would occur where bromadiolone could reach the marine environment.

Various rat species have been shown to impact nesting sea turtles through direct predation of turtle eggs and hatchlings (Meier and Varnham, 2004; Gronwald et al., 2019). Sea turtles have not been observed nesting on Wake Atoll. Therefore, no impact is anticipated from the continued presence of the Pacific rat on Wake Atoll. If Wake Atoll is used for nesting by sea turtles in the future, then the presence of the Pacific rat would impact those nests.

3.3.6.7.3 Potential Impacts: Preferred Alternative

The use of brodifacoum will not result in adverse effects on sea turtles that may occur in and around Wake Atoll. Currently, the only turtle species that has been observed with any frequency at Wake Atoll is the green turtle. The other four species of sea turtles that could occur near Wake Atoll have not been reported in recent surveys. Turtles that may be present in the lagoon or surrounding waters will not be exposed to significant residues of brodifacoum. Limited data on brodifacoum effects on turtles shows low toxicity. Mauldin et al. (2020) administered brodifacoum to painted wood turtles (*Rhinoclemmys pulcherrima*) twice over a seven-day period and monitored for acute and sublethal impacts for 14 days. Wood turtles

administered the low (160 micrograms/milliliter (µg/mL)) and high dose (1605 µg/mL) did not exhibit acute lethal or any sublethal effects. Both concentrations exceeded the solubility limit for brodifacoum in water and would not occur in seawater.

In another study, painted wood turtles were fed high brodifacoum doses receiving 2.5 x 10^{-5} ounces (oz)/lb. (1.6 mg/kg) of turtle body weight of brodifacoum. No turtles died or showed signs of ill health prior to being euthanized one week later. The turtle with the highest liver residue level (2.02 ppm) weighed 0.7 lbs. (319 g), which means that it received about 500 ppm (0.5 mg) of brodifacoum. Since a Brodifacoum-25D pellet contains 25 ppm, the turtle essentially received the equivalent of 20 pellets (USFWS, 2011).

Mitigation measures designed to protect aquatic habitats, the environmental fate of brodifacoum, and dilution of any brodifacoum residues that may occur in marine habitats, will result in residues that will have no short-term or long-term effects on sea turtles. Post-eradication use of alternative rodenticides will not have any short- or long-term effects on turtle populations. The use of alternative rodenticides will be localized, temporary, and no applications made to areas where rodenticide could be transported to the marine environment. Bromethalin may be used in elevated or floating baits stations in lagoon habitats periodically inundated with water but uses would be minor with no expected effect on sea turtles.

There is a very low risk of vessel strike to sea turtles from the proposed eradication. Sea turtles are vulnerable to vessel strikes, as they surface to breathe, bask near the surface, or forage in shallow areas or on prey near the sea surface. Equipment and supplies for the eradication may be delivered by an ocean-going vessel to Wake Atoll. The ship may encounter sea turtles during the trip. Strike avoidance measures would be in place to avoid the risk of vessel strikes to sea turtles. NOAA provides guidance on minimizing the potential for vessel strikes of marine life (Understanding Vessel Strikes | NOAA Fisheries). During the transportation of supplies and materials, vessels should monitor and adjust speeds to no more than 10 knots in the presence of protected marine species and ship captains should maintain at least a 100 yd (91.4 m) buffer around species encountered at sea.

Physical disturbance of nests from the proposed eradication treatments, monitoring, or implementation of the biosecurity plan are not anticipated, since turtles have not been observed nesting on Wake Atoll. If sea turtles or sea turtle nests are observed on Wake Atoll during or after the eradication, workers will avoid disturbing any individuals or nests.

Removal of the Pacific rat from Wake Atoll will result in positive impacts to turtles that could use the island for nesting in the future. Turtle hatchlings would not be susceptible to predation by the Pacific rat and would have a greater probability of survival as eggs and hatchlings.

3.3.6.8 Marine Fish

3.3.6.8.1 Baseline Conditions

Wake Atoll is home to large populations of a diversity of marine fish species. Surveys indicate over 230 species occur in the waters near Wake Atoll, with large populations of the Napoleon wrasse, various shark species, and the humphead parrotfish (Appendix K). Three species that may occur at Wake Atoll have depleted populations and are federally listed as threatened under the ESA (Table 14).

Wake Atoll is surrounded by a 200-mile United States Fishery Conservation Zone, that is part of the PRIMNM where fishery resources are managed by NMFS in consultation with the USFWS. The Western

Pacific Regional Fishery Management Council has developed a Fishery Ecosystem Plan (FEP) that establishes an ecosystem approach for fisheries management. Additional information about the management of these resources by the council is contained in the final report entitled "Fishery Ecosystem Plan for the Pacific Remote Island Areas" (WPRFMC, 2009).

Table 14. Federally listed fish species that may occur at Wake Atoll.

Common name	Scientific Name	IUCN[1] Red List/ESA listing
Scalloped Hammerhead Shark Indo West Pacific DPS	*Sphyrna lewini*	Critically Endangered/Threatened
Oceanic Whitetip Shark	*Carcharhinus longimanus*	Critically Endangered/Threatened
Giant Manta Ray	*Manta birostris*	Endangered/Threatened

[1] International Union for Conservation of Nature

3.3.6.8.2 Potential Impacts: No Action

Current rodent management practices do not impact marine fish populations on Wake Atoll. Rodenticide use is limited to the use of bromadiolone in bait stations in commensal areas and near the marina. Bait stations are not placed where tidal fluctuations could carry rodenticide into the surrounding marine environment where fish are present.

3.3.6.8.3 Potential Impacts: Preferred Alternative

Direct impacts to marine fish populations are not expected under the preferred alternative. Brodifacoum is highly toxic to freshwater fishes based on available acute toxicity data. Acute LC_{50} values range from 0.024 mg/L for the rainbow trout (*Oncorhynchus mykiss*) to 0.12 mg/L for bluegill *(Lepomis macrochirus*) in 96-hour acute exposure toxicity tests. Toxicity data for marine species is limited; however, available data for freshwater fishes shows that brodifacoum could be toxic to marine fishes. Riegerix et al. (2020) exposed the marine fish species, red-toothed triggerfish (*Odonus niger*) and black triggerfish (*Melichthys niger*), to brodifacoum using a single intraperitoneal injection. These types of exposures have limited use in risk assessments due to method of administration of the test chemical, but the study demonstrated that brodifacoum toxicity is similar between marine and freshwater fish species when dosed using similar methods. The study originally tried oral exposures; however, neither fish species would consume bait pellets. Fish were also dosed with brodifacoum using oral gavage but regurgitated the bait pellets. This suggests that these fish species will not preferentially consume bait pellets that inadvertently enter the marine environment.

Howald et al. (2009) also reported that bait pellets were not consumed by fish or aquatic invertebrates after rodenticide applications on Anacapa Island. However, other studies have shown that fish will consume bait pellets. USFWS (2019) reported that bait material or a pyranine biomarker were observed in specimens of pinktail triggerfish (*Melichthys vidua*), black triggerfish, stocky hawkfish (*Cirrhitus pinnulatus*), and blue-lined snapper (*Lutjanus kasmira*) immediately after brodifacoum applications. No evidence of bait consumption was found in blacktail snapper or blotcheye soldierfish (*Myripristis berndti*). Empson and Miskelly (1999) reported that three species of fish were seen eating non-toxic bait within 15 minutes of entering the marine environment in a rodent eradication project on Kapiti Island. Bait consumption by marine fish appears to be species dependent and based on the availability of the pellet, which is short-term.

Brodifacoum-containing pellets that enter the marine environment break down rapidly with remaining brodifacoum residues being diluted and partitioning to suspended solids and sediment, where brodifacoum will slowly degrade. The amount of brodifacoum that could enter the marine environment is expected to be very low from the proposed applications based on the application sites proposed for treatment and mitigation measures designed to protect aquatic resources (Section 2.3.7.1). Exposure and risk to marine fish species from brodifacoum residues in water or sediment is expected to be negligible.

Secondary exposure to brodifacoum may occur for marine fish species that feed near shore. Masuda et al. (2015) evaluated eleven previous accounts of residue examination of coastal marine species following aerial applications of brodifacoum bait and found the overall rate of residue detection was 3.1% for fish (2 of 65 samples tested) and 5.6% for marine invertebrates (11 of 196 samples tested). The risk to marine fish from secondary exposure to brodifacoum is low based on the low frequency of detection in potential prey items. The risk to marine fish from secondary exposure will decrease over time as brodifacoum is metabolized and degraded in the marine environment.

The use of alternative rodenticides will pose negligible risk to marine fish species. Use will be localized and not occur in proximity to marine environments that could result in the runoff of rodenticides. Bromethalin may be used in elevated or floating baits stations in lagoon habitats periodically inundated with water. Bromethalin is highly toxic to fish based on standardized acute freshwater toxicity testing studies (USEPA, 2016). The exposure to marine fishes from bromethalin use will be negligible based on its proposed use pattern and minor use with no expected effects to marine fish. Trapping will have no effects on marine fish. The environmental monitoring plan may include the collection of some fish for tissue residue analysis; however, the number of fish will be low and not result in any short-term or long-term effects on marine fish populations on Wake Atoll. The collection of any marine fish for monitoring will be permitted by the USFWS under a research and monitoring special use permit. Implementation of the biosecurity plan will not result in negative effects on marine fish populations.

3.3.6.9 Marine Invertebrates

3.3.6.9.1 Baseline Conditions

Wake Atoll is home to various marine invertebrates including many coral species that can occur in different habitats (Appendix L). Coral species that occur on the island can be broadly classified into one of four groups. The most dominant group is the scleractinian corals commonly referred to as “stony” or “hard” corals. These corals can be solitary or occur in colonies and are composed of the aragonite form of calcium carbonate. The next most common group is the octocorallia referred to as the “soft corals”. The other two less common groups are the hydrozoan and zoanthid corals. Additional information about corals can be viewed at the NOAA site (Find a Species | NOAA Fisheries).

In 2014, NOAA published a final decision listing 22 coral species in the Federal Register (FR). Four species of coral that are listed as threatened under ESA may occur on Wake Atoll (Table 15).

Table 15. Federally listed coral species that may occur at Wake Atoll.

Scientific Name	IUCN[1] Red List	ESA listing
Acropora globiceps	Vulnerable	Threatened
Acropora jacquelineae	Vulnerable	Threatened
Acropora speciose	Vulnerable	Threatened
Euphyllia paradivisa	Vulnerable	Threatened

[1] International Union for Conservation of Nature

In November 2020, NOAA published proposed critical habitat (CH) designations for seven threatened Indo-Pacific corals including the four species that may occur on Wake Atoll (NMFS, 2020). The area of proposed CH is approximately 230 square miles and contains physical features essential to the conservation of the seven species listed in the notice. Wake Atoll encompasses the proposed CH but is not part of the designation.

The ESA Section 4(a)(3)(B(i) directs the Secretary of the Interior to not designate CH for any lands or other geographical areas owned or controlled by the DoD that are subject to an INRMP that provides a benefit to the species where CH is proposed. The USAF has completed an INRMP that includes conservation measures to protect coral species associated with the island. NOAA recently rated the health of coral population on Wake Atoll as "fair" meaning a moderate decline or moderate impacts related primarily to the effects from climate change (NOAA, 2018).

The most common marine macroinvertebrate in the lagoon is the giant clam which is usually found on hard substrates and in greater abundance on steep sloped substrates. Other macroinvertebrates that occur in lower numbers include the slipper lobster (*Scyarides* sp.), cowries (Cypraeidae sp.), and seastars (*Linkia* sp). Several other benthic organisms are present in the lagoon. Common species include sea cucumber (Holothuria – Chirodotidae spp.), snails (Turridae spp.), clams (Tellinidae spp.), acorn worms (Hemichoradata – Enteropneusta spp.), and mantis shrimp (Stomatopoda – Squillidae spp.) (USAF, 2009).

3.3.6.9.2 Potential Impacts: No Action

Current rodent management practices do not impact marine invertebrate populations on Wake Atoll. Rodenticide use is limited to the use of bromadiolone in bait stations in commensal areas and near the marina. Bait stations would eliminate any runoff potential and are not placed where tidal fluctuations could carry the bait stations and rodenticide into the surrounding marine environment where marine invertebrates are present.

3.3.6.9.3 Potential Impacts: Preferred Alternative

Implementation of the preferred alternative is not expected to have negative short term or long-term impacts to marine invertebrates that occur at Wake Atoll. Brodifacoum is considered toxic to aquatic invertebrates based on the available toxicity data for the freshwater cladoceran, *Daphnia magna*. The reported median effective concentrations (EC_{50}) in a 48-hour exposure range from 0.24 to 0.88 ppm (USEPA, 1991; EU, 2016). Marine invertebrate toxicity data is unavailable however brodifacoum is considered toxic to marine invertebrates, including corals, based on available studies for freshwater

invertebrates. Available toxicity data for other pesticides show that coral sensitivity is within the range of other aquatic freshwater and marine invertebrate toxicity data for various insecticides, herbicides and fungicides (van Dam et al., 2011; Flores et al., 2020). The toxicity to aquatic invertebrates is high but the expected brodifacoum residues and risks to the marine environment will be very low based on the application sites proposed for treatment and mitigation measures designed to protect marine environments (Section 2.3.7.1). Furthermore, any brodifacoum-containing pellets that enter the marine environment will become saturated and break down rapidly, with remaining brodifacoum residues being diluted and partitioning to suspended solids and sediment, where brodifacoum will slowly degrade resulting in low risk to marine invertebrates. USFWS (2019) reported no impacts to coral species associated with the rat eradication project on Palmyra Atoll. The eradication project on Palmyra Atoll used maximum application rates (84.8 kg/ha), which was higher than those proposed for Wake Atoll (≤50 kg/ha).

Brodifacoum residues could potentially accumulate in marine invertebrates. Masuda et al. (2015) evaluated eleven previous accounts of residue examination of coastal marine species following aerial applications of brodifacoum bait and found the overall rate of residue detection was 5.6% for marine invertebrates (11 of 196 samples tested). The sublethal and chronic effects from these types of exposures to marine invertebrates is unknown; however, the frequency of detection is low, suggesting no population level effects to marine invertebrates.

Brodifacoum residues would be higher in small isolated waterbodies that occur on Wake Atoll since the dilution factor is less than what would be seen in the lagoon and ocean facing coastline. The risk to aquatic invertebrates that use these wetland habitats would be higher for sediment dwelling invertebrates due to the chemical and environmental fate characteristics of brodifacoum. Brodifacoum toxicity to benthic invertebrates is expected to be comparable based on available freshwater invertebrate toxicity data. The risks to benthic invertebrates are likely low due to the reduced bioavailability that may occur as brodifacoum binds tightly to soil and sediment (EPA, 2020d). Any impacts to sediment-dwelling invertebrates would be short- and long-term due to the persistence of brodifacoum.

The use of trapping and alternative rodenticides will not have any significant short or long-term effects on marine invertebrates. Their use will be localized and will not occur in proximity to marine environments that could result in runoff of rodenticides. Bromethalin may be used in elevated or floating baits stations in lagoon habitats periodically inundated with water. Bromethalin is highly toxic to aquatic invertebrates based on the acute EC_{50} value for the freshwater cladoceran, *D. magna* (EC_{50} = 5.53 µg/L) (USEPA, 2016). Exposure to marine invertebrates from bromethalin use is negligible based on its use pattern and anticipated minor use with no expected effects to this group of nontarget species. The environmental monitoring plan may include the collection of some marine invertebrates for tissue residue analysis; however, the number of marine invertebrates collected will be low and would not result in any short-term or long-term effects on marine invertebrates. The collection of marine invertebrates will be permitted by the USFWS under a research and monitoring special use permit. Implementation of the biosecurity plan will not result in effects on marine invertebrates.

3.3.6.10 Marine Plants and Algae

3.3.6.10.1 Baseline Conditions

Several species of large algae or seaweed are present within the lagoon at Wake Atoll. Most common is green algae (Chlorophyta), which is present on hard substrates. Prostrate sea cactus (*Halimeda opuntia*), a genticulate coralline algae (Corallinales), and sea grapes (*Caulerpa racemosa*) are also common in the

lagoon. Other documented species include finger algae (*Neomaris annulata),* saw-tooth algae (*Caulerpa serrulata),* green bubble algae *(Dictyosphaeria cavernosa),* and brown algae (*Dictyota* sp) (USAF, 2009; USFWS, 2018).

3.3.6.10.2 Potential Impacts: No Action

Current rodent management practices do not impact marine plant and algae populations on Wake Atoll. Rodenticide use is limited to bromadiolone in bait stations in commensal areas and near the marina. Bait stations are containers that hold the rodenticide eliminating the potential for runoff potential. Bait stations are not placed where tidal fluctuations could them and rodenticide into the surrounding marine environment.

3.3.6.10.3 Potential Impacts: Preferred Alternative

Implementation of the preferred alternative will not have significant negative short-term or long-term effects on marine plant and algal species that occur at Wake Atoll. Expected residues in the marine environment from the proposed brodifacoum broadcast ground and aerial applications will be negligible due to the application sites proposed for treatment and mitigation measures designed to protect marine environments. Any brodifacoum-containing pellets that accidentally enter the marine environment will become saturated and break down rapidly. After pellets degrade the remaining brodifacoum residues are mixed and diluted in the surrounding waters due to tidal action and will also bind to suspended solids and sediments, where brodifacoum will slowly degrade. Brodifacoum is considered toxic to algae with a reported median effective concentration (EC_{50}) of 0.04 ppm for the microalga, freshwater green algae (*Raphidocelis* (formerly *Pseudokirchneriella) subcapitata*). The effects were based on negative impacts to growth in a 72-hour exposure toxicity study (EU, 2016). Algal species that occur in isolated waterbodies are at greater risk of brodifacoum exposure compared to the lagoon and coastline areas where significant dilution of brodifacoum residues would occur. Previously described mitigation measures will reduce the exposure and risk to algal species that may be present in isolated waterbodies during broadcast applications of B-25W.

The use of alternative rodenticides will pose negligible risk to marine plant and algal species. Their use will be localized and will not occur in proximity to marine environments that could result in rodenticide runoff. Bromethalin may be used in elevated or floating baits stations in lagoon habitats periodically inundated with water but uses would be minor with no effects on marine algae and plants. Trapping, monitoring, and the biosecurity plan will not have any effects on marine plant and algal species on Wake Atoll.

Chapter 4 Compliance with Applicable Regulations and Executive Orders

This chapter summarizes compliance with the regulations and executive orders that are relevant to the proposed alternative. Compliance with NEPA is discussed under the Purpose and Need section of this EA.

4.1 Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act

Section 7 of the ESA and ESA's implementing regulations require Federal agencies to ensure that their actions are not likely to jeopardize the continued existence of Federally listed threatened and endangered species or result in the destruction or adverse modification of critical habitat. The NMFS Pacific Islands Regional Office provided USDA-APHIS with a list of jurisdictional species that should be considered in the evaluation of the impacts to federally listed species under Section 7 of the ESA from the proposed rat eradication (Table 16).

Table 16. NMFS Federally listed species that may occur nearshore and offshore at Wake Atoll.

Common name	Scientific Name	ESA listing	Critical Habitat
Blue Whale	*Balaenoptera musculus*	Endangered	None Designated
Fin Whale	*Balaenoptera physalus*	Endangered	None Designated
Sei Whale	*Balaenoptera borealis*	Endangered	None Designated
Sperm Whale	*Physeter macrocephalus*	Endangered	None Designated
North Pacific Right Whale	*Eubalaena japonica*	Endangered	Designated
False Killer Whale[1]	*Pseudorca crassidens*	Endangered	Designated
Scalloped Hammerhead Shark Indo West Pacific DPS	*Sphyrna lewini*	Threatened	None Designated
Oceanic Whitetip Shark	*Carcharhinus longimanus*	Threatened	None Designated
Giant Manta Ray	*Manta birostris*	Threatened	None Designated
Green Sea Turtle Central South Pacific DPS	*Chelonia mydas*	Endangered	None Designated
Hawksbill Sea turtle	*Eretmochelys imbricate*	Endangered	Designated
Loggerhead Sea Turtle South Pacific DPS	*Caretta caretta*	Endangered	None Designated
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	Designated
Olive Ridley Sea Turtle	*Lepidochelys olivacea*	Threatened	None Designated
Coral sp.	*Acropora globiceps*	Threatened	Proposed
Coral sp.	*Acropora jacquelineae*	Threatened	Proposed
Coral sp.	*Acropora speciosa*	Threatened	Proposed
Coral sp.	*Euphyllia paradivisa*	Threatened	Proposed

[1] Main Hawaiian Island Insular Distinct Population Segment (DPS).

USDA-APHIS is preparing a biological assessment (BA) that will evaluate the potential impacts of the proposed rat eradication program to federally listed species under NMFS jurisdiction. The BA also addresses the potential for impacts to essential fish habitat that is required under the Magnuson-Stevens Fishery Conservation and Management Act. The mitigation measures designed to protect aquatic habitats from the proposed aerial and broadcast applications, the use of a wet bait formulation, and the environmental fate of brodifacoum suggests that the proposed rat eradication program will not result in adverse effects on listed species or essential fish habitat. The use of alternative rodenticides and trapping will have no effect to listed species or essential fish habitat. No federally listed species under USFWS jurisdiction occur on Wake Atoll.

4.2 Federal Fungicide, Rodenticide, and Insecticide Act

USDA-APHIS is the registrant for the B-25W formulation, which is the primary rodenticide that will be used in the Wake Atoll rat eradication program. Like previous island rat eradication efforts, USDA-APHIS will submit a supplemental label to USEPA for the proposed uses on Wake Atoll. The other formulation of brodifacoum that is proposed for use in this EA, as well as alternative rodenticides that may be used in post-eradication applications, all have Section 3 registrations under FIFRA. Bell Laboratories will apply for supplemental labels for the use of brodifacoum blocks and zinc phosphide for the proposed uses on Wake Atoll. All activities related to rodenticide use for the Pacific rat eradication program on Wake Atoll will follow FIFRA regulations, including label requirements. All rodenticides proposed for use on Wake Atoll will have approved labels for the intended use prior to the proposed rodenticide applications.

4.3 Marine Mammal Protection Act

USDA-APHIS considered impacts to marine mammals in this draft EA from the proposed rat eradication on Wake Atoll. The proposed action will not result in the take of any marine mammals that could occur nearshore or offshore on Wake Atoll.

4.4 Clean Water Act

The proposed rodenticide applications require a National Pollution Discharge and Elimination Permit (NPDES) under the CWA. USEPA maintains a Pesticide General Permit (PGP) that allows for discharge of pesticides into water because of pesticide applications. USEPA published a prepublication version of the new PGP on December 14, 2020 that will go into effect in late 2021. USDA-APHIS has contacted USEPA Office of Water (OW) to complete the NPDES permit application process required for the proposed broadcast rodenticide applications on Wake Atoll. USDA-APHIS will submit the application for a permit when the new PGP permit has been finalized and prior to 30 days before the planned rodenticide treatments. The proposed treatments will not occur until the NPDES permit has been approved by USEPA.

4.5 Migratory Bird Treaty Act and EO 13186 Responsibilities of Federal Agencies to Protect Migratory Birds

The USDOI Solicitor's Office issued a binding opinion on December 22, 2017 (Memorandum M-37050) that says that a permit is not required for incidental take of migratory birds under MBTA. USDA-APHIS confirmed that this is the status in correspondence with the USFWS dated October 20, 2020. The USFWS published a final rule on January 7, 2021 regarding the regulations governing take of migratory birds (USFWS, 2021). The final rule was to be effective February 8, 2021 however the USFWS has invited public

comment. USFWS is currently evaluating the final rule to determine its application to incidental take permits under MBTA. USDA-APHIS is working with USFWS, who is a cooperating agency in this project, to minimize impacts to migratory birds and adhere to responsibilities outlined in its MOU under EO 13186. USDA-APHIS will continue to communicate with the USFWS regarding any changes to the final rule and potential requirements for incidental take permits under the MBTA.

4.6 National Historic Preservation Act

USDA-APHIS is working with the Alaska SHPO to prepare the required documentation for Section 106 compliance under the NHPA. USDA-APHIS has determined that the proposed rat eradication project on Wake Atoll will have no adverse effect on historic and cultural resources on Wake Atoll as defined under 36 CFR 800.5(b). USDA-APHIS will request concurrence with its determination and will not proceed with the proposed action until notified by the Alaska SHPO that they concur with the no adverse effect determination.

4.7 EO 13089 Coral Reef Protection

EO 13089 directs Federal agencies to protect and enhance the conditions of coral ecosystems when proposing actions that could result in impacts to these habitats. The proposed action as described in this EA complies with EO 13089.

4.8 EO 13112 Invasive Species as amended 12/08/2016 by EO 13751

EO 13751 directs Federal agencies to control or eradicate invasive species whose introduction causes, or is likely to cause, economic or environmental harm, or harm to human, animal, or plant health. The proposed action as described in this EA complies with EO 13751.

Appendix A. Literature Cited

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Appendix C. List of Terrestrial Wildlife at Wake Atoll

Species	Scientific Name	St	Species	Scientific Name	St
Mammals					
Pacific (Polynesian) Rat	*Rattus exulans*	I	Asian House Rat	*Rattus tanezumi*	I?
Birds					
Common Species			**Uncommon Species**		
Pacific Golden-Plover	*Pluvialis fulva*	R	Cackling Goose	*Branta hutchinsii*	W
Bristle-thighed Curlew	*Numenius tahitiensis*	R	Northern Shoveler	*Spatula clypeata*	V
Ruddy Turnstone	*Arenaria interpres*	R	Eurasian Wigeon	*Anas penelope*	V
Sharp-tailed Sandpiper	*Calidris acuminata*	R	Northern Pintail	*Anas acuta*	V
Wandering Tattler	*Tringa incana*	R	Domestic Chicken	*Gallus gallus*	I?
Gray-tailed Tattler	*Tringa brevipes*	R	Rock Dove	*Columba livia*	I?
Brown Noddy	*Anous stolidus*	R	Lesser Sand Plover	*Charadrius mongolus*	V
Black Noddy	*Anous minutus*	R	Eurasian Whimbrel	*Numenius phaeopus*	V
White Tern	*Gygis alba*	R	Sanderling	*Calidris alba*	V
Gray -backed (Spectacled)	*Onychoprion lunatus*	R	Leach's Storm Petrel	*Oceanodroma leucorhoa*	V
Sooty Tern	*Onychoprion fuscatus*	R	Kermadec Petrel	*Pterodroma neglecta*	V
Red-tailed Tropicbird	*Phaethon rubricauda*	R	Mottled Petrel	*Pterodroma inexpectata*	V
White-tailed Tropicbird	*Phaethon lepturus*	R	Black-winged Petrel	*Pterodroma nigripennis*	V
Laysan Albatross	*Phoebastria immutabilis*	R	Bonin Petrel	*Pterodroma hypoleuca*	V
Black-footed Albatross	*Phoebastria nigripes*	R	Buller's Shearwater	*Ardenna bulleri*	V
Wedge-tailed Shearwater	*Ardenna pacifica*	R	Flesh-footed Shearwater	*Ardenna carneipes*	V
Great Frigatebird	*Fregata minor*	R	Christmas Shearwater	*Puffinus nativitatis*	R
Masked Booby	*Sula dactylatra*	R	Townsend's Shearwater	*Puffinus auricularis*	V
Red-footed Booby	*Sula sula*	R	Bulwer's Petrel	*Bulweria bulwerii*	V
Brown Booby	*Sula leucogaster*	R	Lesser Frigatebird	*Fregata ariel*	V
Accidental Vagrant Mammals and Birds					
Hawaiian Monk Seal (T/E)	*Monachus schauinslandi*	A	Common Snipe	*Gallinago gallinago*	A
Garganey	*Spatula querquedula*	A	Common Sandpiper	*Actitis hypoleucus*	A
Mallard	*Anas platyrhynchos*	A	Greater Yellowlegs	*Tringa melaoleuca*	A
Green-winged (Eurasian)Teal	*Anas crecca*	A	Laughing Gull	*Leucophaeus atricilla*	A
Tufted Duck	*Aythya fuligula*	A	Glaucous-winged Gull	*Larus glaucescens*	A
Pacific Long-tailed Cuckoo	*Urodynamis taitensis*	A	Herald Petrel	*Pterodroma heraldica*	A
Common Goldeneye	*Bucephala clangula*		Sooty Shearwater	*Ardenna grisea*	A
Ruff	*Calidris pugnax*		Intermediate Egret	*Egretta intermedia*	A
Red-necked Stint	*Calidris ruficolilis*	A	Pacific Reef Heron	*Egretta sacra*	A
Dunlin	*Calidris alpina*	A	Eastern Cattle Egret	*Bubulcus coromandus*	A
Pectoral Sandpiper	*Calidris melanotos*	A	Black Kite	*Milvus migrans*	A
Long-billed Dowitcher	*Limnodromus scolopaceus*	A	Sea Eagle sp.	*Haliaeetus sp.*	A
Short-billed Dowitcher	*Limnodromus griseus*	A	Short-eared Owl	*Asio flammeus*	A
Extinct Bird Species					
--	--	--	Wake Island Rail*	*Gallirallus wakensis*	X
Reptiles					
Green Sea Turtle (T/E)	*Chelonia mydas*	R	Common House Gecko	*Hemidactylus frenatus*	I
Hawksbill Sea Turtle (T/E)	*Eretmochelys imbricata*	A	Mourning Gecko	*Lepidodactylus lugubris*	R
Leatherback Sea Turtle (T/E)	*Dermochelys coriacea*	A	Stump-toed Gecko	*Gehyra mutilata*	I?
Loggerhead Sea Turtle (T/E)	*Caretta caretta*	A	Azure-tailed Skink	*Emoia cyanura (impar)*	R
Olive Ridley Sea Turtle (T/E)	*Lepidochelys olivacea*	A	Snake-eyed Skink	*Cryptoblepharus poecilopleurus*	I?
Crabs (Population Parameters Unknown)					
Strawberry Hermit Crab	*Coenobita perlata*	R	Flat Rock Crab	*Percnon planissimum*	R
Dwarf Zebra Hermit Crab	*Calcinus laevimanus*	R	Stone Crab	*Leptodius exaratus*	R
Elegant Hermit Crab	*Calcinus elegans*	R	Hawaiian Crab	*Leptodius sanguineus*	R
Yellow-tip Hermit Crab	*Clibanarius virescens*	R	Marine Crab	*Lydia annulipes*	R
Horned Ghost Crab	*Ocypode ceratophtala*	R	Aerolated Xanthid Crab	*Pilodius aerolatus*	R
Red-eyed Cab	*Eriphia sebana*	R	Pilumid Hairy Crab	*Pilumnus longicornis*	R
Fiddler Crabs	*Uca sp.*	R	Pseudozid Crab	*Pseudozius caystrus*	R
Thin-shelled Rock Crab	*Grapsus tenuicrustatus*	R	Sponge Crab	*Dromia personata*	R
Other Invertebrates (Population Parameters Unknown – many likely introduced)					
Scorpions	Scorpionidae sp.	R	Wake Weevil*	*Rhyncogonus fallax*	R
Jumping Spiders	Salticidae sp.	R	Soft Ticks	Argasidae sp.	R
Larder Beetles	Dermestidae sp.	R	Tiger and Lichen Moths	Arctiidae sp.	R
Rove Beetles	Staphylinidae sp.	R	Leaf Miners	Gracillariidae sp.	R
Click Beetles	Elatridae sp.	R	Wake Plant Bug* (no common	Campylomma wakeana	R
Springtails	*Collembola* sp.	R	Tropical House Cricket	*Gryllodes sigillatus*	R
Biting Midges	Ceratopogonidae sp.	R	Fire Ant	*Solenopsis germinate*	I
Fruit Flies	Drosophillidae sp.	R	Big-headed Ant	*Pheidole megacephala*	I
Wasps	Brachonidae sp.	R	Longhorn Crazy Ant	*Paratrechina longicornis*	I
Wake Parasitic Wasp*	*Eupelmus pacificus*	R	Yellow Crazy (Long-legged) Ant	*Anoplolepis gracilipes*	I
148 Arthropod species identified in 2009 (USFWS 2016) and 4 ant sp. (USAF 2017)					

St. – Status (R-resident; I–introduced resident; V–vagrant; W–winter; A–accidental; X–extinct; ? – possibly extirpated) * Endemic

USFWS 2016 - https://www.fws.gov/nwrs/threecolumn.aspx?id=2147587796

Appendix D. MOU between USDA-APHIS WS, USFWS and Island Conservation

APHIS WS MOU #: 16-7100-0377-MU

ADDENDUM JOINING

U.S. DEPARTMENT OF AGRICULTURE, ANIMAL AND PLANT HEALTH INSPECTION SERVICE, WILDLIFE SERVICES

To The

APRIL 16, 2015 MEMORANDUM OF UNDERSTANDING

Between

U.S. FISH AND WILDLIFE SERVICE

And

ISLAND CONSERVATION

This Addendum joins the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) to the Memorandum of Understanding (MOU) entered into between the U.S. Fish and Wildlife Service (Service) and Island Conservation (IC), hereinafter (the Parties), for the purpose of furthering wildlife conservation and ecosystem management interests and responsibilities for the islands, atolls, and reefs under the jurisdiction of the United States. Each of the Parties has a common interest in protecting, restoring, and managing native populations of plants and animals and island ecosystems impacted by invasive alien species (IAS), including but not limited to, rodents, ants, cats, and plants. The Parties desire to jointly promote an integrated and coordinated approach to these efforts through project implementation, information exchange, education and training, coordination, inventorying and monitoring, and sharing of resources whenever appropriate. The Parties agree that support for approval of IAS eradication projects can be enhanced by providing national level guidance. The Service, at its own discretion, may agree to add additional parties to this MOU, upon the written agreement of both the Service and such additional party, at which time such additional party shall be considered one of "the Parties" to this agreement.

I. AUTHORITIES:

Authority for the Service to participate in this MOU is provided for in the Fish and Wildlife Act of 1956 (16 USC 742, *et seq.*), the Refuge Recreation Act (16 USC 460k, *et seq.*), the Fish and Wildlife Coordination Act (16 USC 661, *et seq.*), the Endangered Species Act of 1973 as amended (16 USC 1531 *et seq.*), and the Migratory Bird Treaty Act (16 USC 703, *et seq.*) and the Letter of Intent in the Subject Matter of Conservation and Restoration of the Insular Ecosystems of the Mexican United States, the United States of America, and Canada (Querétaro, México; Attached).

APHIS/WS has statutory authority under the Act of March 2, 1931 (46 Stat. 1468; 7 U.S.C.426-426b) as amended, and the Act of December 22, 1987 (101 Stat. 1329-331, 7 U.S.C. 426c), for the Secretary of Agriculture to cooperate with States, individuals, public and private agencies, organizations, and institutions in the control of wild mammals and birds that are reservoirs for zoonotic diseases, or are injurious or a nuisance to, among other things, agriculture, horticulture,

forestry, animal husbandry, wildlife, and public health and safety.

II. MISSIONS OF THE PARTIES:

(USDA APHIS, Wildlife Services)
The mission of USDA APHIS Wildlife Services (WS) is to provide Federal leadership and expertise to resolve wildlife conflicts to allow people and wildlife to coexist. WS conducts program delivery, research, and other activities through its Regional and State Offices, the National Wildlife Research Center (NWRC) and its Field Stations, as well as through its National Programs.

United States Fish & Wildlife Service

The Mission of the Service is working with others to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.

III. THE PARTIES AGREE AS FOLLOWS:

Subject to annual evaluations of funding availability by the Parties, and all applicable laws governing such funds, the Parties do hereby agree to continue to work cooperatively to protect, maintain, restore, and enhance native species and island ecosystems, and promote effective management and conservation research by sharing information and other resources associated with conservation management of natural resources as described herein for the term of this agreement. This agreement involves no exchange of funds between the Parties. The terms of this MOU do not obligate the Parties to expend funds not appropriated and administratively allocated for such purposes. The Parties to the MOU retain the right to decline to offer or accept assistance on any project on a case by case basis for any reason.

A. USDA, APHIS, WILDLIFE SERVICES, AND CURRENT AND ANY FUTURE "PARTIES" AGREE TO:

1. Provide professional expertise and services when appropriate, to the Service in relation to IAS management projects on islands to benefit native species, in particular species listed under the ESA and species protected under the MBTA.

2. Provide recommendations and support for on-the-ground restoration efforts in cooperation with the Service, including but not limited to, the development and testing of IAS eradication methods, and habitat and/or species restorations, as appropriate.

3. Support the Service with technical and biological information for programmatic or project-focused federal compliance, i.e., National Environmental Policy Act (NEPA).

4. As appropriate, assist the Service with developing and implementing pre- and post-restoration monitoring on a case-by-case basis in cooperation with local field offices.

5. Assist the Service with identification of strategies and key partners for active restoration and conservation translocation of focal recovery species to islands.

6. Assist the Service in the development, implementation, and evaluation of biosecurity plans, on a case-by-case basis.

7. Promote the partnership and its project activities with coordinated communication and outreach.

B. THE SERVICE AGREES TO:

1. Establish a national island restoration planning effort focused on protection and restoration of ESA listed species, migratory birds, at risk species, and other Service Trust resources by removal of IAS.

2. Identify at a national scale, islands where removal of IAS is feasible and necessary to recover or conserve ESA listed or rare and at risk species, migratory birds and other Service Trust resources negatively impacted by these species.

3. Regularly update the Service's "Priorities for Restoration of Islands Addressing Invasive Species" fact sheet as new data on eradication feasibility, presence of ESA listed or rare species, migratory birds, and other Service Trust resources, and/or new IAS or their impacts are identified.

4. Engage and involve the Parties to the MOU in applicable management, planning, compliance and restoration, research or monitoring of projects on islands, as appropriate.

5. Provide national policy level guidance for restoration efforts and projects.

6. Lead efforts for national compliance requirements (i.e., NEPA) on applicable projects and programs.

7. Assist in the development of Island Restoration education and outreach materials for the general public, the Service, non-governmental organizations, or Congress.

8. Engage and involve all Parties to this MOU, in applicable, restoration, research or monitoring projects and/or planning as appropriate with Service oversight.

9. Provide logistical support for restoration efforts and projects.

10. Establish national level, programmatic guidance for IAS management on islands.

11. Where the Service is the land owner, the Service will make final decisions regarding

management actions on Service properties.

12. Promote shared communications strategies to effectively communicate internally and externally the goals, objectives, benefits and risks, and short-term and long-term species population and ecological outcomes of eradications.

C. THE PARTIES AGREE TO:

1. Share information openly and regularly.

2. Share information based on island distribution data on endangered and threatened species, including ESA listed species and IUCN Red Listed species, to aid in informing conservation management and prioritization of restoration projects through appropriate data sharing agreements.

3. Identify public and private funding opportunities to further shared objectives.

4. Seek resources to implement shared conservation goals and objectives.

5. Identify and institutionalize globally, as appropriate, accepted best practices for IAS removal and island restoration.

6. Develop and establish U.S. focused best management practices in conjunction with globally accepted standards for IAS control.

7. Promote eradication of IAS on islands, consistent with the best available science and best management conservation practices, as a valuable biodiversity conservation management tool.

8. Develop and implement coordinated communications strategies on joint projects.

9. Continually strive to identify opportunities to develop and field test new and innovative approaches and/or tools to remove IAS while minimizing risks to native species and ecosystems during eradications.

10. Open this MOU and all the parts here-in to parties interested in joining this partnership in promoting island ecosystem restoration, subject to the approval of the Service.

11. Work together to identify and collect information that will improve the Parties ability to prioritize potential IAS eradication projects on islands.

12. Jointly develop outreach education strategies and materials that will amplify our common messages about the threat of IAS to Service trust resources and island ecosystems.

13. Collaborate on developing training about compliance requirements, best management practices, and monitoring protocol for Service field staff and conservation partners.

14. Establish a core multi-party project review team that can provide national level guidance and support to local projects and facilitate project review.

V. GENERAL TERMS:

A. This MOU is neither a fiscal nor funds obligation document. Any endeavor involving reimbursement or contribution of funds between the Parties to the MOU will be handled in accordance with applicable laws, regulations, and procedures. Such endeavors, if any, will be outlined in a separate agreement that shall be made in writing by the Parties' representatives and shall be independently authorized by appropriate statutory authority.

B. This MOU will **become effective upon date of final signature and will continue in effect for 5 years** and may be renewed as mutually agreed upon by the Parties. It may be modified or terminated at any time by mutual agreement of the Parties, in writing, or by one of the Parties with sixty (60) days' notice in writing to the other Parties. Nothing in this MOU prevents WS from suspending transmission of data in the event a security breach is suspected.

C. Modifications to this MOU may be proposed by any of the Parties and shall become effective upon written concurrence of all the parties.

D. As stated in the opening paragraph of this MOU, the Service, at its own discretion, may agree to add additional parties to this MOU, upon the written agreement of both the Service and such additional party, at which time such additional party shall be considered one of "the Parties" to this agreement.

For USDA APHIS Wildlife Services
William H. Clay
Deputy Administrator, Wildlife Services

Signature William H. Clay Date 3/29/16
William H. Clay, Deputy Administrator

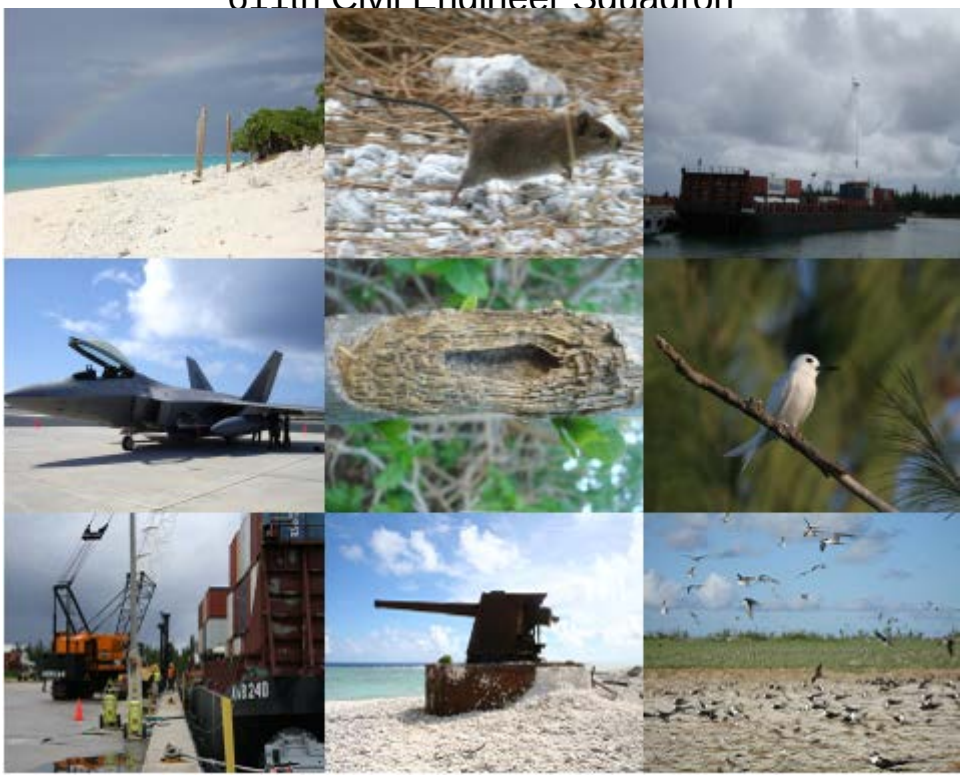
For U.S. Fish and Wildlife Service
Dan Ashe
Director

Signature _____ Date 5/13/16
Name:

WAKE ISLAND BIOSECURITY MANAGEMENT PLAN

Prepared For

The Department of Defense
United States Air Force
Pacific Air Forces Regional Support Center
611th Civil Engineer Squadron



Revised June 2015
Edition 4.0

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Appendices

FOREWARD

The 2012 version of the "Wake Island Biosecurity Management Plan" has been updated to reflect changes impacting the structure of the biosecurity program which is actively managed and implemented by a team of 611th Civil Engineer Squadron staff, remotely embedded support contract staff, and key government collaborators. The preceding version was a pre-requisite milestone associated with the 2012 rodent eradication, which took place in May of 2012. Even though the eradication attempt conducted only resulted in the removal of 1 of the 2 species impacting the atoll (*Rattus tanezumi*), the need for continued implementation of the biosecurity guidance contained within this document is warranted, as are intermittent updates of the plan. The revisions contained herein have been guided by a 30 day public review, internal USAF review, and external natural resource agency (NOAA, USFWS, State of Hawaii) review conducted during the spring of 2015. The processes and procedures detailed within this plan update are applicable to not only the USAF users of the atoll (active duty, civilian, and contract staff) but also to other tenants who use the property on a temporary or long term basis.

EXECUTIVE SUMMARY

A simple definition of biosecurity used by scientific professionals is as follows: protecting an island (or secure area) from a target pest (Browne 2005). Protection can be further divided into operational components such as prevention, detection, and incursion response (Russell 2008). Each of the three components previously mentioned consist of onshore and offshore practices, and when implemented appropriately, are highly likely to result in the successful protection of an island's resources.

The bioseucirty tools utilized during the prevention, detection, and incursion response stages are constantly evolving and researchers have experimented with numerous techniques in an effort to create barriers and inspection processes that are 100% impassable to a wide spectrum of organisms. Unfortunately, a valid biosecurity plan cannot be built upon one component or tool, but rather it must address invasion or re-invasion with an array of barriers and inspection processes that have displayed a high value of efficacy in other scenarios. Practitioners benefit from tailoring their biosecurity plans to the species most likely to re-invade, but in some cases predicting every potential invader is not possible (DON 2015). Given Wake's strong connection to other ports and airfields in the Pacific, in particular Guam and Oahu, the tracking of new incursions at these delivering depots becomes vital and in some cases justification for plan updates. Recent incursions to Oahu (e.g. discovery of Coconut Rhinocerus beetle on Oahu) have resulted in altered monitoring regimes at Wake Atoll, inclusive of the initiation of a trial Coconut Rhinocersus beetle monitoring program. Unfortunately, the discovery of a new invasive species on offshore installations or commercial ports in the Pacific does not result in a reduction of effort, but rather it becomes additive, requiring the biosecurity program to grow and address what management actions shall be implemented to address the new risk. By updating the document to address new risks and management apporoaches, the USAF continues to pledge its commitment to thwart future incursions of invasive species to Wake Atoll and any subsequent receiving installation or port.

The following plan will provide base personnel with a brief history of the island and its unique natural resources, the laws and internal USAF instruction governining biosecurity, applicable invasions routes, incursion prevention guidance, methods and guidance pertaining to interception, detection, and rapid response, and finally a list commonly used biosecurity terms and their definitions.

1.0 WAKE ISLAND BACKGROUND

1.1 Island Location

Wake Island (also commonly referred to as Wake Atoll) is a tiny island lying at approximately 19˚17' 1.854" North latitude and 166˚39' 4.566" East longitude (DATUM WGS 84). It is approximately 2,460 mi. (3956 km) west of Honolulu, 1590 mi. (2,545 km) east of Guam, and 690 mi. (1,140 km) north of Kwajalein Atoll.

1.2 Island History and Previous Management

The islands were first discovered in 1568 by Spanish explorers and then were forgotten for more than 200 years. They were rediscovered in 1796 by the British Captain William Wake and explored in 1841 by U.S. Navy Commander Charles Wilkes and naturalist Titian Peale. The islands were claimed by the United States in 1898, with formal possession established in 1899. In 1899 the United States utilized Wake Island as a cable station; today, Wake Island is an unorganized, unincorporated territory of the United States. Executive Order (E.O.) 11048, Part I (September 5, 1962), designated the Secretary of the Interior responsible for the civil administration of the island. The order gave the Secretary all executive, legislative, judicial authority necessary for that administration other than that of the U.S. District Court for the District of Hawaii (DOI 2015). Because of its unique jurisdictional setting, only federal natural resource and wildlife protection laws apply to Wake Atoll. No state, territorial, or commonwealth natural resource or wildlife protection laws apply (DOI 2015).

The U.S. Navy was given jurisdiction over the islands in 1934 by President Franklin Roosevelt. Development of the islands did not commence until the following year when Pan American Airlines (PAA) received permission to establish a seaplane refueling base on Peale Island. PAA subsequently built a single-story hotel, rainwater catchments, and several other support buildings and structures to support its weekly trans-Pacific flight service.

Plans were developed in 1938 for an outlying military base on Wake Island; however, construction on the atoll for a submarine and seaplane base by the U.S. Navy did not begin until January 1941. U.S. Marines arrived on the base in August 1941, along with a small naval contingent. The base was approximately 65 percent complete and supported a population of over 1,700 civilian and military personnel when the Japanese invaded and overran the island in December 1941. The island was occupied by Japanese forces for the remainder of World War II.

The Japanese continued the development of Wake Atoll during their occupation by constructing a runway, support buildings, and a defense system. Allied planes flew approximately 27 bombing missions on the islands during the occupation. Due to frequent bombing by the United States, many of the Japanese structures were constructed underground or embanked. The islands reverted back to American control in September 1945, after the Japanese surrender and the island was then again placed under the jurisdiction of the U.S. Navy.

In 1947, authority over the islands passed from the U.S. Navy to the Civil Aeronautics Administration, which later became the Federal Aviation Administration (FAA). During this time, contractors for the Military Air Transport Services and later the Military Airlift Command (MAC) provided service to transient USAF aircraft while at Wake Atoll. PAA, Trans-Ocean Airlines, British Overseas Airline Corporation, and others reestablished commercial airline services which lasted until 1972. A U.S. Coast Guard Station was established on Peale Island after the war and abandoned in 1971. Long-

Range Aid to Navigation radar facilities were also established by the Coast Guard on Wilkes Island. During the height of post-WW II use of Wake Atoll, the island population was nearly 2,000. An elementary school had been constructed. The school and many of the houses used by the families have since been torn down because of asbestos problems or have fallen into disrepair.

The development of long-range jet aircraft diminished the need for Wake Atoll as a refueling stop for commercial aircraft and, in 1972, the FAA transferred jurisdiction of its facilities on the islands to the USAF. In the agreement effective June 14, 1972, civil administration authority was transferred from the Federal Aviation Administration (FAA) to the U.S. Air Force. The Atoll was operated as Wake Island Airfield by Det 1, 15th Logistics Group, 15th Air Base Wing, Hickam Air Force Base. In 1993, the USAF terminated its operation of Wake Island but retained real property accountability. The U.S. Army operated the airfield from September 30, 1994 until October 1, 2002 when the USAF resumed direct responsibility for island operations.

Presently, the Pacific Air Forces Regional Support Center (PRSC) based out of Anchorage, Alaska supports Wake Atoll. The installation functions in support of contingency deployments, serves as an emergency landing facility, provides fuel storage, and supports the needs of the greater DoD community. The 611th Civil Engineer Squadron (CES) is responsible for the management of natural resources including biosecurity. The civilian contractor responsible for base operations at Wake Island, including biosecurity support, is Chugach Federal Solutions Inc. (CFSI), also referred to as the Base Operating Support (BOS) contractor. CFSI also participates and supports offshore biosecurity actions, in particular the loading of intercepting tools into containers bound for Wake atoll.

1.3 Current Island Management

The main mission of Wake Island is to support CORONET WEST missions. At present, the activities provided under the BOS contract include but are not limited to the following:

- Produce potable water and maintain the reverse osmosis systems.
- Maintain and operate the fuel systems.
- Maintain and operate electrical power generation and distribution.
- Maintain food inventory and consumables - provide 2,100 hot meals/wk with a surge capacity of 3,100 meals/wk.
- Provide temporary billeting services for 80 personnel with a surge capacity of 45 personnel.
- Provide fire protection and emergency services.
- Maintain grounds, building, equipment, and vehicles.
- Provide refuse collection operations where collected domestic/recycled waste is transported to the solid waste disposal site in the 1600-area.
- Maintain all heating, cooling, and air conditioning (HVAC) systems.
- Repair and maintain the electrical grid.
- Maintain channel buoys in the marina.
- Maintain long-range radios and other communications.
- Provide services of a full-time, board-certified medical physician.

The 9,850-ft. runway has recently been repaired and is capable of handling most aircraft. The aircraft ramp is configured with eight fueling hydrants fed from the fuel storage tanks in the 1500-area. Wake Atoll receives an AMC-chartered flight every other Friday from Joint Base Pearl Harbor Hickam carrying temporary contractors and supplies. Weekly chartered flights have been discontinued. Other supplies, large equipment, and JP-5 fuel are transported to Wake Atoll via ocean-going barges; the frequency of vessel arrivals to Wake is contingent on annual need and project composition. On an annual basis,

Wake is visited by at least one re-supply barge and fuel barge. Barges are towed via tug and the barges are loaded primarily with containerized equipment (both 20 and 40 foot sealed containers). Occasionally break bulk items (vehicles, large heavy construction equipment, and oddly shaped cargo) are shipped in addition to containerized cargo. Two transit routes are utilized by commercial barges to reach Wake. Often the barge will begin its voyage from Oahu and steam directly to Wake, however in some cases due to cost, shipping companies have directed barge traffic to Guam first, prior to final delivery at Wake.

Wake Island Airfield has three distinct areas of activity: the airport, the industrial area, and "downtown" (see Figure 1-1). The airport consists of a 9,850-foot runway, supporting taxiways, tarmacs, airport terminal, and various navigational aids. The industrial area includes aviation and airfield maintenance shops, fire and rescue, aircraft fueling support facilities, Civil Engineering, and supply and warehouse buildings. Other industrial facilities in the area include shops, water collection, and distribution centers. The downtown area supports housing, a cafeteria, a laundromat, medical clinic, chapel, and exercise facilities.

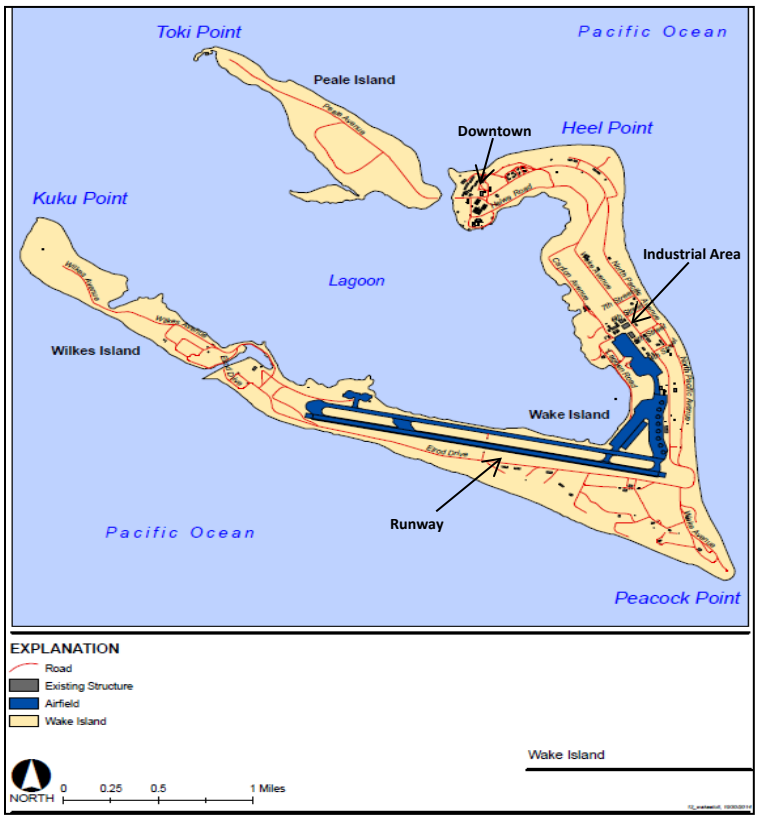

Figure 1-1. Layout of Wake Atoll (*Image Provided by MDA*)

2.0 NATURAL RESOURCES OF WAKE ATOLL

Wake Atoll is home to not only USAF and MDA missions, but also a rich mixture of marine and terrestrial species. Wilkes Island is the location of the atoll's primary seabird colonies, however nesting has been recorded for a variety of avian species on each island. Historical conservation actions have benefited the island's natural resources, in particular the seabirds. It was not until after the feral cats of Wake Island were eradicated that the seabird species richness and population sizes began to increase. In order to track the status and condition of the seabird populations, the USAF funds annual monitoring efforts. Biological surveys have been conducted by the Endangered Species Recovery Council (Ogden 1999), Rauzon and Gilardi (2007, 2008a, 2008b), Pacific Island Research Consortium (PICRA 2008, 2009, 2010), Pacific Rim Conservation (2010, 2011), USFWS (2012), Island Conservation (Pott et al. 2013) and United States Department of Agriculture (USDA) (2014 unpublished data). Survey efforts in some years have focused on biota other than avian species. Non avian monitoring and research has included the following foci: Sea turtle monitoring, intertidal organism population surveys, insect population surveys, invasive rodent eradication planning and research and plant control research (specifically ironwood control).

2.1 Marine Life

The waters surrounding wake have been inventoried by several agencies. The marine waters are home to more than 100 species of coral and a diverse assemblage of pelagic and near shore fishes. In-water survey efforts conducted in 1998 and 2005 provided results which serve as the primary databases for coral species present around the atoll (Kenyon 2013, USFWS 1999). Research efforts have also been extended to include fish and intertidal organisms. USDA fish collection efforts in 2015 assisted with slot size definitions for lagoon species, as well as further documentation regarding the absence or presence of specific compounds within fish tissues. Intertidal surveys conducted in 2009 revealed a diverse array of species and serves as a baseline for future comparisons, should rodents be removed in totality from the atoll (Zabin 2009). The results of the 2009 survey displayed a very rich and diverse array of organisms (see Figure 2-1 below). Marine survey efforts are forecasted in the future (specifically continued coral research and fish population surveys) and will tier off previous survey efforts, so as to ensure changes in population age structure, geography, health, and size are documented appropriately.

Figure 2-1. A sample of species discovered during 2009 Intertidal Surveys (*Image Provided by C. Zabin*)

2.2 Birds

The surveys performed within the previous 15 years have recorded a variety of avian species utilizing Wake Atoll. The shorelines and wetlands provide habitat for a variety of shorebirds and waterfowl, while interior portions of the islands provide refuge for nesting seabirds. Common birds encountered on the atoll are listed in Table 2-1.

TABLE 2-1 COMMON BIRDS OF WAKE ATOLL

Diomedeidae	
Laysan albatross	*Phosbastria immutabilis*
Black-footed albatross	*Phoebastria nigripes*
Procellariidae	
Wedge-tailed shearwater	*Puffinus pacificus*
Christmas shearwater	*Puffinus nativitatus*

TABLE 2-1 COMMON BIRDS OF WAKE ATOLL (CONTINUED)

Fregatidae	
Great frigatebird	*Fregeta minor*
Phaethontide	
White-tailed tropicbird	*Phaethon lepturus*
Red-tailed tropicbird	*Phaethon aethereus*
Sulidae	
Masked booby	*Sula dactylatra*
Brown booby	*Sula leucogaster*
Red-footed booby	*Sula sula*
Laridae	
Black noddy	*Anous minutus*
Brown noddy	*Anous stolidus*
White tern	*Gygis alba*
Sooty tern	*Sterna fuscata*
Grey-backed tern	*Sterna lunata*
Charadiriidae	
Pacific golden plover	*Pluvialis fulva*
Scolopacidae	
Ruddy turnstone	*Arenaria interpres*
Wandering tattler	*Heteroscelus incanus*
Grey-tailed tattler	*Heteroscelus brevipes*
Sanderling	*Calidris alba*
Dunlin	*Calidris alpine*
Sharp-tailed sandpiper	*Calidris acuminate*
Bristle-thighed curlew	*Numenius tahitiensis*
Anatidae	
Pintail Duck	*Anas acuta*

2.3 Other Wildlife

Within the terrestrial ecosystems of the atoll, several small reptiles can be encountered and they include the mourning gecko (*Lepidodactylus lugubris*), house gecko (*Hemidactylus frenatus*), stump-toed gecko (*Gehyra mutilata*), snake-eyed skink (*Cryptoblepharus boutonii*), and azure-tailed skink (*Emoia cyanura*). The snake-eyed skink and stumped toes gecko have not been sighted in recent years, however the remaining aforementioned reptiles are commonly seen.

Aside from two pet cats, the only other mammalian species present on the atoll is limited to the Polynesian Rat (*Rattus exulans*). Rodent eradication efforts in 2012 successfully removed the Asian House Rat (*Rattus tanezumi*) from the atoll, but the Polynesian Rat population survived the eradication effort and has rebounded. As of June 2015, rodents have not been document on Peale Island, suggesting both species have been eradicated from that specific island.

Terrestrial invertebrate populations on Wake Atoll are diverse. In 2009 PICRA completed an arthropod survey resulting in the collection and identification of 148 species (Hebshi et al. 2011). Subsets of the insects discovered in 2009 are considered invasive. For further information pertaining to the wildlife of Wake Atoll, please see "Chapter 5" of the 2015 Integrated Natural Resource Management Plan for Wake Island Airfield, Kokee AFS, and Mt Kaala AFS.

2.4 Threatened and Endangered Species

Federally protected terrestrial biota on Wake Atoll is limited to migratory seabirds and shorebirds. These birds are classified as "migratory" and protected under the Migratory Bird Treaty Act (MBTA) of 1916 (USAF 2012). There is no exclusively terrestrial biota federally listed as threatened or endangered under the Endangered Species Act (ESA), currently or reported from Wake Atoll (USFWS 1998). Sea turtles are present within the waters surrounding wake atoll, and are protected by the ESA, however a confirmed nesting attempt at Wake has never been documented, and thus the island is not considered a prime nesting location for nesting sea turtles.

3.0 IMPETUS FOR BIOSECURITY

The spread of invasive species is now recognized as one of the greatest threats to the ecological and the economic well-being of the planet (IMO 2015). An invasive species is defined by Executive Order (EO) 13112 as a species whose introduction has caused or may cause harm to environmental or human health (NISC 2008). Biosecurity is a concern to the United States government and the world. This plan has been created to help the Air Force carry out their responsibilities for the prevention, rapid response and control of non-native species on Wake Island. As global commerce, trade and travel continue to exist and evolve so will the need and policies of biosecurity management. This section provides a brief introduction to some of the policies and programs that are currently in place that directly or indirectly address non-native species issues on Wake Atoll.

3.1 Non-Native Species Laws, Policies and Protocols

INTERNATIONAL

- The Department of Defense Foreign Clearance Guide (DoD FCG) provides necessary information for aircraft and vessel international mission planning and execution, personnel travel to foreign

countries, as well as general information on foreign locations (including Wake Island). This DoD FCG is directive in nature for all DoD and DoD-sponsored travel abroad; travelers must ensure they comply with this Guide. It is accessible via website: https://www.fcg.pentagon.mil/. It was last updated on 16 March 2015 and is provided within Appendix A for further reading.

- US Pacific Command (USPACOM) Defense Transportation Regulation, (specifically chapter 511), identifies directives and establishes Customs/Border Clearance requirements and procedures and organizational points of contact. This regulation provides the most up to date overseas customs processes (although Wake Island is a US territory it is included within this regulation). A copy of the Wake Island section of the USPACOM Defense Transportation Regulation can be found in Appendix B. It was last updated 15 October 2014 and outlines several key biosecurity requirements shippers must complete prior to arriving to the atoll.

- The International Plant Protection Convention (IPPC) is an international agreement on plant heath with 177 current signatories (signed by the United States in 1951). The IPPC aims to protect cultivated and wild plants by preventing the introduction and spread of pests.

- The International Maritime Organization (IMO) has been at the front of the international effort by taking the lead on addressing the transfer of aquatic invasive species (AIS) through ship. IMO has done this through the adoption of "guidelines adopted in 1997 for the control and management of ships' ballast water to minimize the transfer of harmful aquatic organism and pathogens" (IMO 2011).

NATIONAL

- National Invasive Species Act of 1996 is a reauthorization and amendment to the 1990 Nonindigenous U.S. Aquatic Nuisance Prevention and Control Act of 1990 (P.L. 101-646) which authorized the National Oceanic and Atmospheric Administration and the U.S. Fish and Wildlife Service to address aquatic invaders. Section 1103 of the 1996 act states that the "Secretary of Defense shall implement a ballast water management program for seagoing vessels of the Department of Defense and Coast Guard.

- The Lacey Act combats trafficking in "illegal" wildlife, fish and plants. Amended by the 2008 Farm Bill, the Lacey Act makes it unlawful to import certain plants and plant product without an import declaration (USDA-APHIS 2015).

- The Endangered Species Act of 1973 permits the eradication of non-native species posing a threat to endangered species; furthermore, section 7 of the Endangered Species Act requires Federal agencies to insure that any action authorized, funded or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat.

- EO 13112 which was established to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological and human health impacts that invasive species cause. This executive order defines invasive species, requires federal agencies to address invasive species concerns and to not authorize or carry out new actions that would cause or promote the introduction of invasive species, and also established the Invasive Species Council**.**

AIR FORCE INSTRUCTION (AFI)

- AFI 32-1053, Integrated Pest Management Program. This instruction implements Air Force policy directive (AFPD) 32-10, Installations and Facilities, 27 March 1995, and Department of Defense Instruction (DODI) 4150.7, DOD Pest Management Program, 29 May 2008. The objectives of the AF pest management programs are to meet or exceed DOD pest management Measures of Merit (MoM), and promote and support the following: Military readiness, installation program planning and maintenance, pollution prevention, conservation of natural/cultural resources and environmental compliance and integrated pest management.

- AFI 32-7064, 14.1. Invasive Species Management Policy. Executive Order 13112, *Invasive Species*, February 3, 1999 requires all federal agencies to prevent the introduction of invasive species, provide for their control and minimize their economic, ecological, and human health impacts. Under Executive Order 13112, installations will, to the extent practicable and permitted by law, not authorize, fund, or carry out management actions that are likely to cause the introduction or spread of invasive species. Furthermore, Title 7 U.S.C. §2814 states that each federal agency shall establish and adequately fund an undesirable plants management program through the agency's budgetary process.

- AFI 32-7064, 14.2. Invasive Species Management Program. Address invasive species management in the installation INRMP. Formulate and implement INRMP goals and objectives to detect, respond to, and control populations of invasive species in a cost-effective and environmentally sound manner whenever and wherever practical. INRMP goals should be consistent with the Federal Invasive Species Management Plan and other guidelines promulgated by the Federal Invasive Species Council. The invasive species management element of the INRMP will provide specific information on species to be controlled, recommended control methods, and appropriate level of control effort in consideration of available resources. Promote native habitats and the restoration of native species in ecosystems that have been invaded.

- AFI 32-7064, 14.3. Invasive Species Detection and Monitoring. The INRMP will include a current assessment of the presence and extent of exotic and invasive species on the installation. Conduct surveys to detect and map invasive species. Monitor invasive species populations and update inventory information as new species are discovered and known populations are controlled or eliminated.

- AFI 32-7064, 14.5. Control of Feral Animals. Installations will, to the extent practicable and permitted by law, not authorize, fund, or carry out activities that are likely to cause the introduction or spread of feral dogs, cats, pigs, goats or other non-native domesticated animals on AF-controlled lands. The INRMP will address the specific policies, programs and methods used to control feral animals on AF installations. Feeding or harboring of feral domesticated species is prohibited unless justified in the INRMP as necessary to achieve a specified natural resources management objective. (T-2).

- AFI 32-7064, 14.6. Interagency Cooperation. Title 7 U.S.C. §2814 authorizes cooperative agreements with state agencies for the control of undesirable plant species on federal lands. Partner with other federal, state, and local agencies and adjacent landowners in joint control strategies to collaborate efforts for the control of undesirable species and increase the effectiveness of control measures. (T-0). Installations are encouraged to participate in state or regional Exotic

Pest Plant Councils and Cooperative Invasive Species Management Areas at a level of effort that is commensurate with efforts by the partners and within the legal authority of the AF.

STATE

- Although Wake Atoll is not officially part of the State of Hawaii, it was previously managed by the 15th Air Wing based out of Hickam Air Force Base, Honolulu, Hawaii (as discussed in section 1.2 Island History and Previous Management); currently the Senior Airfield Authority (SAA) for Wake is the 611th Air Operation Center (AOC) with the large majority of access to Wake coming directly from Hawaii. Therefore many of the state laws and regulations that govern and manage invasive species in Hawaii are indirectly applicable to Wake Atoll. The AF currently uses the State of Hawaii list of Invasive and Noxious Weeds as the baseline to determine what is invasive on Wake Island (DPI 2003). The following website depicts a list of species considered to be state listed noxious weeds: http://plants.usda.gov/java/noxious?rptType=State&statefips=15 .

- In 2006, Act 85 amended by Act 109, Session Laws of Hawaii (SLH) 2006, became permanent law in Chapter 194-2, Hawaiian Revised Statues (HRS), and Invasive Species. This law establishes the interagency Hawaii Invasive Species Council (HISC), the purpose of this council is to coordinate and promote efforts to prevent, eradicate or control invasive species and maintain an overview of the issues related to invasive species in Hawaii. The Hawaii State Legislature authorized the creation of HISC under Act 85, SLH 2003, and stated "the silent invasion of Hawaii by alien invasive species is the single greatest threat to Hawaii's economy, natural environment, and the health and lifestyle of Hawaii's people and visitors."

- Invasive Species Committees of Hawai'i (ISCs) are island-based partnerships of government agencies, non-government organizations, and private businesses working to protect our Islands from the most threatening invasive pests, a total of 34 active targets (Hawaii Invasive Species Council, 2009).

3.2 Requirements of the 2009 Environmental Assessment (EA) for Addressing the Systematic Eradication of Non-Native Rodents From Wake Atoll

- The 2009 EA considered the implementation of a biosecurity plan a pre-requisite action. It further defined that should such a plan be implemented to no later than 6 months prior to the application of rodenticide.

- This 2009 EA also stated that the United States Fish and Wildlife Service (USFWS) would not engage in an operation without the existence of a biosecurity plan and more importantly, corresponding action on the ground which includes efficacy testing on a continual basis.

- Other milestones were embedded in the 2009 Operational Plan, which was a component of the EA. These milestones continue to be viewed as pre-requisite actions that shall be monitored for continued implementation. They include but are not limited to the following: the installation of an operational gasifier or incinerator to rid the island of accessible municipal waste which contained edible food items for commensal rodents, proper garden management, and proper waste containment prior to incineration or gasification. These items will remain pre-requisite actions, if a follow on eradication attempt were to be carried out in the future.

4.0 INVASION AND REINVASION ROUTES

The invasion and the reinvasion routes for invasive species accessing Wake Atoll can be described in three pathways: via air, contracted barge or stranded vessel. Cargo containers and break bulk cargo (goods that must be loaded individually, and not in intermodal containers) arriving to Wake via an annual barge departing the Fleet Industrial Supply Center (FISC) at Joint Base Pearl Harbor Hickam (JBPHH) are the biggest concern and threat. Sporadic vessel and air traffic from Guam, specifically Andersen Air Force Base and the Commercial Port of Guam, has resulted in the need to coordinate with USDA – WS to ensure canine teams (trained to detect Invasive Brown Treesnakes) inspect any goods and transportation platforms prior to departure.

4.1 Air

Air transportation guidelines have been created to ensure that all pilots, loadmasters, and flights transiting through Wake are aware of the biosecurity measures applicable to the installation. Guidelines nested within the Defense Transportation Regulations (DTR) and Foreign Clearance Guide (FCG) serve as a primer for crews to read prior to disembarking. Information possessed within the DTR addresses invasive species. The majority of air cargo destined for Wake via air originates at the AMC cargo facility at JBPHH, which is illuminated 24 hours a day for security reasons however this also helps in the detection and, in some cases, as a deterrent of invasive species. The USAF pest control operators issued a high density of traps and bait stations to this area in 2009 (n= 29 stations) in order to heighten the offshore defenses against potential rodent incursions. Pest control shops at JBPHH now fall under Navy control as a result of Joint Basing, thus NAVFAC HI and Navy Region Hawaii manage the financial limits as to what level of control and monitoring can take place on Navy properties.

4.2 Barge

Cargo containers and equipment destined for Wake usually arrive to the FISC in early April of each year and are further shipped to the island using tugs and open aired barges (no engines or quarters are on open aired barges). Rat deflectors, bait stations, traps, and indicators (wax chew blocks, ink cards, and visual inspections) are key elements of offshore prevention that are implemented at the FISC. FISC properties are kept free of weeds and other pest plants, in order to minimize the movement of invasive plants. Further, the FISC wearhouse is cleaned routinely, to ensure harborage for pests is minimized. In 2015, Goodnature traps were purchased in order to trial their efficacy as it pertains to controlling or detecting rodents in the areas.

Threat of invasive species movement via a ship or barge can take place via ballast water and fouled hulls. Ballast water is essential for safe and efficient modern shipping operations, unfortunately it also poses a serious ecological, economical and health threat due to the multitude of marine species being carried in the ballast water. These species may include bacteria, microbes, small invertebrates, eggs, cysts and larvae of various species. If transferred these species may survive to establish a reproductive population in the new host environment, becoming invasive, out-competing native species and multiplying into pest proportions (IMO, Ballast Water Management 2011). Ships and barges arrive at Wake on a more limited basis compared to aircraft, and with a barge comes an associated contract and or written agreement and that is where the AF has its opportunity to mitigate these potential barge threats to the Wake Island ecosystem. Section 5.2 discusses in further detail recommended verbiage for barge contracts.

4.3. Stranded Vessels

Wake also services as an emergency mooring site and harbor for small vessels in distress. Yachts or sailors in distress are required to request access to the installation prior to arrival via radio and rapid response teams will be required to inspect vessels moored to the docks. It is advised that the on-site pest control manager access the vessel, deploy interception tools (traps, bait stations, glue boards, as well as indicators blocks) in the event a rodent lives aboard. Bait stations are staged at the dock on Wake 365 days a year and will be baited appropriately prior to any vessel coming to Wake to target invasive species that may exist in the vicinity. It is advised that rat traps are also placed along travel corridors to increase the diligence of interception probability in the event of a stranded vessel is brought dockside.

5.0 PREVENTION

Prevention of a biosecurity breach is the first line of defense for averting an invasive species threat; other terms commonly used include “offshore biosecurity”. For Wake Island prevention efforts of the spread of invasive species can be broken down into two elements or tasks; Quarantine and Prescreening. Please refer to the most current Defense Transportation Regulation (DTR) part V for Wake Island specific prevention measures.

5.1 Quarantine

In the biosecurity world, quarantine consists of areas and or facilities that are utilized as staging areas for cargo that maintain a high level of pest management at all times. This involves deploying and managing a variety of preventative measures and detection devises that ensure an invasive-free environment. For aircraft this would include the terminal area and baggage holding facilities. The FISC would serve as the “quarantine area” for barge activities. To achieve a level of biosecurity necessary to consider these staging areas to be under “quarantine”, it is recommended that the following activities be conducted on a regular basis at the two aforementioned locales:

- Staging areas shall be illuminated 24 hours a day
- A high density of snap traps and or glue boards should be deployment in tamper resistant bait stations, these should be placed inside and outside of all buildings, (rats prefer to run along the perimeter of building walls rather than across wide gaps, bait stations should be placed along walls and in corners)
- All snap traps and glue boards inside the tamper resistant bait stations should be armed with a professional rat attractant
- If the staging area has a certified pesticide applicator on staff or contracted out, it is highly recommended that an EPA approved rodenticide (poison) be used to arm the tamper resistance bait stations. 2nd generation anticoagulant are suggested and compounds shall be alternated to reduce the occurrence of genetic resistance. Contrac (bromiadialone) is currently in use on JBPHH and is both a DOD and state certified pesticide if used according to the label
- Quality assurance inspections should occur at each staging facility quarterly
- Do not allow vegetation to grow within the confines of the quarantine area.
- Apply EPA approved insecticides to grounds or via stations to combat invasive insects.
- Utilize detection stations (cameras, tracking cards, glue boards) to detect cryptic insects, reptiles, amphibians, and other targets.

5.2 Pre-Screening

As containers baggage and cargo are being staged and prepared to be sent to Wake Island, a biosecurity prescreening inspection of all containers, baggage and cargo should occur. An example of the PRSC biosecurity prescreening inspection form is provided in Appendix C, this particular inspection form does not have to be used but it is recommended. If this USAF inspection biosecurity prescreening inspection checklist is not used, the proposed inspection checklist needs to be submitted to the PRSC, Natural Resources Program Manager for review and approval. All biosecurity prescreening inspection forms must be submitted for record to the PRSC's Natural Resource Program Manager. It is recommended that at a minimum the following biosecurity prescreening activities occur and are accounted for on an inspection form:

- Rat deflector shields or rat guards are to be deployed to every line used to secure the vessel to the dock both on departure and arrival legs (See Figure 5.1). Rat guards shall be placed by ship's company on all mooring lines and other connecting lines such as service lines between the ship, piers, and seawalls immediately upon berthing and during the entire time the vessel lies alongside a pier.

Figure 1-1. Rat Guard (*Image Provided by US Navy*)

- A high density of snap traps and or glue boards are deployment in tamper resistant bait stations along the dock where ships are tied off, in areas where cargo and containers are being staged, and along the inside and outside of all nearby buildings (rats prefer to run along the perimeter of building walls rather than across wide gaps, bait stations should be placed along walls and in corners)
- All closed containers (minus personal luggage) should be inspected for invasive species
- All closed containers must contain a sticky trap, rodent trap, and Dichlorvos-impregnated insect strips
- Inspection of cargo placed inside of each container for the presence of feces, urine stains, chewing, or other signs of incursion.
- Areas used to store equipment prior to departure will be lit 24 hrs a day and inspection strips will be maintained to deter rodents from traveling along preferred corridors.

5.3 Barge Contract Language

To ensure the above mentioned prevention measures are required and carried out, the following recommended verbiage is suggested for usage by Wake USAF project managers and military leaders when planning logistics.

Stipulation 1: Upon arrival at FISC or other loading dock, contracted tug(s) and barge(s) shall grant vessel access to a Government appointed pest control inspector to verify vessels awarded transport contracts do not show evident sign of invasive species infestation. Inspectors shall be appointed by the

611th Civil Engineer Squadron or Detachment 1 Commander. Inspectors shall be granted access to both the tug and barge any time the vessels are tied up to the dock at FISC or Wake Island in order to complete visual inspections.

Stipulation 2: Prior to entering port, equipment, supplies, cargo and waste on ships shall be inspected to avoid the introduction of invasive pests into Hawaii and or Wake Island. All vessels shall, prior to arrival to Hawaii or Wake, comply with DOD 4500.9-R, Defense Transportation Regulation Part V. Documentation of such inspection shall be provided upon arrival.

Stipulation 3: At Wake Island, contracted vessel inspectors should be on site at all times during the off loading activities. Inspectors shall conduct visual inspections to help ensure that items are free of any alien species, such as snakes, insects, lizards, rodents, etc., prior to being offloaded. No invasive species shall be brought ashore at any time.

Stipulation 4: State of Hawaii Department of Agriculture, USDA, Customs and Border Patrol (CBP), or Guam Port Authority inspectors shall be given the ability, if requested, to board US Flag vessels to assist with inspection of food stores, cargo, plants, animals, and garbage.

Stipulation 5: The intentional importation of invasive species that might cause damage to or be injurious or detrimental to agriculture, horticulture, forest of the State or to federally protected, endangered, or threatened species of Hawaii or Wake Island, shall be prohibited.

Stipulation 6: Discovery of invasive species or pest sign (feces, urine, carcass, hair, insect frass, plant seeds, dried vegetation; or an actual specimen) during inspections shall result in vessel delays and extended port stays. The delay period shall thus be referred to as the “emergency quarantine”. If pest sign or an actual specimen (dead or alive) is discovered aboard the barge or tug or external surface of container or cargo, the vessel operator or contractor awarded barge services shall, at their own cost, carry out a vessel wide emergency quarantine action to last at least four days. The Barge operator or awarded party shall incur all costs associated with delays or fees associated with late departure due to vessel operator inability to keep invasive species off their vessel. It is advised that vessels arriving to the FISC carry out invasive species control measures prior to arriving to the FISC so that delays and additional charges are not absorbed by the contracted party.

Stipulation 7: Emergency Quarantine shall consist of the following actions:

- Mandatory usage of bait stations armed with state and federally approved pesticide or trap, depending on the target in question. The Government shall direct barge operator as to which pesticide and trap is suitable for deployment based on the target in question. Barge operators shall submit their emergency quarantine plan to the Government pest control inspector for review and approval and at any time during the quarantine period the inspector shall be granted access to the vessel(s) to ensure the plan is indeed being completed as written. All applications shall abide by EPA approved label directions.
- Fumigants shall be used if the target in question cannot be eliminated via the usage of other tools.
- After completion of Emergency Quarantine actions, all unsealed cargo shall be inspected for fecal matter and incursions by Government appointed pest control inspectors prior to signing off on the success of emergency quarantine actions.
- On the fourth and final day of the quarantine period, Inspectors appointed by the 611th Civil Engineer Squadron or Detachment 1 Commander, shall inspect the vessel and document the efficacy of the treatment.

Stipulation 8: Contractor shall use deterrent devices to ensure vessel equipment does not provide access to the vessel while attached to dock. Vent and scupper openings shall be protected by backing them up with heavy gauge screening to prevent rats from building nests and or accessing vessel.

Stipulation 9: Vessel operators shall grant FISC, Base Operations Support contractor, and US Air Force personnel access to vessels at all times when docked, prior to departure to Wake Island.

Stipulation 10: Every container bound for wake atoll, regardless of original destination, shall possess one rat trap, one glue board, and one pest off strip (containing the active ingredient dichlorvos) prior to being loaded on any barge. Container exteriors shall be clean and free of vegetation or dirt. Power washers shall be utilized for containers which do not possess clean exteriors.

6.0 INTERCEPTION AND CONTROL

By mandating the deployment of container interception tools as described in Stipulation 10 of Section 5.3, interception of rodents, small reptiles, insects, and other invasive species is possible. The aforementioned interception tools are intended to address species which become stowed away in cargo, vessels, or planes. Given the lengthy voyage aboard the barge, interception tools will be enticing to invasive species which are not intercepted or detected at the FISC. USAF civilian and contracted personnel will need to have access to the Navy managed FISC areas, in order to manage interception tools and detection devices or materials.

7.0 EARLY DETECTION AND RAPID RESPONSE (EDRR)

The eradication records from international and domestic islands do indicate that even with a robust quarantine program (including ample deterrent deployment and efficacy monitoring) incursion (a breach; having got past a barrier) is possible and has occurred. The final stage of biosecurity which is used to eliminate an incursion or re-invasion is rapid response. A Rapid Response Team will need to be established and kept up to date to ensure the containment of an alien species once it has been detected. In some cases, the USAF will rely on already developed response programs for providing training and or guidance during response situations.

Often considered the “second line of defense” after prevention, EDRR is a critical component of any the USAF’s invasive species management program. When new invasive species incursions are detected, a prompt and coordinated contamination and eradication response can reduce the environmental and economic impacts (USDA-USFS 2015).

EDRR of new or a reinvasion of invasive species will not only make for a successful biosecurity plan, but will result in lower costs and the utilization of less resources. Properly written contracts for barges and quality assurance will also be key factors for ensuring compliance with a good biosecurity plan occurs; resulting in the most cost efficient program.

Monitoring is the most commonly carried out practice to discover whether or not an incursion has taken place, or a historic action was successful at eliminating the target in question. Track cards, traps, and glue boards also function as detectors and interception tools simultaneously. Wax blocks have been deemed successful for investigating the presence of invasive rodents. This tool has been highly successful for verifying the presence of rodents in both commensal and natural environments and paraffin is sold in 160 degree melting point formulations to allow for its usage in hot environments.

Other detection devices, such as CO2 operated Good-Nature traps were trialed in 2014 by USDA and Colorado State University biologists, but the traps were determined, due to hermit crab populations, to be less effective and not well suited for Wake's outdoor environment. New detection devices and survey methods, aimed at the detection of invasive insects, mammals, and reptiles shall be deployed in 2015, in order to detect the occurrence of species both at cargo and receiving locales.

It is the fear of every biologist to receive word that an incursion has occurred on an island "cleaned" of an invasive species. Rapid response teams must not only identify the incursion, but must act quickly to ensure the target does not give birth, move further away from the inception point, or introduce disease or foreign ectoparasites to an island free of such organisms. Studies have shown the effective nature of rapid response, but failed attempts have been documented which is why the establishment of quarantine, interception, and quality deterrent tools is so vital to a sound biosecurity program and plan. Trained canines have been documented to be effective in the discovery of incursions and elimination of target species. Other forms of rapid response include grid trapping, hand baiting (in accordance with EPA labels), and the establishment of secondary eradication actions (bait station grids). It is a cost exercise to cover large areas, but regardless of the action selected it is has become a standard in the eradication world to ensure that a minimum radial distance of 1 km be used to extend trapping or baiting efforts beyond the point of incursion (Russell 2008). This scale of treatment for trapping or baiting shall also be used for other observed targets, beyond just rodents.

Rapid response kits consist of traps, bait stations, snake sticks, aquariums, flagging and palatable toxic baits; these items are staged at wake atoll in a devoted connex box. The connex box is restricted to environmental staff, ensuring that equipment is not used for other needs. Rapid response training (and re-fresher training) for snakes shall continue to be identified as a requirement for biological staff both on island and sitting remotely in Hawaii. Wake continues to receive barge shipments from Guam, thus this element of the rapid response program is of great concern. As of 2015, only two USAF biosecurity team members (1 civilian / 1 contractor) possess the pre-requisite rapid response training for snake response. The USAF is committed to keeping these two individuals certified with refresher training and if funds are available, increasing the number of trained professionals with the certification as a responder. In 2016, the USAF 611th Natural Resource Project Manager will be attending the DoD Pesticide Applicators Course in order to become a DoD certified pesticide applicator, further increasing the capabilities of the biosecurity program and skill sets deployable during rapid response events.

8.0 BIOSECURITY LANGUAGE

The following language is used by the New Zealand Department of Conservation to define the different elements of biosecurity and applicable stages of a sound plan (Browne 2005).

1) Interception: occurs where a pest is detected in a secured area either on the mainland or island, e.g., quarantine store, wharf, helicopter pad, boat, aircraft, or on the island while unpacking, etc. *Implies: picked up outside a barrier.*

2) Incursion(s): occur where a pest is detected in the wild on an island or steppingstone island. *Implies: a breach; having got past a barrier.*

3) Establishment: implies that enough individuals have been detected that breeding is possible, or evidence of breeding or young is detected.

4) Spread: spread implies that the pest has already spread over the island at the time of detection.

5) Suspicion of invasion: Suspicion of invasion is used where the level of certainty for a possible pest sighting is from:

- a bird-wreck with possible bites or mauls on it having been recovered ;
- a bird-wreck which doesn't necessarily have any bites or mauls on it but from where a pest has been reported in the vicinity; or a second-hand report of a pest on the island.

6) Strait: body of water between islands or an island and the mainland.

7) Pest: An organism which is not wanted on the island or other biologically significant area. Includes both animals and plants.

8) Eradication: Completely remove all living examples of the pest from an island (or operational area).

9) Control: Reduce the numbers of a pest on an island (or within an operational area) to a level where their impact is minimised or mitigated, when measured against an indicator species.

10) Quarantine: Contain the target pest before it reaches the island (or other secure area).

11) Contingency Operation: Containing the target pest once it has arrived on the island (or secure area).

12) Biosecurity: Protecting an island (or secure area) from a target pest. (It encompasses both quarantine and contingency operations.)

13) Surveillance: Active searching for a target pest; it may not involve killing the pest.

14) Neophobia: Fear of new things; reference to rats, cats or other pests experiencing new baits, bait stations or traps within their territory.

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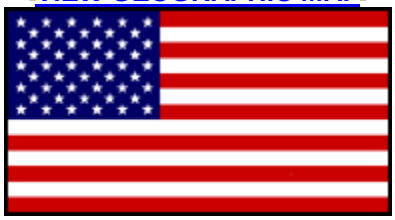
APPENDIX A

DEPARTMENT OF DEFENESE FOREIGN CLEARANCE GUIDE

VIEW GEOGRAPHIC MAP



WAKE ISLAND

Last Modified: 16-Mar-15

General Entry Requirements | Aircraft Entry Requirements | Personnel Entry Requirements for Official Travel | Personnel Entry Requirements for Leave Travel | Maritime Entry Requirements | Travel Information

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SECTION I: GENERAL ENTRY REQUIREMENTS

A. IDENTIFICATION CREDENTIALS FOR OFFICIAL TRAVEL

1. Not applicable.
2. **Consult Section III, below, to ensure compliance with requirements for notification and Theater Clearance.**

B. IDENTIFICATION CREDENTIALS FOR LEAVE TRAVEL

1. Not applicable.
2. **Consult Section IV, below, to ensure compliance with any requirements for Country Clearance, Theater Clearance, and Special Area Clearance (if required).**

C. IMMUNIZATIONS AND OTHER MEDICAL REQUIREMENTS

1. For DoD immunization requirements and sources of additional information on immunization, see the Foreign Clearance Manual, C3.1.3 and C3.2.3.

D. IMMIGRATION, CUSTOMS, OR QUARANTINE INSPECTIONS

1. Pets are not permitted on Wake Island.
2. A rodent eradication effort was conducted in May 2012 and a heightened level of biosecurity to inhibit rodent re-invasion has been implemented. As a result, all cargo entering Wake Island, regardless of origin, is subject to inspection by USAF-appointed inspector at point of departure and upon arrival. Direct inquires associated with invasive species and shipment requirements to the Wake Island Installation Commander via Base Operation at BaseOperations2@wakeisland.net.

E. UNIFORM REQUIREMENTS

1. Not applicable.

F. OTHER

1. None reported.

SECTION II: AIRCRAFT ENTRY REQUIREMENTS

A. CLEARANCE REQUIREMENTS

NOTE 1: Until further notice, USAF use of Wake Island is restricted to contingency operations, emergency diverts, and flights in direct support of activities on the island.

1. Blanket Clearances: None.
2. One-Time Clearances.
    a. Prior permission required (PPR). PPR request procedures and island limitations are published in DoD FLIP Area Planning (AP-3) Pacific-Australia, Antarctica (Oakland FIR-Wake Island).
    b. Wake Island is closed to non-US government aircraft.

B. LEAD-TIME AND VALIDITY

1. Lead-time: 14 days.
2. Clearance valid for: Unstated. For additional information, contact the USDAO.

C. CONTENT OF CLEARANCE REQUEST

1. Not required.

D. ROUTE, FLIGHT, AND OTHER OPERATIONAL INFORMATION

1. Wake Island is currently Day Visual Flight Rules (VFR) only (no lights) due to runway construction.

E. AIRPORTS

1. Enter and depart.

Wake Island/Wake Island Airfield (PWAK)

2. Additional airport information.
    a. Unit mission planners and/or aircrews should refer to the Defense Logistics Agency (DLA) Energy AIR Card System website (Agree with the "Usage Alert" statement by clicking "I agree"; then click on the "FBO Locator" menu on the upper right-hand side of the webpage) for available fuel contract merchants who accept the AIR Card for fuel and/or ground services. Every effort will be made to purchase fuel from the designated contract merchants. Any local merchant that accepts the AIR Card may be used for ground-handling services.
    b. Wake Island airfield is in very limited operations (VLO) status. POL servicing is available (JP-5 only) for emergency recoveries, island resupply flights, and contingency operations. No aircraft maintenance is available.
    c. The airfield on Wake Island operates Tuesday through Saturday 0730-1730 local time. Funding and approvals of other periods requires advance approval and issue of PPR.

SECTION III: PERSONNEL ENTRY REQUIREMENTS FOR OFFICIAL TRAVEL

NOTE 1: In September 2013, US Pacific Command issued the following liberty policy for Service members traveling on temporary duty orders and liberty in the US Pacific Command AOR outside of the United States and its territories. To ensure widest dissemination, travelers are required to acknowledge that they have read the policy when completing the TT/IATP entry.

NOTE 2: US Air Force (USAF) personnel, to include reserve and Air National Guard, must read and understand the additional Commander, PACAF (COMPACAF) requirements while on TDY and/or liberty (pass/leave) in the USPACOM area of responsibility.

A. CLEARANCE REQUIREMENTS

1. Notification of visit to Wake Island.

a. Because Wake Island is US territory, Country Clearance is not required. However, DoD and DoD-sponsored travelers must request entry authorization (EA).

(1) Submit all clearance requests (classified and unclassified) via the Aircraft and Personnel Automated Clearance System (APACS).

2. Theater Clearance.
   a. Theater Clearance is NOT required.
   b. TT/IATP is highly recommended so PACOM can provide traveler with emergency information (i.e., earthquake, tsunami, volcano, riot, political unrest, etc.).
   c. SERE 100 and ISOPREP are NOT required. However, to complete the TT/IATP, travelers will need to insert a valid date - Use 1 January of the current year.
3. Special Area Clearance.
   a. Special Area is not required.
4. Aircrew do not require Personnel Clearance. However, passengers must request Personnel Clearance.
5. The Personnel Clearance requirements in this section apply to official travel only. Refer to Section IV, below, for leave travel. Submit all clearance requests (classified and unclassified) via the Aircraft and Personnel Automated Clearance System (APACS). Note: To avoid delays and EXPEDITE APACS processing, complete Travel Tracker/Individual Anti-Terrorism Plan (TT/IATP) before submitting APACS and enter TT/IATP Entry # in the "Traveler" tab of the APACS request.

B. LEAD-TIME

1. Not applicable.

C. CONTENT OF CLEARANCE REQUEST

1. Prepare and submit the clearance request automatically with APACS at https://apacs.dtic.mil or if classified, https://apacs.dtic.smil.mil.
2. Theater-specific information for inclusion in the “Theater Specific Information” field under “Country Information” on the “Itinerary” tab in APACS: None.
3. Country-specific information for inclusion in the “Country Specific Information” field under “Country Information” on the “Itinerary” tab in APACS: None.
4. If the Travel Clearance Request is classified, include paragraph markings and downgrade instructions to ensure timely processing. See the Foreign Clearance Manual, Figure C3.F1.
5. If personal information is required (e.g., Social Security number, birthplace), include the marking "Personal Data - Privacy Act of 1974."

SECTION IV: PERSONNEL ENTRY REQUIREMENTS FOR LEAVE TRAVEL

NOTE 1: In September 2013, US Pacific Command issued the following liberty policy for Service members traveling on temporary duty orders and liberty in the US Pacific Command AOR outside of the United States and its territories. To ensure widest dissemination, travelers are required to acknowledge that they have read the policy when completing the TT/IATP entry.

NOTE 2: US Air Force (USAF) personnel, to include reserve and Air National Guard, must read and understand the additional Commander, PACAF (COMPACAF) requirements while on TDY and/or liberty (pass/leave) in the USPACOM area of responsibility.

A. CLEARANCE REQUIREMENTS

1. Clearance not required.
2. Theater Clearance.
   a. Theater Clearance is NOT required.
   b. TT/IATP is highly recommended so PACOM can provide traveler with emergency information (i.e., earthquake, tsunami, volcano, riot, political unrest, etc.).

c. SERE 100 and ISOPREP are NOT required. However, to complete the TT/IATP, travelers will need to insert a valid date - Use 1 January of the current year.

3. See IDENTIFICATION CREDENTIALS FOR LEAVE TRAVEL requirements in Section I.B.
4. See IMMUNIZATIONS AND OTHER MEDICAL REQUIREMENTS in section I.C.
5. See IMMIGRATION, CUSTOMS, OR QUARANTINE INSPECTION in section I.D.
6. See OTHER general requirements in section I.F.

B. LEAD-TIME

1. Not applicable.

C. CONTENT OF CLEARANCE REQUEST

1. Not applicable.

SECTION V: MARITIME ENTRY REQUIREMENTS

A. CLEARANCE REQUIREMENTS

1. No information provided.

B. LEAD-TIME AND VALIDITY

1. No information provided.

C. ADDRESSES FOR CLEARANCE REQUESTS

1. No information provided.

Action:
Info:

D. CONTENT OF CLEARANCE REQUEST

1. No information provided.

E. NAVIGATION AND OTHER OPERATIONAL INFORMATION

1. No information provided.

F. OTHER

1. No information provided.

SECTION VI: TRAVEL INFORMATION

A. STATE DEPARTMENT TRAVEL ADVISORIES

1. Travel Warnings: None.
2. Travel Alerts: None.
3. The DoS Bureau of Consular Affairs posts Country Specific Information Sheets as well as Travel Warnings and Travel Alerts at http://travel.state.gov.

B. AMERICAN EMBASSY

1. Location:

a. Wake Island is an unincorporated US territory administered by the Department of the Air Force. Activities on Wake Island are conducted by a BOS Contractor.

2. Telecommunications Contact Information:

a. Phone:

(1) DSN 315-424-2000.

(2) COMM 808-424-2000.

3. Hours: The offices on Wake Island are staffed 24 hours a day.

4. Mailing Address: DET 1, 15AW/CC
APO AP 96518

5. Holidays: Wake Island observes all US holidays except Presidents' Day and Columbus Day. Wake Island also celebrates Wake Island Day (22 March) and the King of Thailand's birthday. In order to sync with US Holidays, all Friday holidays are celebrated on Saturday and all Monday Holidays are celebrated on Tuesday. Weekday holidays such as Thanksgiving are celebrated as they fall.

C. TIME CONVERSION

1. Local Standard Time is Z + 12.
2. Wake Island does not observe Daylight Savings Time.

D. CUSTOMS REGULATIONS

1. Not applicable.

E. HEALTH PRECAUTIONS

1. TRICARE eligible personnel (including eligible family members) requiring overseas emergency medical care, should contact the nearest TRICARE International SOS assistance center via the following website: http://www.tricare-overseas.com/ContactUs/default.htm . Select the applicable country from the drop-down menu for the International SOS assistance center name and 24-hour phone number.
2. Medical support on the island is severely limited. Emergent care and a limited pharmacy is available, but there is no flight surgeon, dental care, or pediatric healthcare.
3. Medical Travel Insurance: All personnel (other than uniform military and civilian expeditionary workforce members) deploying, assigned, attached, or TAD/TDY to Wake Island, to include contract personnel not specifically authorized DoD aeromedical evacuation through their contract, are highly encouraged to have either company provided or private medical travel insurance that specifically covers international healthcare and international medical evacuation services. Non-uniform personnel should complete DD Form 2569 and bring both this form and proof of insurance with them when traveling to Wake Island. DoDI 6025.23 and DoDI 4515.13R contain specific details regarding the limitations of aeromedical evacuation on non-DoD healthcare beneficiaries. Failure to obtain the appropriate insurance may result in the member being held financially liable for any DoD provided healthcare or aeromedical evacuation expenses.
4. While there are no mosquitoes found on Wake Island, precautions should still be taken to prevent insect bites. Wasps, centipedes, scorpions and rats should be avoided.

F. CURRENCY INFORMATION

1. The national currency is the United States Dollar (USD).

G. CLOTHING RECOMMENDATIONS

1. None reported.

H. TRANSIENT ACCOMMODATIONS

1. Billeting for RON personnel is available on a limited basis with prior coordination and approval from Site Manager, Wake Island. Billeting, food services, ground transport, and medical services are austere and severely limited. No off-base quarters are available. No common service support is available; all services are rendered on a cash and credit card (VISA) basis. Shortage of billets often requires doubling-up of RON personnel.

I. TRAVEL PRECAUTIONS AND INFORMATION

1. Force Protection Condition (FPCON) levels can be viewed via the SIPRNET Joint Risk Assessment Management Program (JRAMP) site via http://jramp.smil.mil.

TOP

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APPENDIX B

US PACIFIC COMMAND DEFENSE TRANSPORTATION REGULATIONS_ PART V_ WAKE ISLAND

CHAPTER 511 UNITED STATES PACIFIC COMMAND (USPACOM)

USPACOM Defense Transportation Regulation

CC. WAKE ISLAND

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/. From the left column select Pacific, South Asia, then Wake Island.

2. Cargo.

   a. All cargo entering Wake Island, regardless of origin, is subject to inspection by a US Air Force (USAF)-appointed inspector at point of departure as well as upon arrival. A rodent eradication was accomplished in May 2012 and a heightened level of bio-security to inhibit rodent reinvasion was implemented. The 611th Civil Engineer Squadron (CES) is the lead military POC for issues associated with invasive species and inspection issues. Inquiries associated with invasive species issues particular to Wake Island and shipment requirements to prevent transport of invasive species to the island will be directed towards the Wake Island installation CDR via Base Operations at BaseOperations2@wakeisland.net. All incoming cargo will meet the requirements of the United States Department of Agriculture, Natural Resources Conservation Service- Hawaii Invasive Species List. This list can be located at (http://plants.usda.gov/java/noxious?rptType=State&statefips=15).

   b. Military shippers will ensure that:

      (1) Cargo descriptions are complete and accurate.

      (2) Container packing lists will be in or attached to each container. The USAF requires a container packaging list for all containers. USAF inspectors may also conduct a physical inspection of the selected containers which are sealed with a Customs Seal and delivered to the consignee. These containers are not to be opened until they reach their final destination or unless a USAF inspector is present.

      (3) Advanced copies of the container packing list and the USAF Wake Island Vessel/Aircraft Rodent Pre-departure Inspection Forms are sent to the Wake Island Base Operations at BaseOperations2@wakeisland.net. A copy of the USAF Wake Island Vessel/Aircraft Rodent Pre-departure Inspection Form can be obtained from the Wake Base Operations, the 611th Natural Resources Program Manager, and/or the vessel government contracting officer.

      (4) All vessels destined for Wake will have rat guards on board for immediate deployment upon docking at Wake.

   c. All cargo staging areas where equipment and supplies destined for Wake are held will show documented proof that the facilities have rodent control operations in place throughout the facility. Facilities will be maintained rodent free by continually deploying a network of the following tools: glue boards, snap traps, and anticoagulant baits in tamper proof stations (baits that fluoresce under UV light are recommended - see URL: http://www.belllabs.com/product_details/united-states-pest-control-contrac-with-lumitrack). The spacing of traps and stations will encompass the entire facility. These measures are required at each facility storing equipment that is destined for shipment to Wake Island. Facility pest management contracts will include a quarterly report that will be submitted to the 611th CES, Natural Resources Program Manager, in order to ensure the equipment and supplies came from a facility with an ongoing pest control operation. The reports from pest control contracts will display the type of rodent control in place, the frequency of baiting,

density of traps and trap results. The Wake Island CDR can prohibit the opening of containers or other cargo, if there is no documentation showing that the origin activity has an ongoing pest control program. Contact the 611th CES, Natural Resources Manager, for further information (907-552-0788) or Wake Island Base Operations (808-424-2222).

d. In the event that cargo destined for Wake is discovered to be contaminated with an invasive species (i.e., rodents, snakes, insects) after departure from point of origin, the pilot or captain will isolate the package or container, and refrain from offloading the item on Wake. The pilot or captain will immediately contact Wake Base Ops (DSN: 315-424-2222 or Commercial: 808-424-2222) and alert them to the presence of an invasive species on the vessel or aircraft. This notification will activate the Wake Island rodent rapid response team.

e. Vessel operators will ensure that during loading operation at the location of origin all mooring lines are protected with rat guards and baited snap traps are deployed at each line exit and tie off point. For areas of high activity, baited snap traps will be placed inside a protected station called a "bait station" to avoid accidental triggers.

f. All containers regardless of size will have one baited glue board and one baited snap trap inside of each container prior to sealing. Contract language will include this requirement. Contract language will also include the purchase of these detection devices and supplies (snap traps, glue boards, rat attractant, and/or bait).

g. Vessels or aircraft originating from Guam destined for Wake will display documented proof of equipment and vessel/aircraft inspection with USDA canine prior to unloading equipment on Wake Island. This inspection is required to ensure BTS are not contained within shipments, aircraft, or vessels. This USDA BTS inspection requires advanced coordination with the Guam USDA, Wildlife Services at 671 366 -3886 or 671 635-4400. The Guam USDA inspector will provide the vessel or aircraft operator with a letter of verification, this letter of verification is to be submitted to the Wake Island Base Operations at BaseOperations2@wakeisland.net prior to the vessel or aircraft arrival at Wake.

h. During loading operations at origin, any box, cargo, or container showing signs of infestation (feces, chew marks, urine scent, hair) will be pulled out of the shipment and placed in an isolated area and thoroughly inspected prior to being placed back in the shipment.

3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Wake Island, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

****Information depicted on <http://www.transcom.mil/dtr/part-v/dtr_part_v_511.pdf > accessed 16 June 2015****

APPENDIX C

US AIR FORCE WAKE ISLAND VESSEL AIRCRAFT RODENT PRE-DEPARTURE INSPECTION FORM

USAF Wake Island Vessel/Aircraft Rodent Pre-Departure Inspection Form

Inspectors Name/ Agency: _____

Email / Contact #: _____

Vessel/Aircraft: _____

Origin: _____

Estimated Date and Time of Arrival to Wake Island: _____

Date Cargo Inspection Occurred: _____

Date Vessel/Aircraft Inspection Occurred: _____

Pre-Departure Checklist (Yes/No/Not Applicable):

1) Visual inspection of all cargo for rodent sign____
(sign - feces, chew marks, holes in cardboard, food piles, strong urine scent)

2) Rodent Control Devices Deployed to cargo staging areas____
____Rodenticide Baited Stations within staging area
(Type of Chemical Compound & Commercial Name_____)
____Snap traps
____Glue Boards

3) Maps depicting the location of traps or control devices affixed to this form____

4) Functional Rat Guards aboard vessel and crew notified of immediate usage upon arrival to Wake____

5) Pre-departure crew notification of Wake Defense Transportation Regulation and steps to implement Rodent Rapid Response in the event of a rodent sighting____

6) Cargo identified as infested prior or during loading_____
Unique Identification of Cargo or Manifest # (ie. palletized, boxed, breakbulk)
_____
_____
_____

7) Was contaminated cargo loaded onto vessel/aircraft____

8) Has Wake Island Base Ops and 611 CES Environmental been contacted regarding potential infested cargo identified during loading____

The following recommendations are provided for updating the October 2012 Wake Island Biosecurity Management Plan:

- Update Appendix B with the 24 October 2013 Defense Transportation Regulation – Part IV – Department of Defense Customs and Border Clearance Policies and Procedures.

- Add the following note following the fifth bullet in Section 3.2 (Requirements of the 2009 Environmental Assessment for Addressing the Systematic Eradication of Non-Native Rodents from Wake Atoll):

  Note: The 2012 rat eradication was not successful. The Asian house rat was successfully eradicated, but the Polynesian house rat was not and their population has rebounded. Ongoing efforts to control the rat, including the use of bait stations, are being implemented. Efforts are being made to control the rat population in and around the commensal and marina areas; however these efforts have been very localized with the primary focus on biosecurity as well as health and safety. An approach for a follow-on eradication effort is being developed and evaluated for implementation.

- Throughout the document: Define acronyms when they are first used in the text.

- In Section 4.1 Air: Change the first sentence in the first paragraph to: Air transportation guidelines have been created to ensure that all pilots, loadmasters, and flights transiting through Wake are aware of the ongoing efforts to eradicate rats on the atoll.

- In Section 4.1 Air: In the second to last sentence of the first paragraph insert the following text: A stock of d-Phenothrin aerosol should be available in the Pest Management storage for aircraft disinfection if it is determined to be necessary, as required by the DTR and FCG.

- In section 4.2 in the second sentence of the first paragraph add: No Pest Strips.

- In Section 5.2 Prescreening: Add a bullet after bullet # 4 stating: All closed containers should include two No Pest Strips (20% dichlorvos).

- In Section 5.2 Prescreening: Add a bullet after bullet # 7 (7 after adding the bullet for No Pest Strips) stating:

DEPARTMENT OF THE AIR FORCE
PACIFIC AIR FORCE

JAN 17 2013

MEMORANDUM FOR RECORD

FROM: 611 ASG/CC

SUBJECT: 2012 Wake Island Biosecurity Management Plan

1. In accordance with Executive Order (EO) 13112, for the prevention and introduction of invasive species, the 611th Air Support Group is pleased to provide this Wake Island Biosecurity Management Plan.

2. The spread of invasive species is now recognized as one of the greatest threats to the ecological and the economic well-being of the planet according to the International Maritime Organization. An invasive species is defined by EO 13112 as a species whose introduction has caused or may cause harm to environmental or human health (National Invasive Species Council, 2008). This biosecurity plan has been created to help the Air Force carry out their responsibilities for the prevention, rapid response and control of non-native species on Wake Island. As global commerce, trade, and travel continue to exist and evolve, so will the need and policies of biosecurity management.

3. Please direct any questions regarding this subject matter to our Natural Resources Program Manager, Mr. Matthew T. Moran at (907) 552-0788 or matthew.moran.3@us.af.mil.

ROBYN M. BURK, Colonel, USAF
Commander

4 Attachments:
1. Wake Island Biosecurity Management Plan
2. Appendix A, DoD Foreign Clearance Guide
3. Appendix B, USPACOM Defense Transportation Regulation Part V Wake Island
4. Appendix C, USAF WI Vessel-Aircraft Rodent Pre-departure Inspection Form

THE END

12455-16 05-25-2011

Appendix F. FIFRA Section 3 Labels forAlternativeRodenticides

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

NOTIFICATION

MAY 2 5 2011

John Lublinkhof
Bell Laboratories, Inc.
3699 Kinsman Blvd.
Madison, WI 53704

Subject: Notification remove "Triple Rinse (or equivalent), then" from the Container Handling Statement per Pesticide Registration Notice 98-10
EPA Registration No. 12455-16
Submission Date: May 9, 2011
Decision: D448899

Dear Mr. Lublinkhof:

The Agency is in receipt of your Application for Pesticide Notification under Pesticide Registration Notice (PRN) 98-10 dated May 9, 2011 for product EPA Reg No. 12455-16. The Registration Division (RD) has conducted a review of this request and finds that the action requested falls within the scope of PRN 98-10. The label submitted with the application has been stamped "Notification" and will be placed in our records. If you have any questions, please contact Jessica Rogala at (703) 347-0263 or via email at rogala.jessica@epa.gov. Thank you for your cooperation in this matter.

Sincerely,

J. Rogala

Jessica Rogala
Environmental Protection Specialist
Insecticide-Rodenticide Branch
Registration Division (7505P)

Please read instructions on reverse before comple[te] form. Form Approved. [O]MB No. 2070-0060, Approval expires 2-28-95

EPA

United States
Environmental Protection Agency
Washington, DC 20460

- [ ] **Registration**
- [ ] **Amendment**
- [x] **Other**

OPP Identifier Number

Application for Pesticide - Section I

1. Company/Product Number	2. EPA Product Manager	3. Proposed Classification
12455-16	Rosanna Louie-Juzwiak	[x] None [ ] Restricted
4. Company/Product (Name)	**PM#**	
ZP Tracking Powder	7	

5. Name and Address of Applicant *(Include ZIP Code)*

Bell Laboratories, Inc.
3699 Kinsman Blvd.
Madison, WI 53704

[ ] *Check if this is a new address*

6. Expedited Reveiw. In accordance with FIFRA Section 3(c)(3)(b)(i), my product is similar or identical in composition and labeling to:

EPA Reg. No. _____

Product Name _____

Section - II

- [ ] Amendment - Explain below.
- [ ] Resubmission in response to Agency letter dated _____
- [x] Notification - Explain below.
- [ ] Final printed labels in repsonse to Agency letter dated _____
- [ ] "Me Too" Application.
- [ ] Other - Explain below.

Explanation: Use additional page(s) if necessary. (For section I and Section II.)

Notification of a labeling change per PR Notice 98-10. (See attached statement). Under "Container Handling [Plastic]", the following portion of the statement has been deleted per EPA decision: "Triple rinse (or equivalent), then". Begin the new sentence with "Offer....."

Section - III

1. Material This Product Will Be Packaged In:

Child-Resistant Packaging	Unit Packaging	Water Soluble Packaging	2. Type of Container
[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Metal [ ] Plastic [ ] Glass [ ] Paper [ ] Other (Specify)
* ***Certification must be submitted***	If "Yes" Unit Packaging wgt. / No. per container	If "Yes" Package wgt / No. per container	

3. Location of Net Contents Information	4. Size(s) Retail Container	5. Location of Label Directions
[ ] Label [ ] Container		[ ] On label

6. Manner in Which Label is Affixed to Product: [x] Lithograph, Paper glued, Stenciled [ ] Other _____

Section - IV

1. Contact Point *(Complete items directly below for identification of individual to be contacted, if necessary, to process this application.)*

Name	Title	Telephone No. (Include Area Code)
John Lublinkhof	Director of Regulatory Affairs	608-241-0202

Certification

I certify that the statements I have made on this form and all attachments thereto are true, accurate and complete. I acknowledge that any knowlingllly false or misleading statement may be punishable by fine or imprisonment or both under applicable law.

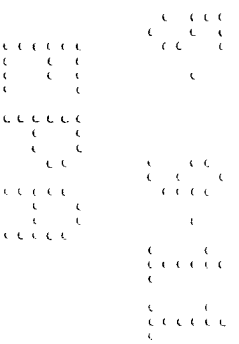
6. Date Application Received **(Stamped)**

2. Signature	3. Title	
John Lublinkhof	Director of Regulatory Affairs	
4. Typed Name	**5. Date**	
John Lublinkhof	May 6, 2011	

EPA Form 8570-1 (Rev. 3-94) Previous editions are obsolete. White - EPA File Copy (original) Yellow - Applicant Copy

Continuation of Section II, EPA Form 8570-1

This notification is consistent with the provisions of PR Notice 98-10 and EPA regulations at 40 CFR 152.46, and no other changes have been made to the labeling or the confidential statement of formula of this product. I understand that it is a violation of 18 U.S.C. Sec. 1001 to willfully make any false statement to EPA. I further understand that if this notification is not consistent with the terms of PR Notice 98-10 and 40 CFR 152.46, this product may be in violation of FIFRA and I may be subject to enforcement action and penalties under sections 12 and 14 of FIFRA.



RESTRICTED-USE PESTICIDE

Due to acute oral, acute dermal and primary dermal irritation toxicity.

For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's Certificate.

ZP®

Tracking Powder

For Indoor Use Only

KILLS HOUSE MICE

ACTIVE INGREDIENT:	
Zinc Phosphide (CAS #1314-84-7)	10%
INERT INGREDIENTS:.....	90%
TOTAL	100%

KEEP OUT OF REACH OF CHILDREN

DANGER – POISON

PELIGRO

FIRST AID

Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact 1-877-854-2494 for emergency medical treatment information.
If you experience signs and symptoms such as nausea, abdominal pain, tightness in chest, or weakness, see a physician immediately. For information on pesticide products (including health concerns, medical emergencies, or pesticide incidents), call the National Pesticide Information Center at 1-800-858-7378.

IF SWALLOWED:

- Call a poison control center or doctor immediately for treatment advice or transport the patient to the nearest hospital.
- Do not drink water.
- Do not administer anything by mouth or induce vomiting unless told to do so by the poison control center or doctor.

IF ON SKIN OR CLOTHING:

- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15 – 20 minutes.
- Call a poison control center or doctor for treatment advice.

IF INHALED:

- Move person to fresh air.
- If person is not breathing, call 911 or ambulance, then give artificial respiration, preferably mouth-to-mouth, if possible.
- Call a poison control center or doctor for further treatment advice.

TREATMENT FOR PET POISONING

If animal eats bait, call veterinarian at once.

NOTE TO PHYSICIAN OR VETERINARIAN

Contains the phosphine-producing active, Zinc Phosphide. Probable mucosal damage may contraindicate the use of gastric lavage. For animals ingesting bait and/or showing poisoning signs, induce vomiting by using hydrogen peroxide. Sodium bicarbonate can be given orally to neutralize the stomach acidity. The stomach and intestinal tract can be evacuated, oxygen administered and cardiac and circulatory stimulants given.

NET WEIGHT: 4 oz. – 25 lb.

Manufactured by:

Bell Laboratories, Inc.
3699 Kinsman Blvd.
Madison, WI 53704 U.S.A.

EPA Reg. No.: 12455-16 EPA Est. No.: 12455-WI-1

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

READ THIS LABEL: Read this entire label and follow all use directions, restrictions and precautions.

USE RESTRICTIONS:

- Do not apply this product in a way that will contact workers or other persons, either directly or through drift.
- Only protected handlers may be in the area during application.
- Keep all other persons out of the treated area during application.
- Do not apply by any method, to any pest, or to any site not specified on this label.
- This product may only be used for the control of house mice (*Mus musculus*) inside homes, industrial and agricultural buildings, and similar man-made structures. The only exception is that the product may also be dusted from the outside of the building into structural voids.
- Apply only in locations inaccessible to children, pets, or domestic animals.
- Do not place bait near or inside ventilation duct openings.
- If using this product in agricultural buildings where livestock feeds are stored, or in commercial food service, food manufacturing or food processing establishments, limit treatments to concealed, inaccessible places such as spaces between floors and walls. Do not apply tracking powder along walls, in corners, or in open floor area of rooms in which food or feed is handled or stored. Do not apply ZP TRACKING POWDER in areas where there is a possibility of contaminating water, food, feedstuffs, food or feed handling equipment, or milk or meat handling equipment or surfaces that come in direct contact with food.

APPLICATION DIRECTIONS:

SELECTION OF TREATMENT AREAS: Determine dry, acid-free areas where house mice will most likely pick up ZP TRACKING POWDER on their feet or fur and ingest it during grooming. Generally, these areas are along walls, by gnawed openings, in corners and concealed places, in spaces between floors and walls, or in locations where house mice or their signs have been observed. Remove goods

piled directly on floor and place on skids. Use boxes or other obstacles to force house mice to travel through constricted areas. When using this product in homes, only treat in concealed, inaccessible places such as spaces between floors and walls.

Evenly sprinkle 3 to 6 grams by lightly agitating spoon (one to two level teaspoonful amounts) of ZP TRACKING POWDER in approximately 3 by 24 inch patches. Using a hand-powered duster, dust into wall voids and spaces between floors. While wearing waterproof gloves, where accessible, collect and dispose of all dead animals. Maintain ZP Tracking Powder in treated areas for seven days or until fresh signs of mouse activity cease to appear. Clean up any powder that is accessible and dispose of in accordance with disposal directions.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

Fatal if swallowed. Fatal if absorbed through the skin. Causes skin burns. Harmful if inhaled. Do not get in eyes, on skin or on clothing. Avoid breathing dust. Any person who retrieves carcasses or unused bait following of this product must wear waterproof gloves.

Personal Protective Equipment (PPE)

All handlers, including loaders and applicators must wear:

- Coveralls, long-sleeved shirt and long pants.
- Chemical resistant shoes plus socks.
- Waterproof gloves
- When mixing and loading, wear a chemical resistant apron.
- When cleaning equipment, wear a chemical resistant apron.

User Safety Requirements

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry. Wash the outside of gloves before removing. Remove PPE immediately after handling this product.

User Safety Recommendations

- Wash hands thoroughly with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

This product is extremely toxic to birds, fish and other wildlife. Dogs, cats and other animals might be poisoned if they feed upon animals that have eaten this bait. Do not contaminate water when disposing of equipment wash water or rinsate.

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

Pesticide Storage: Store only in original container in a cool, dry place inaccessible to children and pets. Keep containers closed and away from other chemicals.

Pesticide Disposal: Wastes resulting from the use of this product may be placed in trash or delivered to an approved waste disposal facility.

Container Handling: Nonrefillable container. Do not reuse or refill this container. **[Plastic]:** Offer for recycling or reconditioning; or puncture and dispose of in a sanitary landfill. **[Paper]:** Dispose of empty container by placing in trash, at an approved waste disposal facility or by incineration.

DISCLAIMER: To the extent consistent with applicable law, seller makes no warranty, expressed or implied, concerning the use of this product other than indicated on the label. To the extent consistent with applicable law, buyer assumes all risk of use and/or handling of this material when such use and/or handling is contrary to label instructions.

050611

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

December 13, 2019

Jennifer Klika
Regulatory Affairs Manager
Bell Laboratories, Inc.
3699 Kinsman Blvd.
Madison, WI 53704

Subject: Label Amendment – Revision of Restricted Use box to remove sale to state natural resource agencies
Product Name: Ditrac D-50 Pellets
EPA Registration Number: 12455-147
Application Date: 11/04/2019
Decision Number: 557964

Dear Ms. Klika:

The amended label referred to above, submitted in connection with registration under the Federal Insecticide, Fungicide and Rodenticide Act, as amended, is acceptable. This approval does not affect any conditions that were previously imposed on this registration. You continue to be subject to existing conditions on your registration and any deadlines connected with them.

A stamped copy of your labeling is enclosed for your records. This labeling supersedes all previously accepted labeling. You must submit one copy of the final printed labeling before you release the product for shipment with the new labeling. In accordance with 40 CFR 152.130(c), you may distribute or sell this product under the previously approved labeling for 18 months from the date of this letter. After 18 months, you may only distribute or sell this product if it bears this new revised labeling or subsequently approved labeling. "To distribute or sell" is defined under FIFRA section 2(gg) and its implementing regulation at 40 CFR 152.3.

Should you wish to add/retain a reference to the company's website on your label, then please be aware that the website becomes labeling under the Federal Insecticide Fungicide and Rodenticide Act and is subject to review by the Agency. If the website is false or misleading, the product would be misbranded and unlawful to sell or distribute under FIFRA section 12(a)(1)(E). 40 CFR 156.10(a)(5) list examples of statements EPA may consider false or misleading. In addition, regardless of whether a website is referenced on your product's label, claims made on the website may not substantially differ from those claims approved through the registration process. Therefore, should the Agency find or if it is brought to our attention that a website contains false or misleading statements or claims substantially differing from the EPA approved registration, the website will be referred to the EPA's Office of Enforcement and Compliance.

Your release for shipment of the product constitutes acceptance of these conditions. If these conditions are not complied with, the registration will be subject to cancellation in accordance

with FIFRA section 6. If you have any questions, please contact Paul Di Salvo by phone at 703-347-0322, or via email at disalvo.paul@epa.gov.

Sincerely,

Paul D. Salvo for

Gene Benbow, Product Manager 07
Invertebrate and Vertebrate Branch 3
Registration Division (7505P)
Office of Pesticide Programs

Enclosure: Stamped Label

RESTRICTED USE PESTICIDE
DUE TO HAZARD TO NON-TARGET SPECIES
For retail sale only to: USDA Animal and Plant Health Inspection Service Wildlife Services, U.S. Fish and Wildlife Service, and the U.S. National Park Service to be used only by certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicators certification.

Ditrac® D-50 Pellets

PELLETED RODENTICIDE BAIT FOR CONSERVATION PURPOSES

For control or eradication of Polynesian rats on islands or vessels for conservation purposes.

ACTIVE INGREDIENT		
Diphacinone (CAS # 82-66-6)	.....	0.005%
OTHER INGREDIENTS	.....	99.995%
TOTAL	**.....**	**100.00%**

EPA REG. NO. 12455-147

EPA EST. NO. 12455-WI-1[k]
EPA EST. NO. 12455-WI-2[p]
EPA EST. NO. 12455-WI-3[w]
[superscript is first letter of lot number]

KEEP OUT OF REACH OF CHILDREN

CAUTION

NET CONTENTS: 4 – 50 pounds (1.81 – 22.68 kilograms)

NET WEIGHT: 4 – 50 pounds (1.81 – 22.68 kilograms)

Manufactured By:
Bell Laboratories, Inc.
3699 Kinsman Blvd.
Madison, WI 53704

Batch Code:

ACCEPTED
12/13/2019
Under the Federal Insecticide, Fungicide and Rodenticide Act as amended, for the pesticide registered under EPA Reg. No. 12455-147

See back [bottom] [and] [side] panel[s] for
First Aid, additional Precautionary Statements, and Directions for Use.

Bold, italicized text is information for the reader and is not part of the label.
[Bracketed information is optional text.]
Text separated by / denotes and/or options.

FIRST AID HAVE LABEL WHEN OBTAINING TREATMENT ADVICE	
If Swallowed:	• Call a poison control center, doctor, or **1-877-854-2494** immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by the poison control center or doctor. • Do not give anything by mouth to an unconscious person.
If on Skin or Clothing:	• Take off contaminated clothing. • Rinse skin with plenty of cool water for 15-20 minutes. • Call a poison control center or doctor immediately for treatment advice.
If Inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor immediate for treatment advice.
If in Eyes:	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor immediately for treatment advice.
NOTE TO PHYSICIAN If swallowed or absorbed through the skin, this material may reduce the clotting ability of the blood and cause bleeding. If ingested, administer Vitamin K_1 intramuscularly or orally. Repeat as necessary based on monitoring of prothrombin times.	
TREATMENT FOR PET POISONING If an animal eats this bait, call a veterinarian or **1-877-854-2494** at once.	
NOTE TO VETERINARIAN For animals ingesting bait and/or showing poisoning signs (bleeding or elevated prothrombin times), give Vitamin K_1. If needed, check prothrombin times every 3 days until values return to normal (up to 30 days). In severe cases, blood transfusions may be needed.	

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals

CAUTION: Harmful if swallowed or absorbed through the skin. Causes moderate eye irritation. Keep away from humans, domestic animals and pets. If swallowed, this material may reduce the clotting ability of the blood and cause bleeding. Wear waterproof gloves when applying or loading bait. With detergent and hot water, wash all implements used for applying bait. Do not use these implements for mixing, holding, or transferring food or feed.

Bold, italicized text is information for the reader and is not part of the label.
[Bracketed information is optional text.]
Text separated by / denotes and/or options.

Personal Protective Equipment
Applicators and other handlers must wear long sleeved shirt and long pants, chemical-resistant gloves, and shoes plus socks.

For aerial application, in addition to the above PPE, loaders must wear protective eyewear or a face shield and a minimum of NIOSH approved particulate filtering face piece respirator with any N,R, or P filter (TC84A) or another NIOSH approved particulate respirator with N,R, or P filter or NIOSH approved power air purifying respirator with an HE filter.

User Safety Requirements:
Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.
Remove PPE immediately after handling this product. Wash the outside of chemical-resistant gloves before removing. As soon as possible, wash hands thoroughly after applying bait and before eating, drinking, chewing gum, using tobacco or using the toilet, and change into clean clothing.

ENVIRONMENTAL HAZARDS

This product is extremely toxic to birds, mammals and aquatic organisms. Predatory and scavenging mammals and birds might be poisoned if they feed upon animals that have eaten bait.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
A copy of this label must be in the possession of the user at the time that the product is applied.
READ THIS LABEL: Read this entire label and follow all use directions and use precautions. Use only for sites, pests, and application methods described on this label.

IMPORTANT:
Do not expose children, pets, or non-target animals to rodenticides. To help to prevent exposure:
1. Keep children out of areas where this product is used or deny them access to bait by use of tamper resistant bait stations.
2. Store this product in locations out of reach of children, pets, and other non-target animals.
3. Apply bait only according to the Directions for Use
4. Dispose of product container and unused, spoiled, or unconsumed bait as specified in the "STORAGE AND DISPOSAL" section.
5. Applications are to be made only in areas uninhabited by humans.

USE RESTRICTIONS:
This product may be used to control or eradicate Polynesian rats (*Rattus exulans*), on islands for conservation purposes, or on grounded vessels or vessels in peril of grounding.

This product may be applied using bait stations, burrow baiting, canopy baiting or by aerial and ground broadcast application techniques.

This product is to be used for the protection of State or Federally-listed Threatened or Endangered Species or other species determined to require special protection.

Do not apply this product to food or feed.

Bold, italicized text is information for the reader and is not part of the label.
[Bracketed information is optional text.]
Text separated by / denotes and/or options.

Treated areas must be posted with warning signs appropriate to the current rodent control project.

Bait Stations:
Tamper-resistant bait stations must be used when applying this product to grounded vessels or vessels in peril of grounding. Bait must be applied in locations out of reach of children, non-target wildlife, or domestic animals, or in tamper-resistant bait stations.

Rats:
Apply 4 to 16 ounces [113 to 454 grams] of bait per placement. Space placements at intervals of 16 to 160 ft (about 5 to 50 meters). Placements should be made in a grid over the area for which rodent control is desired.

Maintain an uninterrupted supply of fresh bait for at least 25 days or until signs of rodent activity cease. Where a continuous source of infestation is present, permanent bait stations may be established and bait replenished as needed.

Burrow Baiting:
Place bait in burrows only if this can be done in a way that minimizes potential for ejection of bait and exposure of bait non-target species.

Rats:
Place 3 to 4 ounces [85 to 113 g] of bait inside each burrow entrance. Baits used in burrows may be applied in piles or in cloth or re-sealable plastic bags. The bags should be knotted or otherwise sealed to avoid spillage and holes should be made in plastic bags to allow the bait odor to escape.

Place one such bag or placement in each active burrow opening and push bag into burrow far enough so that its presence can barely be seen. Do not plug burrows. Flag treated burrows and inspect them frequently, daily if possible. Maintain an uninterrupted supply of bait for at least 15 days or until rodent activity ceases. Remove bait from burrows if there is evidence that bags are ejected.

Canopy Baiting (bait placement in the canopy of trees and shrubs):
In areas where sufficient food and cover are available to harbor populations of rodents in canopies of trees and shrubs, canopy baiting should be included in the baiting strategy. Approximately 4 to 7 ounces [113 to 200 grams] of bait should be placed in a cloth or re-sealable plastic bag. The bags should be knotted or otherwise sealed to avoid spillage and holes should be made in plastic bags to allow the bait odor to escape. Using long poles (or other devices) or by hand, bait filled bags should be placed in the canopy of trees or shrubs. Baits should be placed in the canopy at intervals of 160 ft (about 50 meters) or less, depending upon the level of rodent infestation in these habitats. In some vegetation types, bait stations may need to be used to ensure bait will stay in the canopy.

Broadcast Application:
Broadcast applications are prohibited on vessels, and all applications (including broadcast applications) are prohibited in areas of human habitation. Broadcast bait using aircraft, ground-based mechanical equipment, or by gloved hand application. Set the target application rate and number of applications according to the extent of the infestation and apparent population density. Maintain an uninterrupted supply of fresh bait for at least 25 days or until signs of rodent activity ceases. For eradication operations, treat entire land masses.

Bold, italicized text is information for the reader and is not part of the label.
[Bracketed information is optional text.]
Text separated by / denotes and/or options.

Each application should be applied at a rate no greater than 27 lbs. of bait per acre [30 kg bait/hectare]. If necessary to maintain the supply of fresh bait, make additional applications, typically 5 to 7 days after the previous application, depending on local weather conditions, at a rate no higher than 27 lbs. of bait per acre [30 kg bait/hectare]. No more than 3 broadcast applications should be conducted in this manner to maintain the supply of fresh bait. In situations where weather or logistics only allow one bait application, a single application may be made at a rate no higher than 27 lbs. bait per acre [0 kg/ha].

The application rates above specify the amount of bait delivered on the ground or 3-dimensional surface area. For aerial application, the bucket calibration (sowing) rate should be set accordingly to achieve the target application rate on the ground.

At points where flight lines overlap, the amount of bait applied might locally exceed the prescribed application rate. This could occur along adjacent borders of parallel swaths, at the end of swaths where they intercept the swaths created by shoreline baiting, or adjacent to areas missed during the initial baiting operations and subsequently rebaited, as indicated by the GPS flight path data. Minimize areas where the allowable application rate is exceeded as much as possible while ensuring that all areas are baited sufficiently.

If a bait application is interrupted due to poor weather conditions and cannot be completed on that day, "back baiting" of previously baited swaths is permitted.

This ensures that rats migrating into the treated site following the interruption are exposed to sufficient bait. Use the following rules to determine the extent of back baiting.

Application Delay	**Resume Bait Strategy**
1 Day	At drop boundary
2-3 Days	2-4 swath widths behind the drop boundary
> 3 Days	4-6 swath widths behind the drop boundary

Aerial (helicopter) applications may not be made in winds higher than 35 mph (30 knots). Pilot in command has final authority for determining safe flying conditions.

Assess baited areas for signs of residual rodent activity (typically 7 to 10 days post-treatment). If rodent activity persists, set up and maintain tamper-resistant bait stations or apply bait directly to rodent burrows in areas where rodents remain active. If terrain does not permit use of bait stations or burrow baiting, continue with broadcast baiting, limiting such treatments to areas where active signs of rodents are seen. Maintain treatments for as long as rodent activity is evident in the area and rodents appear to be accepting bait.
For all methods of baiting, monitor the baited area periodically and, using chemical resistant gloves, collect and dispose of any dead animals and spilled bait properly.

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

Pesticide Storage: Store only in original closed container in a cool, dry place inaccessible to unauthorized people, children and pets. Store separately from fertilizer and away from products with strong odors, which may contaminate the bait and reduce acceptability. Spillage should be carefully swept up and collected for disposal.

Pesticide Disposal: Wastes resulting from the use of this product may be disposed of at an approved waste disposal facility.

Container Handling: Nonrefillable container. Do not reuse or refill this container. Offer for recycling, if available**.** Dispose of empty container by placing in trash, at an approved waste disposal facility or by incineration.

WARRANTY: To the extent consistent with applicable law, seller makes no warranty, expressed or implied, concerning the use of this product other than indicated on the label. Buyer assumes all risk of use and/or handling of this material when such use and/or handling is contrary to label instructions.

Bold, italicized text is information for the reader and is not part of the label.
[Bracketed information is optional text.]
Text separated by / denotes and/or options.

OPTIONAL GRAPHICS:

Bold, italicized text is information for the reader and is not part of the label.
[Bracketed information is optional text.]
Text separated by / denotes and/or options.

Wake Atoll
Rat Eradication Program

Environmental Monitoring Plan

Prepared by
USDA APHIS Wildlife Services
Wake Atoll Rat Eradication Team
and Island Conservation

April 13, 2021

INTRODUCTION

On all but the smallest of islands, successful rodent eradication efforts employ the landscape-scale application of toxic baits. The rationale for such short-term contaminant inputs is that the environmental and human health risks of toxicant use are offset by the long-term ecological and societal benefits of invasive rodent removal. The maintenance of this rationale requires that we continue to test assumptions about the actual primary and secondary adverse impacts of rodenticide use.

The United States Air Force (USAF) is proposing to undertake a project to eradicate Pacific rats (*Rattus exulans*) from Wake Atoll. Wake Atoll is a small coral island in the Pacific Ocean that lies approximately 2,200 miles (3,540 km) west of the Hawaiian Islands, 1,600 miles east of Guam and 2,000 miles east of Japan. Wake Atoll consists of three islands: Wake, Wilkes, and Peale. These three islands collectively form a V-shaped figure with a shallow lagoon that is open to the Pacific Ocean (Figure 1). Wilkes Island is joined by a causeway to Wake Island. The north end of Wilkes Island is tidally separated from the rest of Wilkes at high tide. The total land area of Wake Atoll is 2.73 square miles (7.1 square kilometers (sq. km)). Approximately 1,747 acres (ac) (707 hectares (ha)) is dry land with 10 miles (16 km) of ocean shoreline and 6 miles of lagoon shoreline (USAF, 2009).

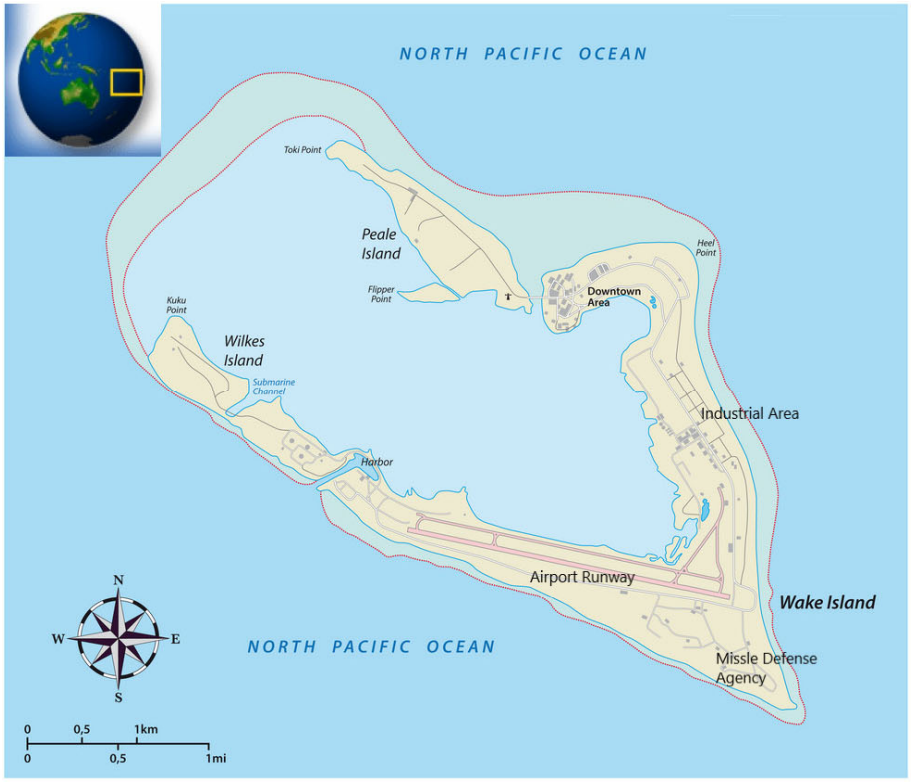


Figure 1. Location of Wake Atoll.

USAF has contracted USDA-APHIS Wildlife Services to prepare the National Environmental Policy Act Environmental Assessment and to lead this eradication effort. Wildlife Services has entered into a Cooperative Agreement with Island Conservation to plan and execute this project.

The eradication effort will be conducted primarily through aerial and hand broadcast application of the rodenticide, Brodifacoum-25W Conservation, to the entire island. The proposed implementation plan calls for up to three broadcast applications of the rodenticide bait containing 0.0025% brodifacoum, a second-generation anticoagulant formulated in a cereal-based bait matrix.

A key component of this project will be to monitor the unintended environmental impacts resulting from broadcast application of this pesticide. This environmental monitoring effort will be conducted by an experienced organization unaffiliated with the rat eradication team. This will ensure the project is monitored by an independent, non-biased entity.

Previous Environmental Sampling on Wake Atoll

A similar rat eradication project was conducted in 2012. That project successfully eradicated the Asian house rat (*Rattus tanezumi*) from Wake Atoll. Post-application environmental monitoring was conducted after that project and the monitoring techniques and results can be found in the following publications (Musashino Keisoku 2012, Siers et al. 2020).

Musashino Keisoku (2012) reported results for analyzing fishes and land crabs to evaluate risk from human exposure. No brodifacoum residues were reported in 2 eel species (species not reported), 11 bonefish (*Albula glossodonta*), 16 milkfish (*Chanos chanos*), 1 goat fish (species not reported) or 6 land crabs (likely *Coenobita*). One out of 8 bluefin trevally (*Caranx melampygus*) and 4 out of 4 blacktail snapper (*Lutjanus fulvus*) collected within the lagoon had low but detectable brodifacoum residues.

Siers et al. (2020) reported analyzing whole body fish samples collected three years after the 2012 eradication project. Of the 69 samples analyzed, two blacktail snapper (*Lutjanus fulvus)* contained detectable, but unquantifiable brodifacoum residues. These fish were collected in an intermittently land locked pond, which is not a truly marine environment. No fishes collected within the lagoon or within near shore waters contained brodifacoum residues.

METHODS and PROCEDURES

Determination of Bait Application Rates

Bait broadcast application rates will be independently assessed by employing a random quadrant survey method. This method entails randomly marking multiple 1-m^2 circular plots in a variety of habitats prior to aerial bait applications. Following aerial operations, and before dark on the day of application, bait pellets will be counted and weighed within all circular plots. Habitats sampled will include ironwood stands, coastal pemphis strands, and other canopied habitats on Wilkes and Peale Islands, open, canopy-less habitats such as mowed and unmowed grassy fields, beach morning glory and other low-profile coastal vegetation habitats. Lagoon and ocean shorelines will be walked, and a visual assessment will be made of bait in aquatic environments.

Environmental Sampling

Environmental sampling will focus on drinking water, sport fisheries, nearshore marine environments, and terrestrial and marine organisms that provide food for terrestrial foraging fauna (Table 1). Brodifacoum analysis of samples will not be conducted until all samples have

been collected. In the event a carcass of a sea turtle or other species of significant interest is found, tissues and stomach content will be collected for brodifacoum residues and a gross necropsy will be performed to examine for signs of anticoagulation poisoning. The number of samples collected and analyzed will be contingent upon the level of funding to support this effort.

Environmental samples collected as part of the environmental monitoring plan at the US Fish and Wildlife Service Wake Atoll National Wildlife Refuge will be collected under a research and monitoring special use permit approved by the refuge.

Table 1. Summary of environmental sampling and purpose.

Environmental Samples (Species TBD)	Sampling Purpose		
	Baseline Sampling	Non-target Species Risk	Human Health and Safety
Terrestrial invertebrates	x	x	
Marine invertebrates	x	x	
Hermit Crabs	x	x	
Ghost crabs	x	x	
Reptiles	x	x	
Marine fishes	x	x	x
Terrestrial and marine non-target carcasses	x	x	
Rat carcasses	x	x	

Sampling Periods
Samples will be collected immediately prior to the aerial bait application, approximately 1 week after the first and last aerial application and then one time approximately 6 months after the last aerial application. Additional sampling may be conducted on an as needed basis and where resources are available.

Sample Collection Techniques
The following techniques are examples of the types of methods that will be employed to collect environmental samples (Table 2).

Table 2. Sampling techniques for environmental sample collection.

	Sampling Technique
Terrestrial and marine invertebrates	Hand capture, pitfall traps, sticky traps
Crabs	Hand capture
Reptiles	Hand capture
Marine fishes	Rod and reel, netting
Rat, terrestrial and marine non-target carcasses	Picked up using gloved hand or implement

Carcass Surveys
Passive surveillance for carcasses will be conducted by all operational personnel when conducting field activities. Beginning one week after aerial baiting operations have commenced, carcasses of recently dead non-target organisms, with birds being the primary taxa, may be collected and preserved for possible rodenticide residue analysis.

The level of survey effort will be balanced with other demands on field personnel time. Effort will be made to identify carcasses found prior to aerial rodenticide applications to document natural mortality and to remove carcasses that could later be confused with mortalities due to rodenticide treatment.

Sample Handling
Fishes and reptiles will be euthanized by manually applied blunt force trauma followed by pithing as described by the American Veterinary Medical Association (AVMA 2013). Efforts will be taken to avoid cross contamination of samples when samples are initially collected, living organisms are euthanized, tissue samples are collected and when samples are placed into storage containers. Crabs and other terrestrial and marine invertebrates will be euthanized by placing them in labeled plastic bags and then chilling and freezing.

Except for large marine fishes, all samples will be stored whole and refrigerated following collection using iced coolers due to the island's remoteness. Samples collected from marine fishes will include muscle and liver tissue. Upon arrival in Honolulu, HI, samples will be shipped in iced coolers to a central location with sub-zero freezers or directly to the laboratory contracted to conduct the brodifacoum analysis.

The AVMA 2013 Guidelines state: "…Because of the variety of situations that may be encountered, it is difficult to strictly classify methods for termination of free-ranging wildlife as acceptable, acceptable with conditions, or unacceptable. Furthermore, classification of a given method as a means of euthanasia or humane killing may vary by circumstances. These acknowledgments are not intended to condone a lower standard for the humane termination of wildlife. The best methods possible under the circumstances must be applied, and new technology and methods demonstrated to be superior to previously used methods must be embraced". Thus, we acknowledge that we may need to be adaptable to changing field conditions and the wildlife we encounter and vary the humane euthanasia methods prescribed above due to unforeseen circumstances or to protect human health and safety.

Chain of Custody
Sample identification, date, location, and collector data will be recorded and maintained with the samples, along with a documented chain of custody between the source location and the laboratory selected to conduct residue analysis.

Sample Analysis Prioritization
Brodifacoum residue analysis will only be conducted if funding is available. Sample analysis will be prioritized for samples related to common human consumption practices and non-target species of conservation concern. Specimens from the sample collected after the last application are likely to have the highest accumulated contaminant levels with the most valuable information for inference on the highest risk of contamination in game fish and will be prioritized for prompt analysis. If any residues are observed in that sample, the final sample (one or two-weeks post-application) will be of the next highest priority, to determine if residues persist in food fish tissues. Chemical analysis of the remaining samples will be prioritized around which samples will provide the most opportunity to assess brodifacoum residues in the environment. It is likely that lab results will take six months or longer to become available, with limited opportunity for expedited results.

Analytical Chemistry
Samples will be analyzed for brodifacoum residues by liquid chromatography and mass spectrometry (LC-MS/MS) at an independent contract laboratory with demonstrated experience analyzing biological tissues for rodenticide residues. If a laboratory cannot be contracted, samples will be analyzed by the USDA-APHIS WS NWRC Chemistry Lab Unit in Fort Collins, CO. Detection and quantitation limits for each sample type would be established during analysis and compared to the limits established during the previous assays that employed high performance liquid chromatography (HPLC) followed by ultraviolet-visible photodiode array absorbance (PDA) detection.

Statistical Analysis
Data will be tabulated and reported with simple summary statistics and binomial confidence intervals for estimated proportions of samples containing brodifacoum residues.

Human Health and Safety Concerns
Collecting organisms within rocky intertidal zones on Pacific Islands exposes workers to unique health and safety risks. Shoreline rocks can be both slippery and jagged and thus reef boots or similar grippy and tough footwear is recommended. Certain fishes have spines and crabs have pincer claws therefore its best to handle them when alive with gloved hands. None of the targeted fish species are poisonous. Birds found dead will be handled with gloved hands and double bagged and tagged. Hand washing will be recommended after handling carcasses.

Literature Cited

AVMA. 2013. AVMA guidelines for the euthanasia of animals: 2013 Edition. American Veterinary Medical Association, Schaumburg, IL. 102p.

Musashino Keisoku. 2012. Measurement of brodifacoum in fish. Quality Control Report. Musashino Keisoku Ltd., Tachikawa, Japan, 9p.

Siers, S.R., A.B. Shiels, S.F. Volker, K. Rex and W.C. Pitt. 2020. Brodifacoum residues in fish three years after an island wide rat eradication attempt in the tropical pacific. Mgt. of Biol. Invasion 11(1):105-121.

Appendix H. Wake Island Quarterly Bird Survey

WAKE ISLAND QUARTERLY BIRD SURVEY

4th Quarter FY2020

In partial fulfillment of PO #15017943 WEWS

Prepared by:

John Gilardi

SUMMARY

This report presents the results of the bird survey conducted by John Gilardi between 30 August-11 September 2020 and summarizes the results of four surveys conducted during FY 2020. The June survey was conducted by Jamie Gilardi, a highly-qualified ecologist with extensive Pacific seabird experience.

Laysan Albatross were observed consistently during the December and March surveys, with a high count of 18 individuals seen in March. Three nests were discovered in the incubation phase during the December survey; all had failed by the March survey.
A total of 16 active Wedge-tailed Shearwater burrows were recorded in the Wilkes field and 14 active burrows in the ironwood forest colony near the 1500 area during the June survey. In September, most of the burrows in the Wilkes field had collapsed and a single adult was observed on the ground one evening after sunset. Burrows are typically too deep to determine content.
Three Christmas Shearwaters were observed along the Wilkes road, adjacent to the field, during the March survey and 4 Christmas Shearwaters were counted during the June survey. No Christmas Shearwater nests were found during FY 2020.
A total of 77 Masked Booby nests were counted in the Wilkes field in December, 93 nests in March, 73 nests in June and 33 nests in September.
A total of 24 Brown Booby nests were counted in the Wilkes field in December, 19 nests in March, 180 in June and 46 nests in September.
A total of 354 Red-footed Booby nests were counted on the transect through the colony on Wilkes Island in December, 203 nests in March, 162 nests in June and 67 nests in September.
An estimate of 270 Great Frigatebirds were present on Wilkes Island during the December survey, 120 in March, 400 in June and 250 during the September survey. No Great Frigatebird nests were found during FY 2020.
A total of 22 Red-tailed Tropicbird nests were found during searches in traditional nesting areas during the December survey, 61 nests found during the March survey and two nests found during the September survey. No nests were discovered during the June survey.
Three White-tailed Tropicbird nests were discovered during the December survey, one nest during the March survey. A single White-Tailed Tropicbird nest with a small downy chick was discovered during the September survey.

An estimate of 1500 fully-feathered Sooty Terns remained in the Wilkes field during the September survey. During December, there were an estimate of 2,000 Sooty Tern fledglings in the Wilkes field and 5,600 fully-feathered juveniles on Peale Island. In March, only 50 Sooty Tern fledglings remained on Peale Island. In June, the Sooty Tern colony in the Wilkes field covered 53,300 m2 (13.2 acres) with an estimate of 106,600 nests. The first eggs began hatching on 21 June. An estimate of 8,000 adult Sooty Terns were observed near the eight-inch gun on Peale Island but no eggs were laid on Peale during the survey.

Grey-backed Terns were not observed during the September or December surveys. During the March survey, Grey-backed Terns were consistently observed and hazed on the beach adjacent to the Echo taxiway. High-count was 30 terns. During the June survey survey, Grey-backed Terns were observed at Peacock Point on all visits, with a high-count of 42 adults. Several birds exhibited incubation behavior but no eggs or chicks were found. Eleven terns were observed on Toki Point, Peale Island, including two fledglings.

In the noddy plots, Black Noddy nesting peaked in June, with 65 nests.

In June and August Brown Noddy a high-count of 7 nests were counted in the plots.

White-tern nest high-count was 11 in March.

Four Intermediate Egrets were observed during the September survey. This is the first recorded observation of this species at Wake Atoll.

High-counts of 87 Pacific Golden Plovers, 53 Ruddy Turnstones, and 7 Wandering Tattlers were made. A high-count of 8 Bristle-thighed Curlews were observed on Peale Island. One Sanderling and one Sharp-tailed Sandpiper were observed during the December survey.

SPECIES ACCOUNTS

Laysan Albatross, *Phoebastria immutabilis.*

Methods. Opportunistic observations were made on Wake and Wilkes Islands, with particular attention given to historic nesting sites.

Results: Laysan Albatross were not observed during the September survey, typical for this time of year. Albatrosses were consistently observed during the December survey, with a high-count of 11 individuals. Three nests, all in the incubation phase were found. All three nests failed and had been abandoned by the time of the March survey. A high-count of 18 albatrosses were observed during the March survey. Albatross were not observed during the June survey.

Wedge-tailed Shearwater, *Puffinus pacificus.*

Methods. Three known colonies were visited during the daytime, at dusk and after dark. Wedge-tailed Shearwaters typically arrive and begin excavating burrows on Wake Atoll in late March. A burrow was considered active if signs of fresh excavation, scent or feathers were visible.

Results. A single adult Wedge-tailed Shearwater was observed in the Wilkes field colony during the September survey. Most burrows had collapsed or were too deep to determine contents. Many burrows showed signs of activity in the ironwood forest/ 1500 colony but it is difficult to accurately count burrows within the roots of *Casuarina*; no adults were observed or vocalizations heard during two visits after dark. All burrows were too deep to determine contents. No activity was observed in the runway swale colony. Construction activity here that filled in the culvert appears to have disrupted this colony.

Wedge-tailed Shearwaters were not observed during the December or March surveys. During the June survey, a total of 16 active burrows were counted in the Wilkes field. Adult birds were observed in burrows and on the ground after dusk. A total of 14 burrows showed signs of activity in the ironwood forest adjacent to the 1500 area. A single adult was observed in flight above the colony in the swale near Peacock Point; no active burrows were found.

Christmas Shearwater*, Puffinus nativitatus.*

Methods. Opportunistic observations were made while conducting bird surveys in the daytime, at dusk and after dark on Wilkes Island.

Results. Christmas Shearwaters were not observed during the September survey, typical

for this time of year.

Christmas Shearwaters were not observed during the December survey. A total of three shearwaters were observed during the March survey and high-count of 4 shearwaters were observed during the June survey. No Christmas Shearwater nests were found during FY 2020.

Masked Booby, *Sula dactylatra.*

Methods. The total number of nests and adult Masked Boobies were counted in the colony in the field on Wilkes Island. The number of nests was tallied by walking through the entire colony early in the morning. Developmental status of each nest was noted. In order to avoid unnecessary stress, adults were not disturbed from their nests, in which case nest contents were noted as "unknown" (either incubating or brooding a naked or small downy chick). Adults were counted in the evening, when numbers are typically highest, using binoculars and a spotting scope, from numerous sites in the Wilkes field and on the beach at Kuku Point.

Results. A total of 33 active Masked Booby nests, in all stages of development, and 240 adults were counted during the September survey. A total of 149 nests were counted in December, 174 nests in March and 85 nests in June. The results of the censuses since July 2014 are shown in Chart 1 and Appendix I. Figure 1 shows the extent of the Masked Booby colony in the Wilkes field.

Chart 1. Masked Booby nest counts, July 2014- June 2020.

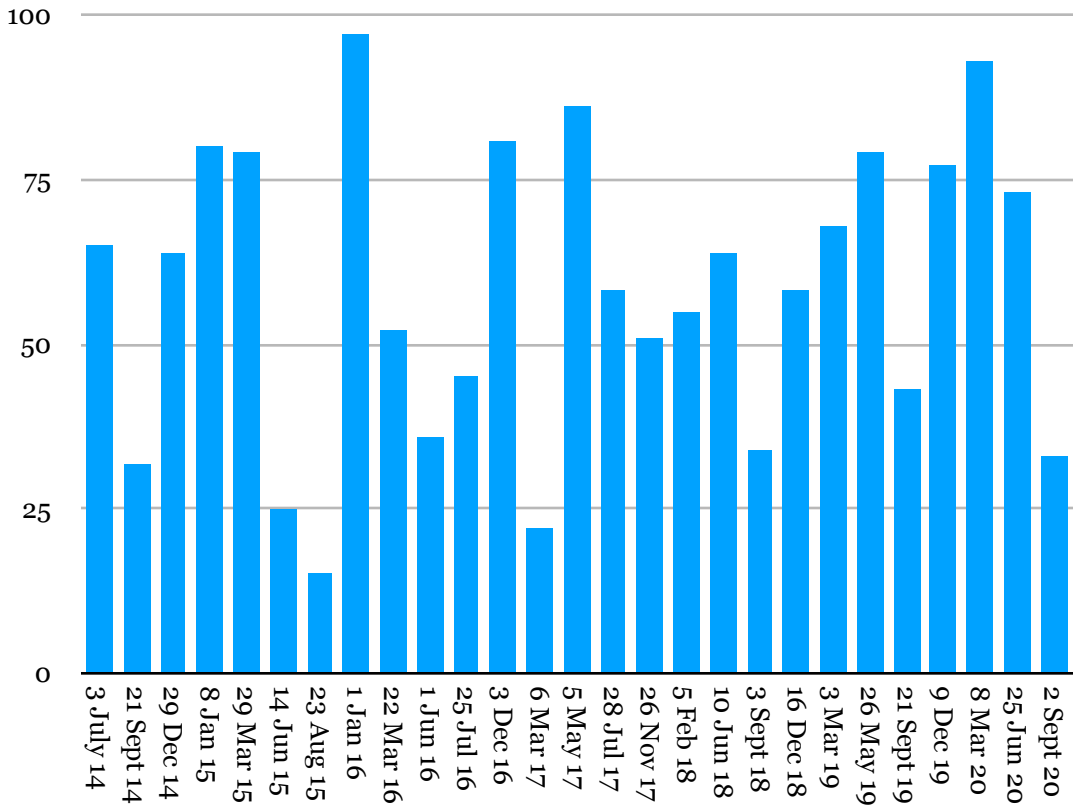


Figure 1. Extent of Masked Booby colony, Wilkes field.

Brown Booby, *Sula leucogaster*.

Methods. The total number of nests were counted in the colony on Wilkes Island. The number of nests was tallied by walking through the entire colony in the early morning. Developmental status of each nest was noted. In order to avoid unnecessary stress, adults were not disturbed from their nests, in which case nest contents were noted as "unknown" (either incubating or brooding). Adults were counted in the evening, using binoculars and a spotting scope, from numerous sites in the Wilkes field and from Kuku Point. Brown Boobies are synchronous breeders at Wake Atoll, with nesting activity peaking in May and June.

Results. A total of 46 active Brown Booby nests and 290 adults were counted during the September survey. Most nests contained partially-feathered or fully-feathered juveniles, indicating that this is late in the breeding cycle, typical for this time of year. A total of 58 nests were counted December, 106 nests in March and 180 nests during the June survey. The results of the censuses since July 2014 are shown in Chart 2 and Appendix 2. Figure 2 shows the extent of the Brown Booby colony in the Wilkes field.

Chart 2. Brown Booby nest counts, July 2014-September 2020.

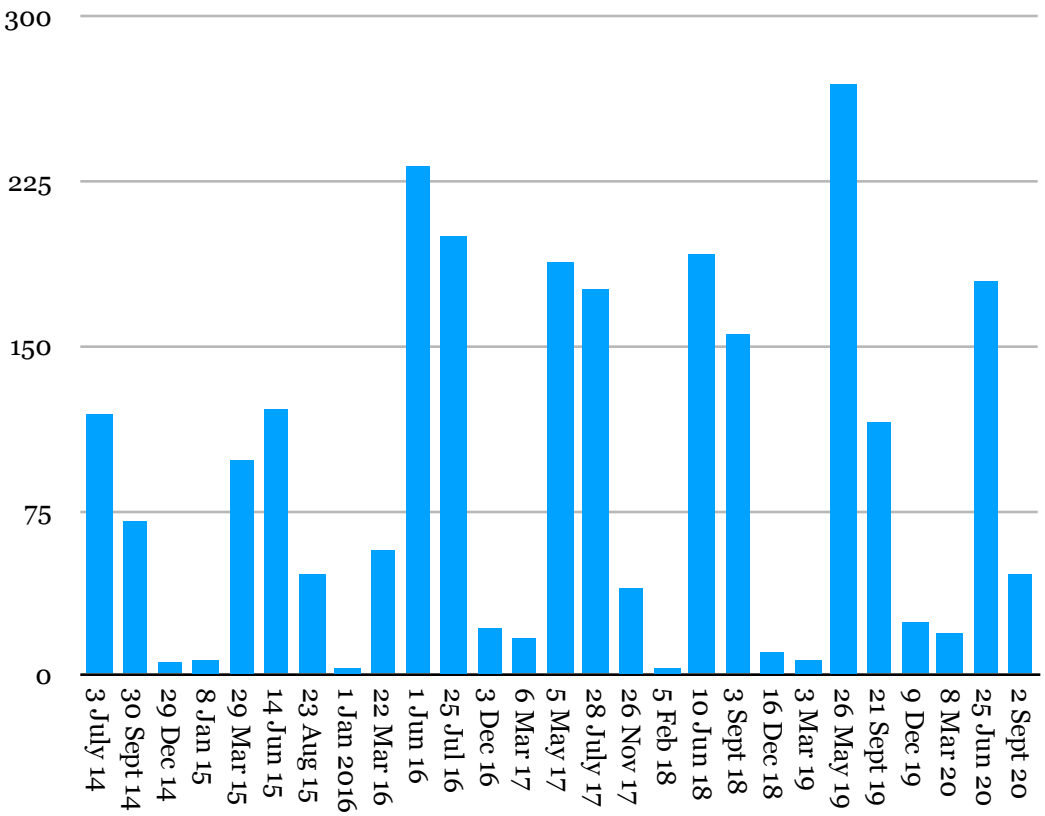


Figure 2. Extent of Brown Booby colony in Wilkes field.

Red-footed Booby, *Sula sula*.

Methods. Red-footed Boobies nest in *Heliotropium* trees on Wilkes Island. Nests were counted by walking a linear transect that creates minimal disturbance and provides visibility of much of the colony. A nest was considered 'active' only if an adult bird was in an incubating posture, or a chick was visible. Adult numbers are difficult to determine since they roost in numerous dispersed locations in the *Heliotropium* and *Cordia* forests on Wilkes Island.

Results. A total of 57 active nests were counted during the September survey. Most nests contained a fully-feather juvenile, indicating that this is late in the breeding cycle, typical for this time of year. Chart 3 and Appendix III display the results of the Red-footed Booby nest censuses since the first census in January 2016. Figure 3 shows the extent of the Red-footed Booby nesting and roosting areas and the walking transect.

Chart 3. Red-footed Booby nest count, January 2016-September 2020.

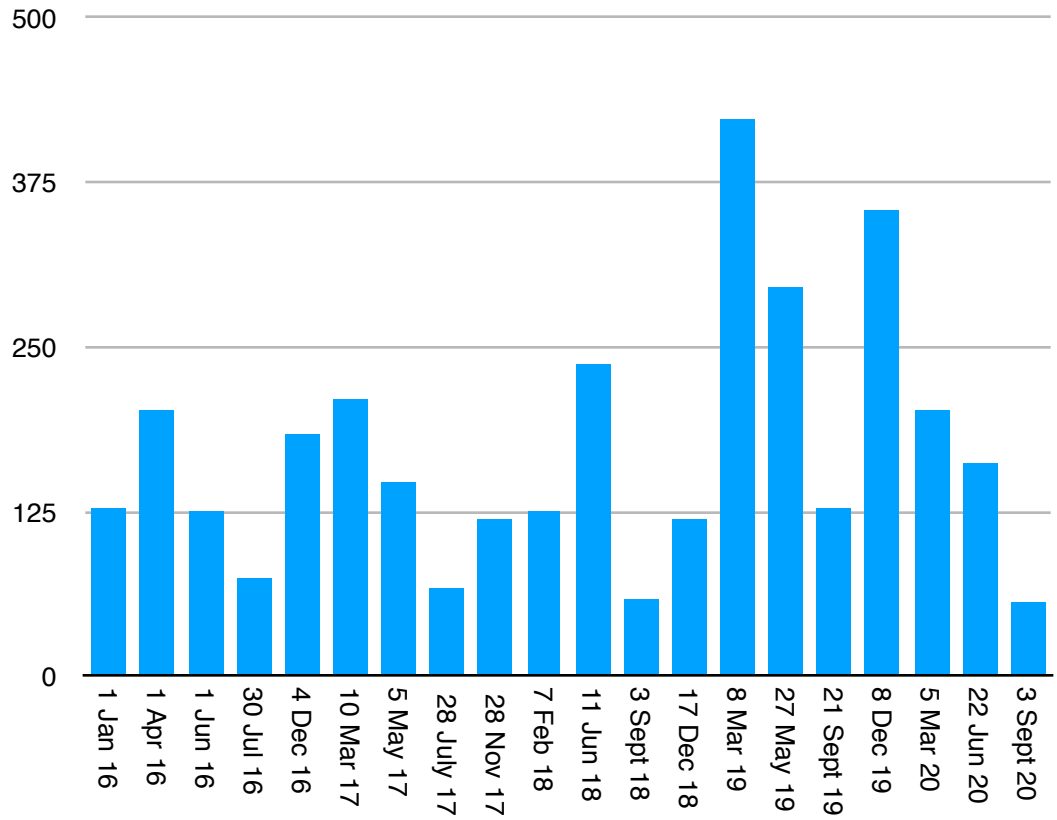


Figure 3. Red-footed Booby nesting and roosting areas, Wilkes Island. Walking transect for nest census is indicated in red.

Great Frigatebird, *Fregata minor*.

Methods. Great Frigatebirds roost in numerous locations in *Heliotropum*, *Casuarina,* and one large *Pisonia* tree on Wilkes Island. Their roosts are widely dispersed and variable, and because they are sensitive and easily flushed, they are difficult to accurately census. Frigatebirds were counted at their roosts and in flight. Each roost was approached and counted from a distance through binoculars or a spotting scope.

Results. An estimate of 300 Great Frigatebirds were present on the atoll during the September survey. In December, there were an estimate of 270 frigatebirds, in March 120 frigatebirds and 400 frigatebirds in June. Although higher numbers of adult male frigate birds were observed during FY 2020, very little courtship display was observed and no nests were found.

Red-tailed Tropicbird, *Phaethon rubricauda*.

Red-tailed Tropicbirds incubate a single egg and nest on the ground beneath several species of shrubs or trees and inside bunkers on Wake and Wilkes Islands. They also nest under scrap metal and machinery in the marina area on Wake Island. Although small numbers of birds are regularly observed above Peale Island, very few nests have

been found there. Both the ironwood removal project and the BASH program have transformed 75% of the traditional nesting area for Red-tailed Tropicbirds. In the 1800 area, the lower branches of all ironwood trees were cut and stacked, all trees were killed and most needles have fallen. This vastly reduces suitable nesting habitat in the area. In addition, most Red-tailed Tropicbird nesting areas (the 1800 and marina areas, the causeway, Vortac, MDA, the *Pemphis* at the lagoon edge, and the 1500 area and fuel line) were hazed by the BASH program during 2018. Due to disruption in nesting habitat, many nest locations have changed are more difficult to find. Many potential nests (a bird in an incubation posture) are situated deep within *Pemphis* trees which are very difficult to penetrate. Red-tailed Tropicbirds perform aerial courtship displays by flying in large circles, alternating between gliding and short periods of rapid wing-beating while making loud vocalizations.

Results. Red-tailed Tropicbird courtship activity was very low thought the atoll during the September survey. Two fully-feathered juveniles were found during nest searches and a high-count of 6 adults in aerial courtship display were observed above the 1800 area.

A total of 22 nests, most in the incubation phase, were discovered during the December survey and 61 nests during the March survey with high numbers of birds displaying aerial courtship during both surveys. No nests were found during the June survey; aerial courtship activity was very low.

White-tailed Tropicbird, *Phaethon lepturus***.**

Methods. White-tailed Tropicbirds occur in very small numbers on Wake Atoll. They nest in a shaded location on the ground and are opportunistically observed soaring high in the sky. Opportunistic observations were made throughout the atoll, particularly in areas with a history of observations. Six historic nest sites were checked for activity.

Results. A single White-tailed Tropicbird nest with a small downy chick was discovered during the September survey. An adult was present at another traditional nest site on several visits, but no egg was laid during the survey. A single adult was observed in flight on two occasions above manager's housing, four adults were observed in flight over the industrial area and a single adult was observed in flight over the channel to

Peale Island.

Three White-tailed Tropicbird nests were discovered during the December survey, one nest during the March survey. No nests were found in June.

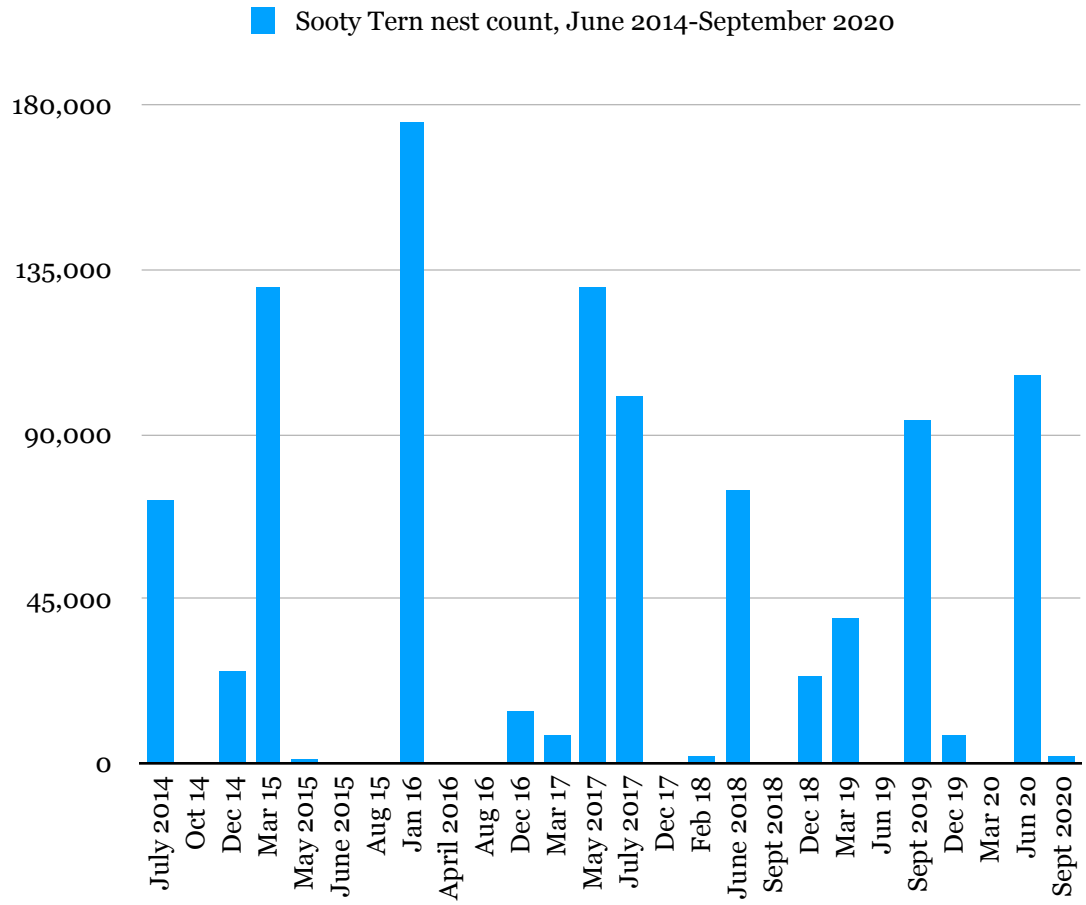
Sooty Tern, *Onychoprion fuscata***.**

Methods. Sooty Terns are the most abundant seabird on the atoll, historically nesting on Wilkes and Peale Islands. When actively nesting, the area of the Sooty Tern colony is determined by walking the perimeter of the colony with a handheld GPS unit. When incubating, nest density is typically 2 eggs/m². When most eggs have hatched, nest density declines to ~ 1 egg/m² due to mortality.

Results. During the September survey, an estimate of 1,500 fully-feathered juveniles were present in the Wilkes field.

In December, there were 2,000 fully-feathered juveniles in the Wilkes field, 2000 fully-feathered juveniles at Toki Point on Peale Island and 3,600 fully-feathered juveniles at the seaplane parking area on Peale Island. In March, <50 juveniles remained on Peale Island and 250 adult Sooty Terns were counted in flight above the Wilkes field. On 22 June, the Sooty Tern colony in the Wilkes field covered 53,300 m² and an estimate of 106,600 nests were present. Chicks had just begun to hatch in several areas. Figure 4 shows the Sooty Tern colony in the Wilkes field in June. Although 8,000 Sooty Terns were observed on Peale Island during the June survey and courtship display was observed, no eggs were laid. Nest counts since June 2014 are shown in Chart 4.

Figure 4. Extent of Sooty Tern colony, Wilkes field, 22 June 2020. Area = 53,300 m².



Grey-backed Tern, *Onychoprion lunatus*.

Methods. Grey-backed Tern egg-laying typically begins in late March at Wake Atoll. They do not build a nest, but lay a single speckled egg in the sand or coral rubble on windward shorelines. All traditional nesting areas were visited during the survey. Decoys and a sound system playing back Grey-backed Tern vocalizations are still present on the windward side of Peale Island near the eight-inch gun.

Results. Grey-backed Terns were not observed during the August/September survey, typical for this time of year. Grey-backedTerns were not observed during the December survey. During the March survey, Grey-backed Terns were consistently observed on the beach adjacent to the Echo taxiway. In early March, 10 birds were present and by 12 March, as many as 30 birds were observed. Grey-backed Terns were consistently hazed along the beach adjacent to the Echo taxiway during March and April (Pers. comm. Travis Pearson, BASH Manager) and most likely moved to Peacock Point. During the June survey survey, terns were observed at Peacock Point on all visits, with a high-count of 42 adults on 24 June. Several birds exhibited incubation

behavior but no eggs or chicks were found. On 25 June, 11 terns were observed on Toki Point, Peale Island, including two fledglings. Grey-backed Terns were not observed or heard at any of the traditional nesting locations on Wilkes Island during FY 2020.

Noddy Plots

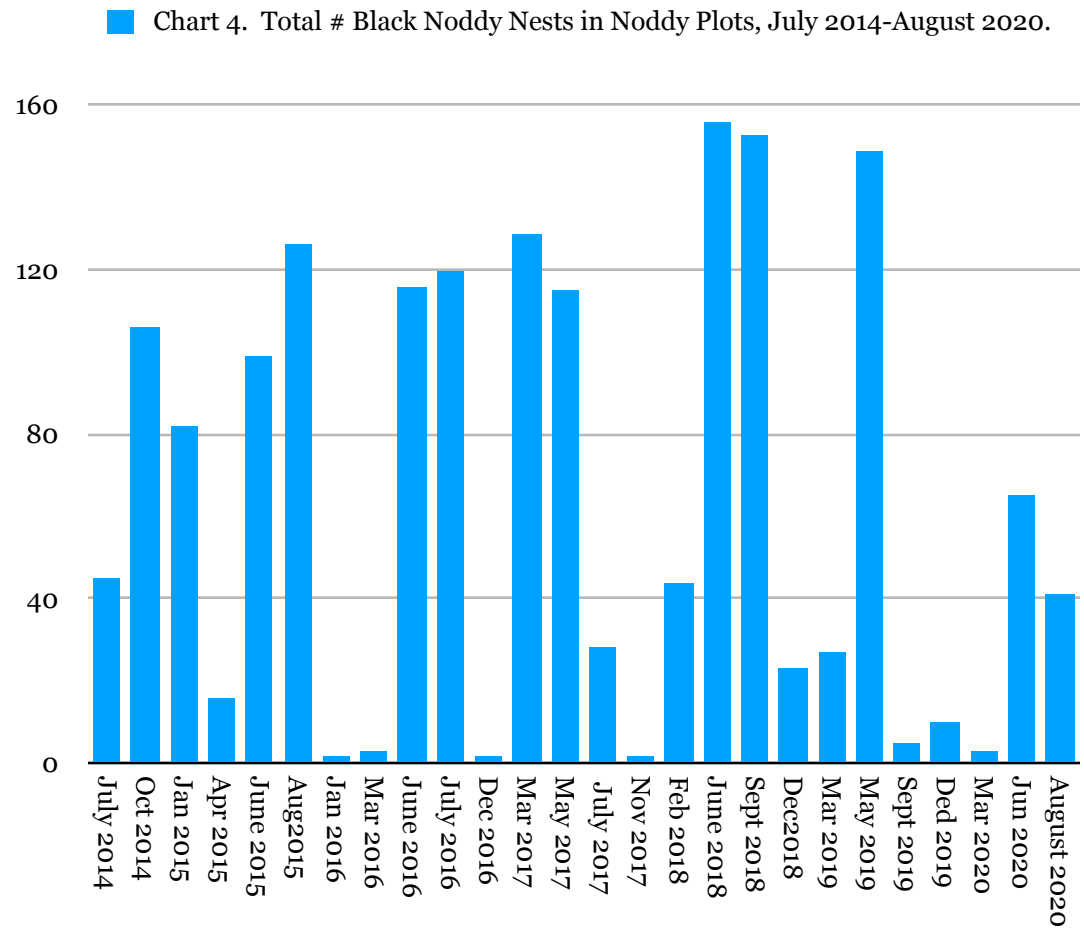
Methods. Nesting chronology and relative abundance of Black Noddies, Brown Noddies and White Terns were monitored in 10 plots on Wake Island. Each plot was 15 x 15 meters in size and contained a variable number of *Casuarina* trees. Tree structure is different in each plot. Within each plot, the total number of adults were counted and the number of active nests in the following developmental categories: incubating/brooding; small downy chick; large downy chick; and dependent juvenile. Nests were considered to be active if an adult was sitting on the nest in a horizontal posture indicative of incubation. All nests are too high to be able to determine the contents - unless a chick can be observed, active nests were designated "incubating/brooding". Nests with no bird present or with a standing adult were considered inactive.

All of the ironwood trees on Peale Island and many of the ironwood trees in the residential area have been treated with herbicide, are dead and have dropped needles. Noddies continue to nest in the standing dead trees. Three large ironwood trees growing adjacent to the patio at Drifter's Reef were felled in June 2017. Although there were no active nests at the time of felling, it is possible that birds that have traditionally used these trees might nest in one of the Noddy Plots nearby and increase nest and adult count there.

Results. Noddy plot nest totals since July 2014 are shown in charts 4-6 and results from individual plots are displayed in Appendices IV-VII.

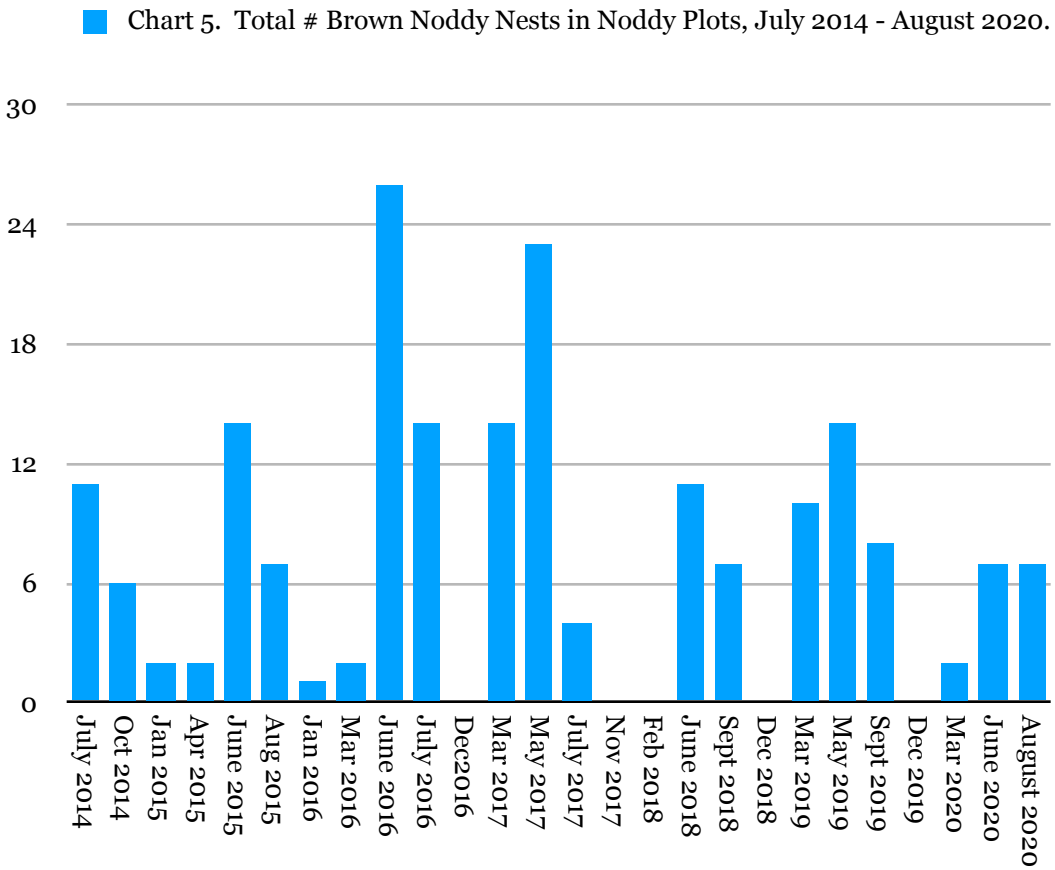
Black Noddy, *Anous minutus*.

Black Noddies are asynchronous breeders and nest year-round, exclusively in *Casuarina* trees on Wake Atoll. A total of 41 nests and 79 adults were recorded in the noddy plots.



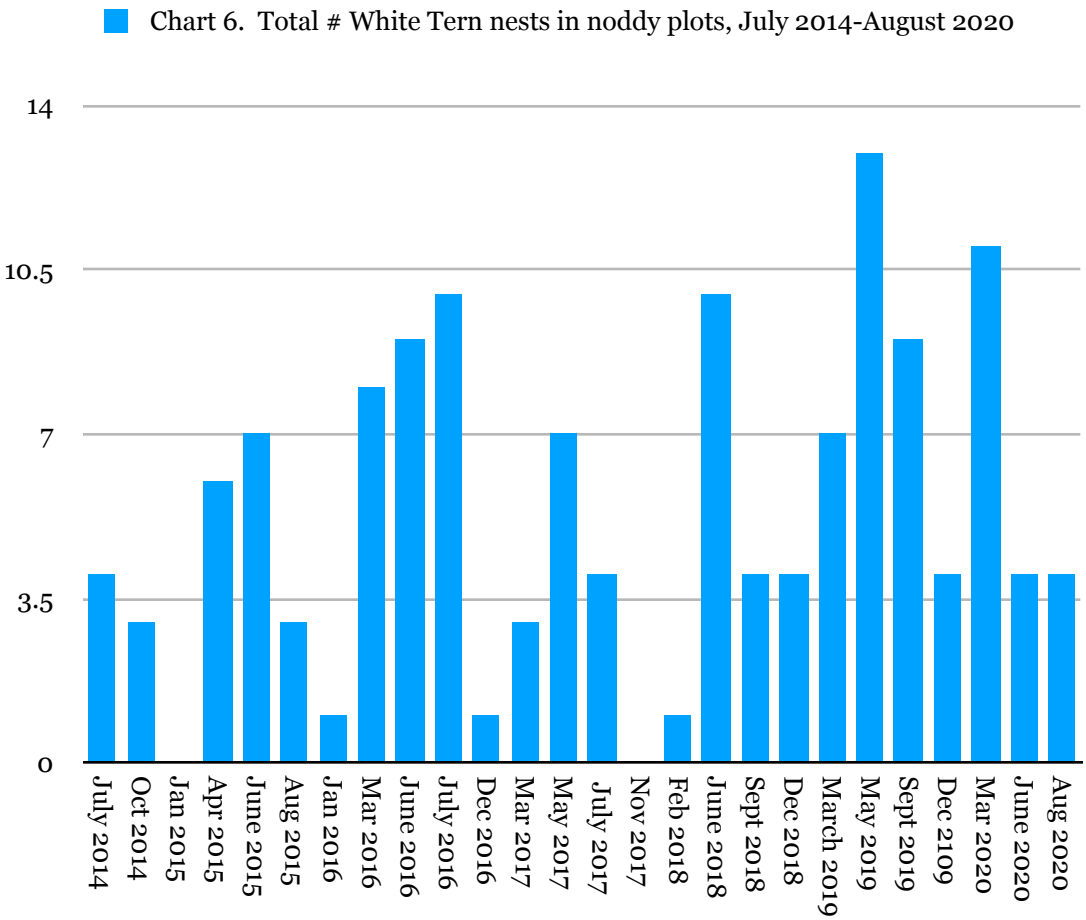
Brown Noddy, *Anous stolidus*.

Brown Noddies are synchronous breeders, and nest in C*asuarina* trees, on the ground, on roots of fallen trees, and on large offshore coral blocks on Wake Atoll. Peak nesting on Wake occurs during March-July. Relatively few Brown Noddies were present on the atoll during this survey. A total of 7 nests and 15 adult Brown Noddies were counted in the noddy plots.



White Tern, *Gygis alba*.

White terns breed year-round on Wake Atoll with less activity between November-February. They lay a single egg directly on a bare branch or other substrate. Four nests and 23 adults were counted in the plots during this survey.



WETLAND BIRD MONITORING

Methods. Seven wetland monitoring sites were visited regularly and opportunistic observations of shorebirds were made throughout the atoll.

Pacific Golden Plover, *Pluvialis fulva*.

Pacific Golden Plovers are observed throughout the atoll, in mowed fields, at pond edges and in the intertidal zone, and are consistently the most numerous shorebird observed

at Wake. Plovers breed during the summer in the Arctic tundra in Siberia and western Alaska and migrate as far as 6,000 km to spend winters on Wake, as well as other Pacific islands and Australasia. A small number of young birds stay during the summer each year. During the September survey, high-count of 36 plovers were counted on tidal flats from DJ's beach house.

During the December survey, a high count of 87 plovers was recorded. High count in March was 17, and in June, high-count was 6.

Ruddy Turnstone, *Arenaria interprets*.

Ruddy Turnstones are observed throughout the atoll, in mowed fields, pond edges and in the intertidal zone. They breed in the Arctic tundra and migrate south for winter. A high-count of 28 turnstones were observed at the detention pond on 9 September. During the December survey, high-count was 48, during March the high-count was 29 and during the June survey, high-count was 53.

Wandering Tattler, *Tringa incana*.

Wandering Tattlers occur in low numbers on Wake Island and most observations are of a single bird or pair of birds at the ponds and in the intertidal zones. They breed in eastern Russia, Alaska, and northwestern Canada and migrate south for the winter. During this survey, a high-count of 7 Wandering Tattlers tattlers were observed at the detention pond.

During each of the December, March and June surveys, high-count was two tattlers.

Bristle-thighed Curlew, *Numenius tahitiensis*.

The total world population of Bristle-thighed Curlews is estimated at 7,000 birds. They nest in two areas in Alaska, migrate south to winter on tropical Pacific islands and are considered “vulnerable” by the International Union for the Conservation of Nature (IUCN). Nearly all sightings of curlews occur on many visits to Peale Island, with a high-count of 8 individuals recorded at the channel adjacent to Flipper Point.

During the December survey, two curlews were observed. Five curlews were observed in March and 6 curlews were counted in June.

Intermediate Egret, *Egretta intermedia*.

The Intermediate Egret ranges from Australia to Africa and is an uncommon winter visitor to western Micronesia. This is the first recorded observation of this species on

Wake Atoll. Intermediate Egrets were observed consistently during the September survey in the residential and industrial areas, and in the Wilkes channel and field. A high-count of 4 birds was recorded (see cover photo, with gecko).

Sanderling, *Calidris alba*.

The Sanderling is an arctic breeder and uncommon winter visitor to Wake Atoll. A single Sanderling was observed on two visits to the detention pond during the December survey.

Sharp-tailed Sandpiper, *Calidris acuminata*.

The Sharp-tailed Sandpiper breeds in northeast Asia, is an uncommon visitor to Wake Atoll and typically observed at the 1500 and detention ponds. A single Sharp-tailed Sandpiper was observed at the detention pond on 14 December.

Rock Dove, *Columba livia*.

A single Rock Dove still resides on Wake Atoll and lives at the Thai beach house adjacent to the power plant.

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APPENDICES

Appendix I. Masked Booby Censuses, Wake Atoll, July 2014-September 2020.

Date	nest unk. content	nests with eggs	naked chick	small downy chick	large downy chick	partially feathered juvenile	fully feathered juvenile	Total # nests	# Adults in colony	#Adults on beach & offshore rocks	Total # adults
3 July 14	15	5	0	6	15	15	9	65	68	5	73
21 Sept 14	6	10	1	1	2	5	7	32	108	12	120
29 Dec 14	25	14	3	9	9	1	3	64	65	0	65
8 Jan 15	37	15	3	9	13	2	1	80	156	0	156
29 Mar 15	26	3	3	5	18	8	16	79	131	0	131
14 Jun 15	1	2	0	0	6	3	13	25	55	3	58
23 Aug 15	8	3	0	0	0	0	4	15	234	5	239
1 Jan 16	31	5	3	6	28	19	5	97	190	13	203
22 Mar 16	18	0	0	0	2	9	23	52	74	91	165
1 Jun 16	9	11	1	1	6	0	8	36	148	35	183
25 July 16	9	23	1	4	3	0	5	45	146	35	181
3 Dec 16	14	8	2	12	9	19	17	81	102	76	178
6 Mar 17	8	1	2	1	2	1	7	22	112	44	156
5 May 17	44	22	3	3	2	4	8	86	104	48	152
28 July 17	6	15	0	2	11	14	10	58	178	45	223
26 Nov 17	17	2	1	5	9	7	10	51	170	69	239
5 Feb 18	25	4	0	5	1	3	17	55	158	5	163
10 June 18	11	0	1	8	17	15	12	63	154	41	195
3 Sept 18	4	0	0	0	4	3	23	34	113	37	150
16 Dec 18	46	0	1	3	2	4	2	58	155	47	202
3 Mar 19	36	0	0	5	6	16	5	68	160	98	258
26 May 19	23	0	0	15	10	11	20	79	140	28	168
21 Sept 19	8	0	0	0	1	3	32	44	118	100	218
9 Dec 19	56	0	0	6	3	2	10	77	149	6	155
7 Mar 20	42	0	0	7	16	14	14	93	174	36	210
25 Jun 20	4	4	2	1	8	11	43	73	85	46	131
2 Sept 20	8	2	1	1	3	3	15	33	143	97	240

Appendix II. Brown Booby Censuses, Wake Atoll, July 2014-September 2020.

Date	nest unk content	nest with eggs	naked chick	small downy chick	large downy chick	partially feathered juvenile	fully feathered juvenile	Total # nests	# adults in colony	Adults on offshore rocks	Total # adults
3 July 14	41	3	1	6	27	32	9	119	158	123	281
30 Sept 14	5	29	0	6	17	2	11	70	77	320	399
29 Dec 14	0	4	0	0	0	2	0	6	73	65	138
8 Jan 15	0	5	0	0	0	2	0	7	135	160	295
29 Mar 15	84	14	0	0	0	0	0	98	157	6	163
14 Jun 15	60	6	0	7	28	11	9	121	208	169	377
23 Aug 15	19	9	2	4	5	1	6	46	387	50	437
1 Jan 2016	2	1	0	0	0	0	1	4	127	69	196
22 Mar 16	47	10	0	0	0	0	0	57	224	133	357
1 Jun 16	141	41	12	22	16	0	0	232	227	106	333
25 Jul 16	45	18	3	22	20	79	13	200	201	154	355
3 Dec 16	0	1	0	0	2	5	14	22	47	86	133
6 Mar 17	10	7	0	0	0	0	0	17	89	132	221
5 May 17	134	27	5	17	3	2	0	188	216	40	256
28 July 17	42	11	2	11	20	74	16	176	283	105	388
26 Nov 17	2	1	0	1	4	8	24	40	161	70	231
5 Feb 18	0	2	0	0	0	0	2	4	18	66	84
10 Jun 18	75	0	0	28	23	65	1	192	237	51	288
3 Sept 18	40	0	0	4	14	49	48	155	179	127	306
16 Dec 18	0	0	0	0	0	8	3	11	37	117	154
3 Mar 19	7	0	0	0	0	0	0	7	126	79	205
26 May 19	177	0	0	44	40	9	0	270	297	67	364
21 Sept 19	5	0	2	4	3	40	61	115	NC	128	NC
9 Dec 19	0	0	0	0	0	6	18	24	58	54	112
8 Mar 20	19	0	0	0	0	0	0	19	106	94	200
25 Jun 20	86	6	5	10	61	10	2	180	180	78	258
2 Sept 20	1	0	0	0	1	22	22	46	154	136	290

Appendix III. Red-footed Booby Nest Counts, January 2016-September 2020.

Date	Nest Unk Content	Small Downy Chick	Large Downy Chick	Partially Feathered Juvenile	Fully Feathered Juvenile	Total # nests
1 Jan 16	not recorded	not recorded	not recorded	not recorded	not recorded	128
1 Apr 16	not recorded	not recorded	not recorded	not recorded	not recorded	202
1 Jun 16	50	23	48	5	0	126
30 Jul 16	8	2	4	21	39	74
4 Dec 16	174	0	1	6	2	183
10 Mar 17	107	1	27	75	1	211
5 May 17	111	2	9	20	5	147
28 July 17	37	1	1	17	11	67
28 Nov 17	96	2	10	8	3	119
7 Feb 18	112	9	2	2	1	126
11 Jun 18	14	32	90	94	7	237
3 Sept 18	0	0	0	3	56	59
17 Dec 18	120	0	0	0	0	120
8 Mar 19	360	19	25	19	0	423
27 May 19	97	24	50	59	66	296
21 Sept 19	122	1	0	4	0	127
8 Dec 19	335	1	4	14	0	354
5 Mar 20	153	16	19	15	0	203
22 Jun 20	0	10	81	59	12	162
3 Sept 20	0	0	0	4	53	57

Appendix IV. Noddy Plots results. July 2014-June 2020.

Date	Black Noddy total # adults	Black Noddy total # nests	Brown Noddy total # adults	Brown Noddy total # nests	White Tern total # adults	White Tern total # nests
July 2014	128	45	44	11	17	4
October 2014	133	106	15	6	30	3
January 2015	139	82	20	2	20	0
April 2015	80	16	18	2	20	6
June 2015	138	99	26	14	38	7
August 2015	198	126	57	7	27	3
January 2016	33	2	9	1	20	1
March 2016	23	3	18	2	29	8
June 2016	160	116	42	26	43	9
July 2016	236	120	36	14	5	10
December 2016	67	2	11	0	18	1
March 2017	168	129	31	14	30	3
May 2017	169	115	44	23	40	7
July 2017	73	28	28	4	26	4
November 2017	10	2	7	0	17	0
February 2018	170	44	18	0	15	1
June 2018	451	156	42	11	26	10
September 2018	343	153	35	7	28	4
December 2018	83	23	6	0	31	4
March 2019	52	27	26	10	30	7
June 2019	268	149	34	14	46	13
September 2019	59	5	27	8	56	9
December 2019	47	9	10	0	74	4
March 2020	9	3	4	2	58	11
June 2020	107	65	23	7	65	4
August 2020	79	41	15	7	23	4

APPENDIX V. Black Noddy Plots, 31 August 2020.

Plot #	Total # adults	incubate/ brooding	Small downy chick	Large downy chick	Fully feathered juvenile	Total # nests
1	8	4	0	1	0	5
2	13	5	0	0	2	7
3	0	0	0	0	0	0
4	9	3	0	0	0	3
5	0	0	0	0	0	0
6	1	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	23	14	1	1	0	16
10	25	9	2	0	0	11
Total	79	35	3	2	2	41

APPENDIX VI. Brown Noddy Plots, 31 August 2020.

Plot #	Total # adults	incubate/ brooding	Small downy chick	Large downy chick	Fully feathered juvenile	Total # nests
1	0	0	0	0	0	0
2	5	2	0	1	1	4
3	5	0	0	0	0	0
4	3	3	0	0	0	3
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	1	0	0	0	0	0
10	1	0	0	0	0	0
Total	15	5	0	1	1	7

APPENDIX VII. White Tern Plots, 31 August 2020.

Plot #	Total # adults	incubate/ brooding	Small downy chick	Large downy chick	Fully feathered juvenile	Total # nests
1	1	0	0	0	0	0
2	3	0	0	0	0	0
3	0	0	0	0	0	0
4	1	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	1	0	0	0	0	0
8	0	0	0	0	0	0
9	4	0	0	1	1	2
10	13	0	1	0	1	2
Total	23	0	1	1	2	4

Figure 5. Brown Noddy fledgling.

Cover photo: Intermediate Egret with gecko.

Appendix I. List of Terrestrial Plants at Wake Atoll

Scientific Name	Common Name
Abutilon albescens	Sweet monkeybush
Abutilon asiaticum var. albescens	Indian mallow
Agave americana	American century plant
Agave angustifolia	century plant
Agave sisalana	Sisal
Agave sp.	agave sp.
Aglaonema commutatum	Aglaonema
Allium cepa	Onion
Allium fistulosum	Green onion
Allium sp.	Onion sp.
Allium tuberosum	Chinese chive
Aloe vera	Aloe
Alpinia galanga	Greater galangal
Alpinia purpurata	Pink ginger; Jungle Queen
Amaranthus dubius	Spleen amaranth
Amaranthus graecizans	Tumbleweed
Amaranthus tricolor	Joseph's coat
Amaranthus viridis	Slender amaranth
Ananas comosus	Pineapple
Anethum graveolens	Dill
Annona muricata	Soursop
Annona squamosa	Sweetsop
Apium petroselinum	Garden parsley
Araucaria heterophylla	Norfolk Island pine
Asparagus densiflorus	Sprenger asparagus fern
Asplenium nidus	Bird's-nest fern
Barringtonia asiatica	Fish poison tree
Bauhinia sp.	Camel's foot tree
Bidens alba	white beggar-ticks
Bidens pilosa var. minor	Beggar-ticks
Boerhavia albiflora var. powelliae	--
Boerhavia diffusa	Red Spiderling
Boerhavia repens	anena
Boerhavia sp.	Spiderling sp.
Bothriochloa pertusa	Indian blue grass
Bougainvillea spectabilis	bougainvillea
Brassica nigra	Mustard
Brassica oleracea var. italica	Brocolli
Caesalpinia bonduc	Grey nickers
Caladium bicolor	Caladium
Calotropis gigantea	Crown flower
Capsicum frutescens	Cayenne pepper
Capsicum annuum	chili pepper
Carica papaya	Papaya
Casuarina equisetifolia	Casuarina

Scientific Name	**Common Name**
Catharanthus roseus	periwinkle
Cenchrus brownii	Brown's sandbur
Cenchrus echinatus	Sandbur
Chamaesyce hirta	hairy spurge
Chamaesyce hypericifolia	Graceful spurge
Chamaesyce prostrata	Prostrate spurge
Chamaesyce thymifolia	Gulf sandmat
Chloris barbata	swollen fingergrass
Chlorophytum comosum	Spider plant
Chrysophyllum cainito	Star apple
Citrus hystrix	Kaffir lime
Citrus sp.	Citrus
Cleome gynandra	wild spider flower
Coccinia grandis	Ivy gourd
Coccoloba uvifera	Sea grapes
Cocos nucifera	coconut palm
Codiaeum variegatum	Croton
Coleus scutellarioides	Common coleus
Colocasia esculenta	Taro
Conyza bonariensis	Hairy horseweed
Conyza canadensis var. pusilla	Canada horseweed
Cordia subcordata	Cordia
Cordyline fruticosa	Ti
Cordyline terminalis	Coco yam
Coriandrum sativum	Chinese parsley
Corymbia citriodora	Lemon-scented gum
Crassula ovata	Jade plant
Crinum amabile	Sumatran giant-lily
Crinum angustum	Queen Emma-lily
Crinum sp.	Lily sp.
Crinum asiaticum	Giant lily
Cucumis melo	Cantaloupe
Cucumis sativus	Cucumber
Cucurbita pepo	Squash
Cuscuta pentagona	Fiveangled dodder
Cymbopogon citratus	lemon grass
Cynodon dactylon	Bermuda grass
Cyperus pumilus	Low flatsedge
Cyperus rotundus	nutgrass
Cyperus involucratus	Umbrella plant
Dactyloctenium aegyptium	crowfoot grass
Delonix regia	royal poinciana
Desmanthus pernambucanus	slender mimosa
Dieffenbachia seguine	Dumb cane
Digitaria ciliaris	Henry's crabgrass
Digitaria gaudichaudii	--
Digitaria insularis	Sourgrass
Digitaria setigera	Itchy crabgrass

Scientific Name	**Common Name**
Digitaria sp.	crabgrass species
Digitaria bicornis	Asian crabgrass
Dracaena marginata	Money tree
Eichhornia crassipes	Water hyacinth
Eleusine indica	goosegrass
Epipremnum pinnatum	Taro vine
Eragrostis amabilis	Japanese love grass
Eragrostis minor	little lovegrass
Eragrostis scabriflora	Fijian lovegrass
Eryngium foetidum	False Chinese parsley
Erythrina variegata var. orientalis	Indian coral tree
Euphorbia cyathophora	wild poinsettia
Euphorbia lactea	Mottled candlestick tree
Euphorbia milii	Crown of thorns
Euphorbia pulcherrima	Poinsettia
Euphorbia tirucalli	Pencil tree
Eustachys petraea	Pinewoods fingergrass
Ficus carica	Edible fig
Ficus microcarpa	Chinese banyan
Ficus rubiginosa	Port Jackson fig
Ficus sp	fig sp.
Fimbristylis cymosa	button sedge
Fimbristylis dichotoma	Forked fimbry
Gardenia taitensis	Tahitian gardenia
Gomphrena globosa	Globe amaranth
Gossypium hirsutum	Cotton
Gossypium hirsutum	upland cotton
Hedychium coronarium	White ginger
Helianthus annuus	Common sunflower
Heliotropium anomalum	Hinahina
Heliotropium procumbens var. depressum	four-spike heliotrope
Hibiscus sp	hibiscus sp..
Hibiscus tiliaceus	Hau
Hymenocallis littoralis	Beach spider lily
Hymenocallis pedalis	Spider lily
Ipomoea aquatica	Swamp morning-glory
Ipomoea batatas	Sweet potato
Ipomoea pes-caprae spp. brasiliensis	beach morning glory
Ipomoea tuba	moon flower
Ipomoea violacea	beach moonflower
Ixora sp.	Ixora
Jasminum sambac	Arabian jasmine
Jatropha integerrima	Rose-flowered Jatropha
Kalanchoe pinnata	Cathedral bells
Kalanchoe daigremontiana	Kalanchoe
Kalanchoe delagoensis	Chandelier plant
Kalanchoe pinnata	Air plant
Lactuca sativa	Lettuce

Scientific Name	**Common Name**
Lepidium bidentatum	Kunana pepperwort
Lepturus gasparricensis	--
Lepturus repens	Pacific Island thintail
Leucaena leucocephala	Tangantangan
Lobularia maritima	Sweet alyssum
Mangifera indica	Mango
Manilkara zapota	Chicle
Momordica charantia	bitter melon
Morella faya	Fire tree
Morinda citrifolia	Indian mulberry
Moringa oleifera	Horseradish tree
Musa acuminata	Banana
Nerium oleander	Oleander
Nicotiana tabacum	Tobacco
Nidularium sp.	Nest bromeliad
Noronhia emarginata	Madagascar olive
Nymphaea sp.	Waterlily
Ocimum basilicum	sweet basil
Ocimum tenuiflorum	holy basil
Opuntia littoralis	coastal pricklypear
Opuntia cochenillifera	Cochineal nopal cactus
Pandanus tectorius	Screwpine
Pandanus tectorius - variegated form	Variegated screwpine
Paspalum setaceum	thin pasplum
Paspalum vaginatum	seashore pasplum
Paspalum scrobiculatum	Knotgrass
Passiflora foetida var. hispida	Passion fruit
Passiflora sp.	Passion fruit
Pedilanthus bracteatus	Candelilla Slipper
Pedilanthus tithymaloides	Redbird flower
Pemphis acidula	Pemphis
Pennisetum polystachion	Feathery pennisetum
Petroselinum crispum	Parsley
Phaseolus coccineus	Scarlet runner bean
Phaseolus lunatus	Lima bean
Phaseolus vulgaris	String bean
Philodendron undulatum	Philodendron
Philodendron hederaceum var. oxycardium	Philodendron
Phoenix sp.	Date palm
Phyllanthus acidus	Otaheite gooseberry
Phyllanthus amarus	carry me seed
Phymatosorus scolopendria	Laua'e fern
Pilea microphylla	Artillery plant
Piper lolot	Lolot
Pisonia grandis	Pisonia
Pithecellobium dulce	Manila tamarind
Pluchea carolinensis	Sour bush
Pluchea odorata	Sweetscent

Scientific Name	**Common Name**
Plumeria obtusa	Singapore Plumeria
Plumeria rubra	Red Plumeria
Plumeria sp.	plumeria sp.
Polyscias fruticosa	Ming aralia, Elegans
Polyscias guilfoylei	Wild coffee
Polyscias scutellaria	Balfour aralia, Balfourniana
Portulaca australis	Purslane
Portulaca cv.	Wildfire
Portulaca lutea	yellow purslane
Portulaca oleracea	Common purslane
Portulaca pilosa	Akulikuli
Portulaca samoensis	--
Portulaca sp	purslane sp.
Pseuderanthemum carruthersii var. atropurpure	Purple false eranthemum
Pseuderanthemum carruthersii var. carruthersii	Eldorado
Psidium guajava	Guava
Psophocarpus tetragonolobus	Wing bean
Raphanus sativus	Daikon
Raphanus sativus	Radish
Ricinus communis	Castor bean
Rosa hybrid	Rose
Sansevieria trifasciata	Bowstring hemp
Sansevieria roxburghiana	--
Scaevola sericea var. taccada	scaevola
Schefflera actinophylla	Octopus tree
Sedum sp.	stonecrop sp.
Sempervivum tectorum	Common houseleek
Sesbania grandiflora	Sesban
Sesuvium portulacastrum	seaside purslane
Setaria verticillata	Bristly foxtail
Sida fallax	ilima
Solanum lycopersicum	Tomato
Solanum torvum	Wild tomato
Solanum melongena	eggplant
Solenostemon scutellarioides	Coleus
Sonchus oleraceus	thistle Aztec
Sorghum bicolor	Sweet sorghum
Spondias pinnata	Amra
Stachytarpheta cayennensis	Nettle-leaved vervain
Stachytarpheta jamaicensis	Jamaican vervain
Strelitzia reginae	Bird-of-paradise
Syngonium auritum	Syngonium
Tagetes erecta	marigold
Tagetes patula	French marigold
Tamarindus indica	Tamarind
Terminalia catappa	Indian almond
Thespesia populnea	Milo
Tournefortia argentea	tournefortia

Scientific Name	**Common Name**
Tradescantia pallida	Purple Tradescantia
Tradescantia spathacea	Oyster plant
Tribulus cistoides	Puncture vine
Tribulus terrestris	Puncture vine
Tridax procumbens	coatbuttons
Vigna unguiculata ssp. sesquipedalis	Yard-long bean
Vitex trifolia	Blue vitex
Waltheria indica	uhaloa
Zea mays	Corn
Zinnia violacea	Zinnia
Ziziphus mauritiana	Indian jujube
Zoysia matrella	Manila grass

Source: Vegetation of Wake.pdf (fws.gov).

Appendix J. List of Fish Species Reported at Wake Atoll

Name
RHINCODONTIDAE (Whale Shark)
Rhincodon typus
CARCHARHINIDAE (Requiem Sharks)
Carcharhinus amblyrhynchos
Carcharhinus melanopterus
Eulamia commersoni
Triaenodon obesus
MYLIOBATIDAE (Eagle Rays)
Aetobatus narinari
MOBULIDAE (Manta Rays)
Albula glossodonta
MORINGUIDAE (Spaghetti Eels)
Moringua abbreviata
CHLOPSIDAE (False Morays)
Kaupichthys sp.
MURAENIDAE (Moray Eels)
Anarchias sp.
Anarchias cantonensis
Anarchias seychellensis
Echidna leucotaenia
Gymnomuraena zebra
Gymnothorax buroensis
Gymnothorax enigmaticus
Gymnothorax fiavimarginatus
Lycondontis flavomarginata
Gymnothorax javanicus
Gymnothorax meleagris
Gymnothorax pictus
Gymnothorax ruppelliae
Gymnothorax undulatus
Lycodontis undulata
Uropterygius macrocephalus
Uropterygius xanthopterus
OPHICHTHIDAE (Snake Eels)
Myrichthys colubrinus
Myrichthys maculosus
Scolecenchelys gymnota
CONGRIDAE (Conger and Garden Eels)
Conger cinereus
Heteroconger hassi
CHANIDAE (Milkfish)
Chanos chanos
MYCTOPHIDAE (Lanternfishes)
Myctophum spinosum
Dasyscopelus spinosus
BYTHITIDAE (Livebearing Brotulas)
Dinematichthys ilucoeteoides
MUGILIDAE (Mullets)
Crenimugil crenilabis
Liza vaigiensis
Neomyxus leuciscus
CLUPEIDAE (Herrings)
Spratelloides sp.
EXOCOETIDAE (Flyingfishes)
Cypselurus poecilopterus
Exocoetus volitans
Cypselurus rondelitii
HEMIRAMPHIDAE (Halfbeaks)
Hyporhamphus acutus acutus
Oxyporhampus micropterus
HOLOCENTRIDAE (Soldierfishes and Squirrelfishes)

Name
Myripristis adusta
Myripristis amaena
Myripristis berndti
Myripristis kuntee
Myripristis murdjan
Myripristis violacea
Holocentrus opercularis
Holocentrus samara
Sargocentron melanospilos
Holocentrus microstomus
Holocentrus laeteoguttatus
Neoniphon opercularis
Sargocentrum spiniferum
Holocentrus spinifer
Sargocentron tiere
SYGNATHIDAE (Pipefishes and Seahorses)
Corythoichthys conspicillatus
Doryrhampus excisus
AULOSTOMIDAE (Trumpetfishes)
Aulostomus chinensis
FISTULARIIDAE (Cornetfishes)
Fistularia commersonii
SCORPAENIDAE (Scorpionfishes)
Pterois antennata
Scorpaenodes guamensis
Sebastapistes ballieui
Sebastapistes coniorta
Sebastapistes fowleri
Sebastapistes mauritiana
Sebastapistes tinkhami
CARACANTHIDAE (Orbiculate Velvetfishes)
Caracanthus maculatus
Caracanthus unipinna
Family SERRANIDAE (Groupers and Sea Basses)
Aporops bilinearis
Cephalopholis argus
Cephalopholis spiloparaea
Cephalopholis urodeta
Epinephelus fasciatus
Epinephelus hexagonatus
Epinephelus lanceolatus
Family SERRANIDAE (Groupers and Sea Basses)
Epinephelus merra
Epinephelus polyphekadion
Epinephelus microdon
Epinephelus tauvina
Pseudanthias pascalus
Epinephelus spilotoceps
Epinephelus tauvina
Liopropoma tonstrinum
Plectranthias longimanus
Pleetranthias nanus
Plectranthias winniensis
Pseudanthias pascalus
Pseudanthias ventralis
Pseudogramma polyacantha
Variola louti
CIRRHITIDAE (Hawkfishes)
Amblycirrhitus bimacula
Cirrhitus maculatus
Neocirrhites armatus
Paracirrhites arcatus

Name
Paracirrhites forsteri
Paracirrhites hemistictus
PSEUDOCHROMIDAE (Dottybacks)
Pseudochromis sp.
Pseudoplesiops sp.
PRIACANTHIDAE (Bigeyes, Glasseyes)
Heteropriacanthus cruentatus
APOGONIDAE (Cardinalfishes)
Apogon eoeeineus
Apogon cyanosoma
Apogon doryssa
Apogon exostigma
Apogon fuscus
Apogon kallopterus
Apogon savayensis
Apogon susanae
Apogon taeniophorus
Cheilodipterus macrodon
Cheilodipterus quinquelineata
Powleria isostigma
MALACANTHIDAE (Sand Tilefishes)
Malaeanthus brevirostris
ECHENEIDAE (Remoras)
Remora remora
Remora osteoehi
CORYPHAENIDAE (Dolphinfishes)
Coryphaena hippurus
CARANGIDAE (Jacks)
Seomberoides lysan
Seriola rivoliana
Traehinotus baillonii
LUTJANIDAE (Snappers)
Aphareus furea
Aprion vireseens
Lutjanus fulvus
Lutjanus monostigma
Macolor niger
LETHRINIDAE (Emperors)
Lethrinus obsoletus
Lethrinus rubriopereulatus
Monotaxis grandoculis
Lethrinus kallopterus
Lethrinus ramak
MULLIDAE (Goatfishes)
Mulloidichthys flavolineatus
Mulloidichthys vanicolensis
Parupeneus barberinus
Parupeneus cyclostomus
Parupeneus insularis
Parupeneus multifasciatus
Parupeneus pleurostigma
Upeneus arge
Mulloides vanicolensis
Parupeneus bifasciatus
PEMPHERIDAE (Sweepers)
Pempheris oualensis
CHAETODONTIDAE (Butterflyfishes)
Chaetodon auriga
Chaetodon ephippium
Chaetodon lineolatus
Chaetodon lunula

Name
Chaetodon ornatissimus
Chaetodon punctatofasciatus
Chaetodon quadrimaculatus
Chaetodon reticulatus
Chaetodon semeion
Chaetodon ulietensis
Chaetodon unimaculatus
Forcipiger flavissimus
Forcipiger longirostris
Hemitaurichthys thompsoni
Heniochus acuminatus
Chaetodon oxycephalus
POMACANTHIDAE (Angelfishes)
Centropyge flavissima
Centropyge loricula
Centropyge multicolor
KYPHOSIDAE (Rudderfishes, Sea Chubs)
Kyphosus bigibbus
Kyphosus cinerascens
KUHLIIDAE (Flagtails)
Kuhlia sandvicensis
OPLEGNATHIDAE (Knifejaws)
Oplegnathus punctatus
CARANGIDAE (Jacks)
Carangoides ferdau
Carangoides orthogrammus
Caranx ignobilis
Caranx lugubris
Caranx melampygus
Caranx sexfaseiatus
Deeapturus maearellus
Elagatis bipinnulatas
Gnathanodon speeiosus
Decapterus macarellus
Carangoides orthogrammus
Caranx lugubris
Caranx melampygus
Caranx sexfaciatus
POMACENTRIDAE (Damselfishes)
Abudefduf septemfasciatus
Abudefduf sordidus
Abudefduf vaigiensis
Abudefduf saxatilis
Chromis acares
Chromis agilis
Chromis vanderbilti
Chromis viridis
Chrysiptera biocellata
Chrysiptera brownriggii
Chrysiptera glauca
Dascyllus aruanus
Plectroglyphidodon dickii
Plectroglyphidodon imparipennis
Plectroglyphidodon johnstonianus
Plectroglyphidodon lacrymatus
Plectroglyphidodon phoenixensis
Stegastes albifasciatus
Stegastes fasciolatus
Stegastes nigricans
LABRIDAE (Wrasses)
Ammolabrus diems
Anampses caeruleopunctatus

Name
Bodianus anthioides
Cheilinus chlorourus
Cheilinus fasciatus
Cheilinus trilobatus
Cheilinus undulatus
Coris aygula
Epibulis insidiator
Gomphosus varius
Halichoeres biocellatus
Halichoeres margaritaceus
Halichoeres ornatissimus
Halichoeres trimaculatus
Hemigymnus fasciatus
Iniistius sp.
Labroides bicolor
Labroides dimidiatus
Labroides pectoralis
Labroides rubrolabiatus
Novaculichthys taeniouris
Oxycheilinus diagrammus
Oxycheilinus orientalis
GOBIIDAE (Gobies)
Amblygobius phalaena
Asterropteryx semipunctatus
Bathygobius fuscus
Cabillus tongarevae
Coryphopterus duospilus
Coryphopterus neophytus
Coryphopterus sp.
Ctenogobiops aurocingulus
Ctenogobiops feroculus
Ctenogobiops pomastietus
Eviota alfelei
Eviota epiphanes
Eviota saipanensis
Favonigobius sp.
Gnatholepis cauerensis
Gobiodon rivulatus
Paragobiodon lacunicolus
Priolepis kappa
Priolepis semidoliatus
Trimma sp.
MICRODESMIDAE (Dartfishes and Wormfishes)
Ptereleotris evides
Ptereleotris microlepis
SIGANIDAE (Rabbitfishes)
Siganus argenteus
ZANCLIDAE (Moorish Idol)
Zanclus cornutus
ACANTHURIDAE (Surgeonfishes)
Acanthurus achilles
Acanthurus blochii
Acanthurus guttatus
Acanthurus leucopareius
Acanthurus nigricans
Acanthurus nigricauda
Acanthurus nigrofuscus
Acanthurus nigroris
Acanthurus nubilus

Name
Acanthurus olivaceus
Acanthurus thompsoni
Acanthurus triostegus
Ctenochaetus cyanocheilus
Ctenochaetus hawaiiensis
Ctenochaetus striatus
Naso brevirostris
Naso hexacanthus
Naso lituratus
Naso unicornis
Naso vlamingii
Zebrasoma flavescens
Zebrasoma veliferum
SPHYRAENIDAE (Barracudas)
Sphyraena barracuda
SCOMBRIDAE (Tunas and Mackerels)
Acanthocybium solanderi
Euthynnus affinis
Katsuwonus pelamis
Thunnus alalunga
Thunnus albacares
Thunnus obesus
ISTIOPHORIDAE (Billfishes)
Istiophorus platypterus
Makaira indica
Makaira mazara
Tetrapturus angustirostris
Tetrapturus audax
NOMEIDAE (Driftfishes)
Cubiceps pauciradiatus
BOTHIDAE (Lefteye Flounders)
Bothus mancus
Bothus pantherinus
BALISTIDAE (Triggerfishes)
Balistoides viridescens
Melichthys niger
Melichthys vidua
Rhinecanthus aculeatus
Rhinecanthus rectangulus
Sufflamen bursa
Xanthichthys mento
MONACANTHIDAE (Filefishes)
Aluterus scriptus
Cantherhines dumerilii
OSTRACIIDAE(Trunkfishes, Boxfishes)
Ostracion cubicus
Ostracion meleagris
TETRAODONTIDAE (Puffers)
Arothron hispidus
Arothron meleagris
Arothron stellatus
Canthigaster amboinensis
Canthigaster janthinoptera
Canthigaster solandri
DIODONTIDAE (Porcupinefishes)
Diodon hystrix
ALBULIDAE (Bonefish)
Albula vulpes

Source: USFWS, and NMFS. 1999. Table E-8. Fish Species Found on Wake Atoll. Retrieved February 18, 2021 from https://www.fws.gov/uploadedFiles/Region_1/NWRS/Zone_1/Pacific_Reefs_Complex/Wake_Atoll/Documents/Fish%20of%20Wake%20Atoll.pdf.

Appendix K. List of Coral Species Reported at Wake Atoll

Scleractinian Corals, Octocorals, Hydrozoans Corals and Other Anthozoa Reported at Wake Atoll from 1979 to 2005 Surveys.

Coral Name	Habitat Observed		
Scleractinian Corals	**Fore Reef**	**Reef flat**	**Lagoon**
Acanthastrea echinata	X	X	X
A. hillae	X		
Acropora abrotanoides	X		
A. aculeus (RL)	X		
A. acuminate (RL)		X	X
A. cf. cerealis	X		
A. formosa		X	X
A. humilis	X		
A. hyacinthus	X		
A. lutkeni	X		
A. cf. *microclados*	X		
A. nasuta	X	X	X
A. ocellata sensu Randall	X		
A. palmerae (RL)	X		
A. cf. *striata*			X
A. surculosa	X		
A. valida	X	X	X
Acropora sp. (I)	X	X	X
Acropora sp. (2)	X		
Acropora sp. (3)	X		X
Acropora sp. (4)	X		
Astreopora myriophthalma	X	X	
A. randalli	X		
Cyphastrea chalcidicum	X	X	X
C. microphthalma	X		
C. serailia	X	X	X
Echinopora lamellosa	X		
Favia favus	X		
F. helianthoides	X		
F. matthai	X	X	X
F. pallida	X	X	
F. speciosa		X	
F.stelligera	X	X	
Favia sp.	X		
Favites abdita	X	X	X
F. complanata	X		
F.flexuosa	X	X	
F.halicora	X	X	
Fungia scutaria	X		
Goniastrea edwardsi	X		X
G. favulus	X		
G. pectinata	X	X	

G. retiformis	X	X	
Hydnophora exesa	X		
Leptastrea aequalis		X	
L. purpurea	X	X	
L. transversa	X		
Leptoria phrygia	X		
Leptoseris mycetoseroides	X		
Lobophyllia hemprichi	X		
Merulina ampliata	X		
Montastrea curta	X	X	
M. valenciennesi	X	X	X
Montipora danae	X		
M. foveolata	X		
M. grisea	X	X	X
M hoffmeisteri	X	X	X
M. incrassata	X		
M. informis	X	X	
M. lobulata (RL)	X	X	X
M. marshallensis		X	
M. monasteriata	X		
M. tuberculosa	X		X
M. verrucosa	X		
Montipora sp. (2) *sensu* Randall	X		
Montipora sp. (5)	X		X
Montipora sp. (6)	X		
Montipora sp. (7)	X		
Montipora sp. (8)	X		X
Pavona duerdeni	X		
P. maldivensis	X		
P. varians	X	X	X
Pavona sp. (1) *sensu* Randall	X		
Platygyra daedalea	X	X	
P. lamellina	X		
P. sinensis	X		
Pocillopora damicornis		X	X
P. elegans (RL)	X		
P. eydouxi	X		
P. meandrina	X		
P. setchelli	X		
P. verrucosa	X		
Porites lichen	X		
P. lobata	X	X	X
P. lutea	X	X	X
P. rus	X		
P. solida	X		

Psammocora profundacella *Psammocora sp.*	X X	X	
Scapophyllia cylindrica	X		
Seriatopora hystrix		X	
Stylophora mordax	X		
Symphyllia radians *S. recta*	X X		
Tubastrea sp.	X		
Octocorallia Corals			
Lobophytum sp.	X		
Sarcophyton sp.	X	X	
Similaria sp.	X		
Stereonephthya sp.	X		
Hydrozoan Corals			
Millepora exaesa *M. platyphylla*	X X		
Zoanthids			
Palvthoa sp.	X		

(1) caespitose colonies; tubular incipient axial corallites are common; (2) thick-branched, with nariform radial corallites; (3)corymbose colonies with nariform radial corallites; (4) caespitose colonies with tubular radial corallites; (5) encrusting colonies with coenosteal papillae; (6) encrusting colonies with prominent thecal papillae; (7) encrusting colonies with coenosteal papillae, often forming short ridges; (8) encrusting colonies with coenosteal papillae mostly forming short ridges.

Species denoted "*sensu* Randall" identified according to characteristics described in Randall and Myers (1983). RL =IUCN Red List of Threatened Species.

Source: Kenyon, J., Bonito, V., and Wilkinson, C. B. 2014. Characterization of Coral Communities at Wake Atoll in the Remote Central Pacific Ocean. Atoll Research Bulletin, 601:1-21.

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