2013 ATST HCP Annual Report

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Advanced Technology Solar Telescope
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INTRODUCTION

The ATST Resource Management Team submits this annual report and has conducted these monitoring/management efforts in accordance with the ATST Habitat Conservation Plan (HCP) and the Final Biological Opinion (BO) of the US Fish and Wildlife Service (USFWS, 1-2-2011-F-0085).

Background of the ATST Project

The Advanced Technology Solar Telescope (ATST) is funded by the National Science Foundation (NSF) for the construction of the ATST Project within the 18.166-acre University of Hawaiʻi Institute for Astronomy (IfA) Haleakalā High Altitude Observatory (HO) site at the summit of Haleakalā, County of Maui, Hawaiʻi. Construction of the ATST began on December 3rd, 2012. The ATST was dedicated to late Senator Daniel K. Inouye and renamed the Senator Daniel K. Inouye Solar Telescope (DKIST) on December 15th, 2013. Since most work in 2013 was conducted under the project name of ATST, we will continue to use ATST in the annual report.

The ATST facilities will include a 143-foot (ft) (43.6-meter (m) tall building housing the telescope, an attached support and operations building, and a utility building. As the largest and most capable solar telescope in the world, the ATST will provide researchers with 2.5-mile (mi) (4-kilometer (km) resolution images of the Sun's surface. The primary goals of the ATST Project are to understand solar magnetic activities and variability, both because the Sun serves as a key resource for understanding the underpinnings of astrophysics and our understanding of magnetic plasmas, and because activity on the Sun drives space weather. Space weather creates hazards for communications to and from satellites, as well as for astronauts and air travelers. Furthermore, and perhaps most importantly, the variability in solar energy induced by solar activity affects the Earth's climate. The key to understanding solar variability and its direct impact on the Earth rests with understanding all aspects of solar magnetic fields, which in turn control the fluctuating Sun.

ATST Habitat Conservation Plan/Incidental Take License

The ATST Habitat Conservation Plan (HCP), which was approved by the State of Hawaiʻi Board of Land and Natural Resources (BLNR) in January 2011, addresses anticipated impacts to state and federal threatened, endangered, and listed species from the construction of ATST at HO, pursuant to Chapter 195D, Hawaiʻi Revised Statutes (HRS 195D). Once construction of ATST is complete, the operations of the ATST facility are not expected to result in incidental take of listed species under HRS 195D. The State of Hawaiʻi Board of Land and Natural Resources (BLNR) issued an Incidental Take License (ITL), No. ITL-13, to the NSF on November 30, 2011. The ITL grants permission of take, if such take is incidental to and not the purpose of the carrying out of an otherwise lawful activity, for 35 Hawaiian petrel individuals: 30 fledglings and 5 adults.

FAA/Coastguard Communication Tower Monitoring

Because the ATST facility may interfere with Federal Aviation Administration's (FAA) ground-to-air signal conveyance, NSF, through AURA/NSO, has funded necessary tower upgrades on two of the existing FAA towers located on FAA property adjacent to HO. Tower upgrades were completed October 8, 2012. By agreement between NSF and FAA, the ATST Resources Management Team also monitored the FAA tower site to collect baseline petrel-tower collision information.

Hawaiian Petrels

Status of the Species

The endangered Hawaiian petrel (*Pterodroma sandwichensis*) is a medium-sized seabird in the family Procellariidae (shearwaters, petrels, and fulmars). The Hawaiian petrel formerly was treated as a subspecies of *P. phaeopygia*, with the nominate subspecies occurring in Galapagos (*P. p. phaeopygia*). Based on differences in morphology and vocalization, the two subspecies were reclassified as full species in 1993 (Monroe and Sibley, 1993) and genetic analysis confirmed the split several years later (Browne, et al., 1997).

Listing Status

The Hawaiian petrel was listed as endangered on March 11, 1967 (32 FR 4001).

Historical and Current Distribution and Threats

Hawaiian petrels were abundant and widely distributed in prehistory; their bones have been found in archaeological sites throughout the archipelago (Olson and James, 1982). Introduced avian diseases (Warner, 1968), collection for use as food (Harrison 1990), and introduction of dogs(*Canis lupus familiaris*) , pigs (*Sus scrofa domesticus*), cats (*Felis silvestris catus*), rats, and mongoose (*Herpestes javanicus*) predators have resulted in substantial declines in the distribution and numbers of this species and has led to small relict colonies of Hawaiian petrels in high-elevation, remote locations. This species has no natural terrestrial predators other than the Hawaiian owl (Pueo, *Asio flammeus sandwichensis*).

Aside from these threats, other significant anthropogenic sources of Hawaiian petrel mortality are light attraction and collision with communications towers, power transmission lines and poles, fences, and other structures (Simons, 1983). The Hawaiian petrels fly over 30 miles/hour (48 km/hour) (Day and Cooper, 1995), which likely reduces the ability to detect obstacles in the dark and avoid them. This problem is likely to be exacerbated by the continuing development and urbanization throughout Hawaiʻi.

Hawaiian petrels are currently known to nest on at least five islands (Simons and Hodges, 1998), but their distribution is limited to high elevation sites where predation pressure is lower. Maui may harbor as much as one quarter of the breeding population and most of Maui's petrels nest along the rim of Haleakalā Crater (Simons and Hodges, 1998) in Haleakalā National Park and in the vicinity of the ATST action area. The most recent estimate of breeding petrel numbers in these areas is roughly 400 to 600 breeding pairs (Simons and Hodges, 1998; Bailey 2006, personal communication).

An accurate estimate of total numbers of Hawaiian petrels is not available; however, estimates range from the thousands to about 34,000 (e.g., Spear, et al., 1995; Ainley, et al., 1995). Spear, et al. (1995)

estimated the at-sea population size of adult and sub-adult Hawaiian petrels of 19,000 birds (with a 95 percent confidence interval of 11,000 to 34,000). Ainley, et al. (1997) estimates a breeding population of about 1,600 pairs on Kaua'i and Ainley (USFWS, unpublished field notes) estimates that there are a few thousand pair occurring on Lana'i and 1,500 on Haleakalā. Darcy Hu (2009, personal communication) located 115 active burrows within the Hawai'i Volcanoes National Park (HAVO) in 2006. Jay Penniman currently estimates that between 1,000 and 6,000 Hawaiian petrels come to shore each year on all islands (2009, personal communication).

Nesting Habitat

Nesting habitat of Hawaiian petrels on Maui is currently at elevations above 7,200 ft (2,195 m), although historically the species may have nested at lower elevations (USFWS, 1983). The largest known nesting colony of Hawaiian petrels is located in and around the National Park (Simons and Hodges, 1998). Approximately 30 known burrows are located along the southeastern perimeter of HO, several burrows are northwest of HO, and additional burrows have been found northeast of the ATST Project site (NPS, 2003). Hawaiian petrels are present at Haleakalā from February through October and are absent from November through January.

The Hawaiian petrel nests on Haleakalā in high elevation burrows located beneath rock outcrops, along talus slopes or along edges of lava flows where there is suitable soil underlying rock substrate for excavation of tunnels. Hawaiian petrel nesting burrows are located among rock outcrops, under boulders, within the cinder substrate, and along cliff faces. Vegetation is sparse in nesting areas on Haleakalā Crater owing to the high elevation and dry environment; within the ATST Project area, vegetation is predominantly grass (*Deschampsia australis*) and bracken fern (*Pteridium aquilinum*). The rocky substrate is disturbed in the immediate area around the construction site due to previous construction activities.

The majority of known Hawaiian petrel burrows are located along the western rim of the Haleakalā Crater, where this habitat is most abundant and also where predator control is afforded. Using survey efforts from 1990-1996, previous estimates of burrow density, including part of the mitigation area, range from 5 to 15 burrows per ha, compared to 15 to 30 burrows per ha along the western crater rim. Similarly, in 2004 and 2005, Hawaiian petrel passage rates, collected using ornithological radar, were 4 to 7 times greater during summer and fall at the Visitor's Center (Western rim), when compared to the Haleakalā Observatory complex, suggesting bird numbers are lower on the western slopes encompassing the ATST mitigation site. Importantly, the population trend at Haleakalā is increasing, which suggests that additional recruitment into this site is possible (Holmes, 2010b).

Burrows are excavated to a depth of three to six ft (one to 1.8 m), but sometimes reach a length of 15 ft (4.6 m) or more. Most of the nests on Haleakalā are in rock crevices in sparsely vegetated, xeric habitat (Simons and Hodges, 1998). Birds spend much of their time at sea where they are known to feed on squid, small fish, and crustaceans displaced to the surface by schools of tuna (Larson, 1967; Simons, 1985). Petrels have been recorded in the Philippines (Rabor, et al., 1970), Japan (Nakamura, 1979), the Gulf of Alaska (Bourne, 1965), and off the coast of Oregon and California (Pyle, et al., 1993). Hawaiian petrels have been tracked taking single trips exceeding 6,200 mi (10,000 km) circumnavigating the north Pacific during the nestling stage (Adams, et al., 2006).

Similar to other members of its family, the Hawaiian petrel has a well-defined, highly synchronous nesting season (Simons, 1985), albeit there is clear evidence of intra-island variation in breeding phenology in Hawaiʻi, with Haleakalā breeders initiating, and completing, breeding approximately one month earlier than Kauaʻi, Lanaʻi, and Hawaiʻi Island. Birds arrive in their colonies in late February. After a period of burrow maintenance and social activity they return to sea until late April when egg-laying commences. Non-breeding birds visit the colony from February until late July (Simons and Hodges, 1998). Many of these may be young birds seeking mates and prospecting for nest sites, but some proportion is thought to be mature adults that do not elect to breed.

Non-breeders and failed breeders typically begin leaving the colony once the eggs have hatched. Chicks fledge between late September and late November. Both adults participate in incubating the egg and feeding the chick; after a brief brooding period, both adults are foraging at sea and will have absences from the nest (Simons, 1985). Although adults are occasionally observed to remain after fledglings depart, colonies generally are empty by the end of November. A hiatus of only about three months occurs between the end of one breeding season and the beginning of the next. Hawaiian petrels are thought to begin breeding at about five or six years of age, and roughly 90 percent of breeders attempt to breed each year (Simons and Hodges, 1998). Beginning in mid-February to early March, after a winter absence from Hawaiʻi, breeding and non-breeding birds visit their nests regularly at night, for a period of social activity and burrow maintenance work. Pairs are site tenacious, returning to the same burrow year after year. From mid-March to mid-April, birds visit their burrows briefly at night on several occasions. Then breeding birds return to sea until late April or early May, when they return to lay and incubate their eggs.

Male and female birds alternate incubation attendance. Total incubation period ranges from 45 to 58 days (Simons, 1985). Egg temperature and evaporative water loss are controlled by the incubating adult. Because the metabolism of awake, resting birds is almost twice that of sleeping birds (Simons, 1985), disturbance of incubating birds' sleep could potentially result in more rapid weight loss and an inability of the adult to stay on the egg until its mate relieves it.

During the incubation period, many non-breeding birds also inhabit the colony. Many of these are young birds gaining experience seeking mates and prospecting for nest sites; the remaining portions are experienced breeders that did not elect to breed. Non-breeders and failed breeders typically begin leaving the colony once the eggs have hatched. They continue to visit their burrows at night through early August (Simons, 1985). By September, the only birds visiting the colony are adults returning to feed their chicks (Simons, 1985). Chicks do not appear to require much brooding from their parents. Adults depart from the nest to forage at sea within one to six days after the chick hatches (Simons, 1985). Chicks spend 66 percent of their time alert, resting quietly, 26 percent of their time sleeping, 6 percent of their time preening or stretching, and 2 percent of their time walking around (Simons, 1985). Nocturnal feeding by one parent occurs approximately every other day until the chick is 90 days old. After 90 days, adults appear to continue to feed chicks until the chick refuses food. Chicks fledge between late September and late October, after an average of 111 days after hatching (Simons, 1985). Although adults are occasionally observed to remain after fledglings depart, colonies generally are empty by the end of November.

There are four Hawaiian petrel burrow clusters, and a number of isolated burrows, within approximately 1,250 ft (381 m) of the ATST Project site, totaling approximately 31 individual burrows. Burrow clusters and individual burrows to the west and the northwest of the construction site historically have not been highly used by nesting Hawaiian petrels (Bailey, 2009, personal communication); approximately 5 to 10 burrows (mostly inactive) are 500 to 800 ft (244 m) from the construction site to the west.

Breeding Success

The primary reason for the relatively large numbers of petrels and their successful breeding around Haleakalā summit today is likely due to the fencing and intensive predator control maintained by Haleakalā National Park since about 1982. The petrel's habitat is destroyed or severely compromised by feral ungulates such as goats, and by pigs in wetter and more vegetated environments than the summit of Haleakalā. In addition to collapsing burrows and compacting the substrate, these animals provide vectors for non-native invasive plants that alter the vegetation structure and may hinder the birds' access to traditional nesting areas.

ATST HCP CONSERVATION AREA AND CONTROL SITE

ATST HCP Conservation Area includes observatory facilities, broadcast facilities, communication towers, and the portion of Skyline Trail dividing the area from the northeast to southwest. Adjacent lands include the Kula Forest Reserve, Kahikinui Forest Reserve, NPS, DHHL, and private land. The conservation/mitigation site contains a number of cinder cones, of which Puʻu Kolekole is the highest in elevation. This cone is about 0.3 mi (0.5 km) from the highest point on the mountain, Puʻu ʻUlaʻula (Red Hill) Overlook, which is in the Park and outside of the state lands (Figure 1). Based on the State of Hawaiʻi website published TMK GIS layer, the area was estimated to be 328 ac (133 hc), but after the ground survey using existing metes and bounds, the area covers an area of 130.22 hc (321.79 ac, Figure 1).

The HCP Conservation Area is located between approximately 8,800 to 10,000 ft (2,686 to 3,048 m) in elevation, where snow and hail can occur. The annual average total precipitation on the Haleakalā summit, in the vicinity of the proposed mitigation area, between 1949 and 2005, was 52.92 inches (in) (134 centimeters (cm). At or near the summit, sustained wind speeds of 50 miles per hour are not unusual. The greatest wind speed recorded at the summit is over 125 miles (mi) per hour (201 km per hour). The topography within the conservation site is rugged and barren, and the elevation drops with an average slope greater than 30 percent (ATST 2010). Temperatures at the summit of Haleakalā can range between below freezing to highs of 65°F (18°C, HNP 2011).

The Control Site is one kilometer west of the west boundary of the Conservation Area, just north of the Skyline Trail, at an elevation of 8,700 to 9,300 ft. (2652 to 2835 m). The topography within the Control Site is similar to that of the Conservation Area. This Control Site encompasses 80 acres and will be used to compare and evaluate the ATST's Resource Management Team's conservation efforts within the HCP Conservation Area (Figure 1).

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Note: The ground-truth ATST HCP Conservation Area boundary on the map is different from the State of Hawai'i website published TMK GIS layer. The actual metes and bounds on the ground vary from the GIS layer up to 33 meters.

ATST HCP COMPLIANCE

Hawaiian Petrel Burrow/Reproductive Success Monitoring

Hawaiian Petrel burrow/reproductive success monitoring has been conducted annually since the 2011 breeding season by ATST's resource management team, in both the Conservation Area and Control Site (Figure 1). Due to the acute angle shapes of petrel burrows and the volcanic rock, utilizing a burrow scope of current design in the Haleakalā summit area is not feasible. Therefore data on the number of petrel pairs that laid eggs was not available, and for the purpose of this report, we are using "fledgling success" instead of the textbook definition of "reproductive success" to denote Hawaiian Petrel reproductive success in this area. "Fledgling success" is estimated by dividing the total number of burrows that fledged one petrel chick by the number of active burrows within the same season.

Birdstrike Monitoring

Birdstrike monitoring has been underway since 2011 between February 1st and November 30th (2011 was an exception for which monitoring began on June 7th). Monitoring is done in an area of about 3.3 acres inside and around the construction site, at distances from construction equal to about 1.25 times the 143 foot height of the tallest structure that will ultimately be part of the ATST facility. The site was monitored every morning, seven days a week during this period. Prior to the start of construction of ATST in 2011 and 2012, only the FAA and Coastguard communication towers were monitored. Monitoring of the ATST construction site within a radius of 1.25 times the eventual height starting from the outer perimeter of the structure (observatory and support building) began on February 1st, 2013 (Figure 2) and ended on November 30th, 2013.

Control Site Selection and Setup

In order to fulfill the monitoring obligations of the HCP, a Control Site was selected based on GIS research and the ATST resource management teams' ground search data in the Haleakalā summit area in 2011 (Figure 1). A DLNR Permit for Access was issued on 05/31/2012 in order to conduct monitoring activities in this area.

Site Boundary, Conservation Fence Line Surveying/Marking

The ATST Conservation Area boundary survey and marking was completed by Akamai Land Surveying Inc. on July 3rd, 2013 using the approved ATST HCP area maps, the Hawaii Government published GIS TMK map and existing metes and bounds as guidance. The final survey of the fence boundary was conducted on August 15th, 2013 by Rock N H Fencing Company personnel, International Archaeological Research Institute Inc. archeologist and the ATST resource management team, to ensure the fence is within the ATST Conservation Area boundary and avoids disturbing any known Hawaiian Petrel burrows and cultural resource sites. Based on the survey, the Conservation Area covers an area of 130.22 hc (321.79 ac, Figure 1).

Conservation Fence

The conservation fence Conservation District Use Permit (CDUP) was issued on May 17th, 2013. On July 25th, 2013 Rock N H Fencing Company was awarded the contract to construct the conservation fence. The construction started on September 1st, 2013 and was completed on November 18th. A total of 4.23 km (2.63 mi) of fence was built and 126.53 hc (312.66 ac) of Conservation Area was enclosed, which included 0.66 hc (1.64 ac) of Haleakala National Park land outside of the park fence (Figure 1).

Searcher Efficiency Trial (SEEF)

In order to accurately estimate mortality rates of endangered species during construction of ATST, annual tests must be conducted each year to evaluate the overall efficiency of carcass detection in the ATST project area. Therefore, searcher efficiency trials are conducted to estimate search accuracy. These trials are to be conducted by a third party contractor, and must take place unbeknownst to the searcher(s). KC Environmental Inc. (KCE) is a Maui-based third party contractor selected to conduct the 2013 SEEF Trials on behalf of ATST in coordination with the Project's resource biologist. The 2013 SEEF trial was undertaken between May 28th and August 26th, 2013 within the birdstrike monitoring Search Area A of ATST's approved Conservation Area, outlined in red in figure 2. Search Area B is non-searchable on the ground by personnel due to extremely steep terrain (Figure 2). A total of 20 carcasses were placed for the trial on random days and in random quantities.

[redacted]

Figure 2. ATST conservation Birdstrike/Search Area

For the trials, the ATST resource management team was operating as a sub-permittee under KC Environmental's Migratory Bird Permit (USFWS 02/27/2013)/Protected Wildlife Permit (DLNR 03/04/2013) The procedure is similar to the birdstrike monitoring, except that surrogate Wedge Tailed Shearwater (*Puffinus pacificus*) carcasses are returned to a cooler at the site and events are reported only to KC Environmental, with photos, bird tag numbers and coordinates included in the report.

Of the 20 placed during the trial period, 17 carcasses were found and 3 were not found, resulting in a searcher efficiency rate of 85% for the ATST Resource Management team. (Fein and Allan 2013a).

Carcass Removal Trial (CARE)

Pursuant to the approved HCP and published BO, CARE trials will be conducted three times each year, for an estimated mitigation period of 6 years. Carcass removal trials are undertaken to determine the

Advanced Technology Solar Telescope (ATST) scavenging rate by cats, rats and mongoose or other scavengers of any birds killed via birdstrike. This information will be used to guide search intervals for birdstrike monitoring for the ATST project. These trials are to be conducted by a third party contractor. The 2013 CARE trial was undertaken by KCE beginning on September 30, 2013 and it was concluded on October 30, 2013 within approved fenced predator control grid in Conservation Area, and this area was at least 50 m from any known petrel burrows (Figure 3).

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Carcasses were placed in a variety of positions including 2 that were exposed (thrown), 1 hidden to simulate a crippled bird and 1 partially hidden.

The first ATST CARE trial yielded zero scavenging rates at three of the four approved carcass locations over a period of thirty days. One bird was removed from a partially concealed location within two weeks of placement, with only feathers left behind. None of the findings suggest that temporal or spatial intervals for birdstrike monitoring should be reduced during ATST construction, particularly since reporting and recovery of birds in a timely manner is essential to determining the cause of mortality. However, the consistent physical evidence remaining after predation of birds on the upper slopes of Haleakalā may warrant reduction of the carcass removal factor in any calculations of unobserved take (Fein and Allan 2013b).

Long-term rodent control grid

Jayson Panglao, an ATST resource technician, obtained his "state commercial II forest pesticide applicator certification" in November 2012, in order to utilize diphacinone in ATST's long-term rodent control grid. A 48-meter bait box grid of 51 stations was established, which was a modification from the original 50-meter plan, due to the spatial baiting requirements on the diphacinone label. The newer 48 meter grid layout plan was approved by USFWS in March 2013. Each station is equipped with a Protecta ™ temper-resistant rat bait box and a mouse box. Due to the ongoing ATST construction activities, 44 of the planned 51 stations are in place at this time. The ATST resource management team will adjust the location and number of working stations based on construction activities. The 51 station system should be fully functional once work external to the ATST project is completed (Figure 4).

Each rat bait box was deployed with eight 1-oz Ramik™ diphacinone blocks. The stations were checked after one week and then two weeks, and at the time of removing the blocks to estimate the take. The grid was implemented from April 2nd to May 28th, 2013. Due to diphacinone label expiration on 05/30/2013, use of diphacinone was discontinued. Only 6.6 oz. of diphacinone bait was taken. T-Rex rat and mouse snap traps have been deployed until the new label is approved. In 2013, these temporary rodent traps killed 18 field mice, 10 roof rats and two unidentifiable rats.

Rodent and Predator Population Monitoring

A 48 m grid system consisting of 20 stations was installed in the Conservation Area using the existing Long-Term Rodent Control Grid, and in the Control Site. The two rodent population monitoring grids were 2,030 meter apart to ensure the independence of the Control Site grid from our Long-Term Rodent Control Grid treatment. Each Station was equipped with a T-Rex rat and a T-Rex mouse trap housed in Protecta temper-resistant bait boxes. We used peanut butter as bait and the traps were pre-baited one week before the traps were set. Each monitoring period consisted of two trap nights. The rodent population was monitored seasonally in March, June, September and December of each year (Figure 4). Table 1 summarizes the rodent monitoring results. The capture rate is low; at most, only one rodent was caught in each season in each grid.

Table 1. 2013 Rodent Caught in ATST Rodent Monitoring Grids

Season	Spring		Summer		Fall		Winter	
Spp./location	Control	Conservation	Control	Conservation	Control	Conservation	Control	Conservation
Roof Rat	0	1	0	0	0	1	1	1
Norway Rat	0	0	0	0	0	0	0	0
Polynesian Rat	0	0	0	0	0	0	0	0
Field Mouse	0	0	1	0	1	0	0	0
Total	0	1	1	0	1	1	1	1

[redacted]

Ungulate/predator population monitoring data was collected with camera traps. 20 Bushnell Trophy Cam HD camera traps, 10 at each site (Conservation Area and Control Site) were installed at random locations generated by ArcGIS 10.0 on 04/23/2013 in the Conservation Area and on 04/24/2013 in the Control Site (Figure 4).

Six additional camera traps were mounted at six selected fence posts along the fence line on 12/03/2013, where previous goat tracks were detected to monitor whether ungulate eradication is needed (Figure 4).

While these efforts are not required by the HCP, the ATST resource management team has implemented invasive mammal monitoring programs to help achieve Net Recovery Benefit through an Adaptive Management approach. Rodent population monitoring grids and predator/ungulate population monitoring camera traps in the Conservation Area and Control Site are part of these efforts.

Predator Control

In 2012, after examining footage from surveillance cameras, the presence of a feral cat below MEES Observatory was discovered. Camera footage revealed that the feral cat had visited five different burrows and entered at least one. A Havahart trap was set near burrow SC37 just below MEES Observatory on September 13, 2012. Friskies brand cat food was used as bait. The trap was labeled (CT001) along with the GPS coordinates of the trap location.

After consulting with USFWS, a 125-meter Predator control grid system was installed consisting of 18 Havahart traps (for cats) and 19 A-24 automatic traps (New Zealand Goodnature Company, for mongoose) that cover the northern part (the lower portion with higher risk of predation) of the Conservation Area. This grid is not as uniform as it appears in plan -- in the actual on-ground layout of the grid; we avoided placing traps within 50 meters of any known petrel burrow to avoid attracting predators into petrel colonies (figure 4). Each Havahart trap was equipped with a Telonics TBT-600NH trapsite transmitter to ensure the traps are checked at least every other day to avoid petrel by-catch and to ensure the welfare of the trapped animals.

The installation of the northern trap grid was completed on 09/16/2013, and was operational until 11/18/2013. The southern part of the gird will be installed in 2014.

No cats or Indian small mongoose were caught during this period of time. The A-24 traps killed three roof rats and the Havahart traps caught two roof rats.

HAWAIIAN PETREL REPRODUCTIVE SUCCESS MONITORING METHODS

Personnel Training

All current members of the ATST Resource Management Team received extensive training in 2011. This training included both field and administrative training. Members were trained on petrel carcass search and handling, petrel burrow identification, classification of burrow status based on signs of petrel activity, and avoidance of cultural resources during field work. The Predator Control Technician is certified for Commercial Applicators of Restricted Pesticides. Each member was trained in handling rodenticide and rodent carcasses. Two of the team members were either State of Hawaii Hunter Education certified or NRA firearm certified. All members were previously trained in the use of GPS and ArcGIS software and all completed First Aid/First Responder and CPR certifications.

Petrel Burrow Search

The ATST Resource Management Team began monitoring known burrows and searching for new burrows in the HCP Conservation Area and Control site on August 10th in 2011, and on February 22nd in 2012. Monitoring ended on November 16th in 2011 and on November 10th in 2012 when the petrel chick from the last known burrow fledged. In 2013, the monitoring/search effort began on May 7th, after the peak egg laying period of the year. Monitoring efforts ended when the last known petrel chick fledged on October 24, 2013.

The team began this year's efforts by visiting all the burrows that were recorded during the 2011 and 2012 nesting season. Any newly identified burrows were documented as they were discovered. Coordinates of the newly discovered burrows were recorded with handheld Garmin Oregon 450 and 550 GPS units. A systematic search of both the Conservation Area and the Control Site was also conducted using natural landmarks and handheld Garmin Oregon 450 and 550 GPS units to locate and record petrel burrows. Signs of petrel activity (feathers, droppings, egg shells, footprints, regurgitation, smell, and other body parts) and GPS coordinates at each burrow were recorded. Toothpicks were placed vertically along the entrance of each burrow to monitor petrel movement in and out of burrows. Fallen or height-altered toothpicks suggested current activity. Standing toothpicks denoted no activity (Hodges 1994).

Hawaiian Petrel Reproductive Success

Breeding success was classified based on signs at the entrance, status of placed toothpicks, and the latest date of activity. Burrows which were classified as "Active" were rechecked weekly until signs of successful or failed fledging were observed. A burrow was defined to be the source of "Successful Fledging" by the presence of petrel chick down feathers at the burrow entrance, and disturbed toothpicks after September 24, 2012. Burrows classified as "Failed" showed signs of activity during initial search, but no further signs were found while conducting the rechecks, which suggested these burrows were either abandoned or the chicks did not reach fledgling age.

In addition to mechanical means of monitoring, cable surveillance video cameras were also installed to monitor petrel activities at 18 burrows adjacent to the MEES Observatory. In 2013, Bushnell "Trophy Cam HD™" camera traps were installed between 10/15 and 11/07/2013 at 16 burrows that were still active in mid-October to monitor the Hawaiian Petrel reproductive success.

Due to the limitation of utilizing burrow scopes in the summit area of Haleakalā, the actual number of petrel nest burrows that contained an egg is unavailable. After discussing this situation with other biologists that have worked in this area and encountered the same limitations, we decided to use the term "fledgling success" instead of the textbook "reproductive success". The "fledgling success" is estimated by dividing the total number of burrows that fledged one petrel chick by the number of active burrows of the same season.

Birdstrike Monitoring

As mentioned earlier in this report, the perimeter boundary search area for birdstrike monitoring is 1.25 times the height of the objects associated with the construction of the ATST, or about 180 feet. The perimeter, designated as Area A extends approximately that distance around the boundary of the ATST observatory site, the support and operations building, and the lower and upper enclosures were delineated. This search area covers 3.3 ac (1.3 ha, Figure 2).

Within this search area, two zones were identified. Area A (3.3 ac (1.3 ha)) lies on the ATST plateau and includes other observatories. This area includes roads, pathways and roofs of buildings, plus open rocky habitat with little obstruction for detecting bird carcasses. No restriction on this search area exists. Area B (1.4 ac (0.6 ha)) lies on the slopes south and east below the ATST plateau and includes rocks and boulders of various sizes that would obstruct simple observation of bird carcasses. This area is in existing Hawaiian petrel habitat and frequent access for birdstrike monitoring is not recommended because it would degrade breeding habitat there.

However, searchers were able to access the edge of the cliff at the demarcation between Area A and Area B, and were able to visually inspect Area B from the Skyline Trail road below. Using careful visual scanning (binocular-assisted) of Area B from both Area A and the Skyline Trail road was feasible. However, take was adjusted for Area B, which couldn't be covered adequately enough to accurately count downed birds. Visual scanning, however, was useful in detecting and recovering any downed birds in the open, so that they did not become a predator attraction.

An area equal to a seventy-five foot radius of the FAA towers (Figure 1) was delineated. This radius is one and one quarter (1.25) the height of the two FAA towers (60 ft). Due to the close proximity of an additional Coast Guard communications tower, which is 100 feet tall, a 125 foot radius around this tower was also searched, since it would be impossible to discriminate the source of collision between these towers in the event a downed bird were to be found.

ATST resource management team members, who have been trained by the ATST resource biologist responsible for monitoring, conducted birdstrike monitoring in these two sites. Due to the cultural sensitivity in the summit area, the resource management team could only use existing landmarks to systematically search these two sites.

If any collisions were to have occurred, the following information would have been documented: date, time, coordinates, species, photo of the bird in question, and person attending. This information would be included in a report that would be forwarded to the U.S. Fish and Wildlife Service HCP and law enforcement departments and DOFAW. Based on the BO, the carcass would be handled according to the official protocol of the USGS Wildlife Health Center, Honolulu office and injured individuals would be delivered to appropriate local Maui veterinarians, and ATST would fund the acute care and the bird's transport, if necessary, to a permitted wildlife rehabilitation center (currently located on Oahu and the island of Hawaii).

In the future, the resource management team will work with DOFAW to integrate downed wildlife handling protocol into our current downed wildlife handling protocol.

Monitoring of birdstrike is scheduled to be conducted from February 1st to November 30th each year (June 7th to November 30th in 2011). No collision events were detected in 2011 (154 person-days), 2012 (304 person-days), or 2013 (304 person-days) at the ATST construction site and the FAA/Coastguard tower site.

HAWAIIAN PETREL REPRODUCTIVE SUCCESS MONITORING RESULTS AND DISCUSSION

Petrel Burrow Search

In 2011, we spent a total of 77 person-days (10 hours per person per day) searching for burrows (old and new) in the HCP Conservation Area and 36 person-days searching the Control site. A total of 36 person-days were spent conducting rechecks of the known "Active" burrows within the Conservation

Area. Two person-days were spent conducting re-checks in the Control site of the known "Active" burrows. During 2012, a total of 75 person-days were spent monitoring and searching for burrows (old and new) in the HCP Conservation Area, and 12 person-days were spent searching the Control Site.

The ATST resource management team invested a total of 52 person-days monitoring and searching for burrows (old and new) in the HCP Conservation Area, and 7 person-days in the Control Site in 2013. Table 2 summarizes the number of burrows recorded in the past three seasons.

Table 2. Hawaiian Petrel Burrows Found in ATST HCP Conservation Area and Control Site on Haleakala, Maui, Hawaii.

Year	**2011**		**2012**		**2013**	
Status	**New**	**Old**	**New**	**Old**	**New**	**Old**
Conservation Area*	**117**	**91**	**22**	**259**	**6**	**281**
Control Site	**21**	**0****	**4**	**21**	**1**	**25**

***Due to the newly marked boundary, the numbers of burrows included in our monitoring results varied annually before the conservation fence was built in 2013. In addition, the national park identification of burrows was often duplicated for a single burrow, or a burrow identified singly might have multiple entrances. **new site that year.**

Burrow Status

Based on our monitoring data, Hawaiian Petrel burrows were classified as "Active", "Not Active" and "Not A Burrow" (collapsed burrow). In our analysis, only burrows that were either "Active" or "Not Active" and were inside the boundary were included.

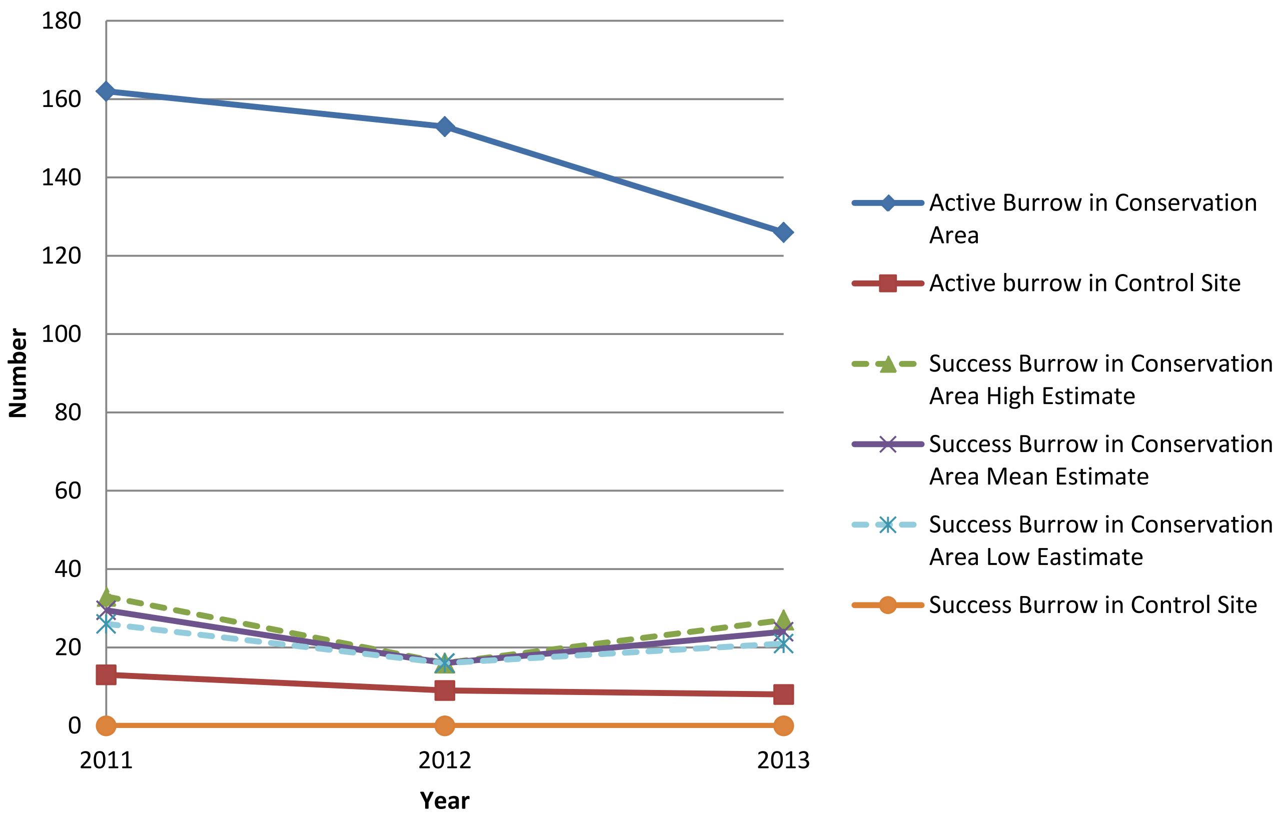
Due to other management obligations and adverse weather conditions in 2013, we didn't follow up on fledging events at six burrows in the Conservation Area. However, based on our previous experience and signs of activity at the burrow entrances, we assumed these to be possible success burrows, as was the case in 2011. Due to the newly surveyed boundary, the data from the following burrows is no longer being included in this or future data analysis: Five failed burrows, one possible successful burrow and four not active burrows that were found in 2011; one failed burrow and thirteen not active burrows found in 2012. Note that the numbers of burrows involved in this year's status are different from reports from previous years, due to the newly marked boundary and therefore burrows that are now outside of ATST's Conservation Area. Table 3 summarizes the adjusted status of burrows found between 2011 and 2013, and the success/failure statistics.

Although the number of successful burrows and fledgling success rate fluctuated in the Conservation Area and remained at zero in the Control Site during the last three seasons, the active burrow numbers steadily declined in both the Conservation Area (by 22%) and Control Site (by 38.5%). The overall decline of 23.43% is somewhat troubling, in that almost one quarter of the potential breeders did not return to the colonies during this period of time (Figure 5).

Table 3. Hawaiian Petrel Burrows and Reproductive Success in ATST HCP Conservation Area and Control Site on Haleakala, Maui, Hawaii.

Year	2011		2012		2013	
Status/Site	**Conservation**	**Control**	**Conservation**	**Control**	**Conservation**	**Control**
Active	**162**	**13**	**153**	**9**	**126**	**8**
Success	**26-33**	**0**	**16**	**0**	**21-27**	**0**
Fail	**129-136**	**13**	**137**	**9**	**99-105**	**8**
Not Active	**36**	**8**	**114**	**16**	**155**	**18**
TOTAL	**198**	**21**	**267**	**25**	**281**	**26**

Figure 5. Trend of Hawaiian Petrel Burrow Status from 2011 to 2013 in ATST HCP Monitored Areas on the Summit of Haleakala Volcano, Maui



Hawaiian Petrel Mortality

In 2013, one female adult was discovered to be deceased in front of her burrow, due to trauma of collision with an unknown object, not likely related to ATST activities since there was no ATST structure above original ground level at the time. One adult pair was found dead inside their burrow due to starvation and dehydration. Two very young petrel chicks were found dead at the entrances of their burrows approximately 58-127 meters south and southeast of ATST's construction site without detectable signs of predation. Premature emergence from the burrow leading to starvation is thought to be the cause of these fatalities. Three pre-fledging young petrels were killed by mammalian predators near the burrow entrances. One was perhaps killed by a mongoose due to the size of the entrances. One egg had rolled out of the burrow, probably caused by inexperienced adults. The remains of one adult and one very young chick were also found this year, but the mortality events seemed to have occurred prior to the 2013 season. All mortality events were recorded inside the Conservation Area and no mortality events were detected in the Control Site this year.

Table 4 summarizes all mortality events recorded since the 2011 breeding season. Invasive mammalian predators were the cause of 68.18% of all detected petrel mortality in ATST's HCP encompassed areas. The smallest fraction (1/3) and number (3) of mortalities in 2013 were due to predation. All three predated petrel carcass were pre fledging chicks found between 8,900 and 9,100 feet of elevation in the Conservation Area. Similar to the previous two seasons, predation was more likely to occur in the lower portion of the ATST HCP monitored area. In order to standardize the impact of predation at different elevations, we used predation/trampling density (events/hectare) as the metric in this analysis. We found a strong negtive correlation (R^2>0.49) between predation/trampling events density and elevation in 2011, 2012 and the sum of all three years in the ATST Conservation Area, and no predation/trampling event was recorded above 9,800 ft. elevation, (Figure 6)

The petrel mortality events recorded in our monitoring area underwent a steady decline; from 27 in 2011 down to nine in 2013, and predation/trampling from 20 in 2011 down to three in 2013 in both the Conservation Area and Control Site (table 4). In order to understand whether ATST construction activities resulted in the decline of active Hawaiian Petrel burrow numbers, we examined the trend of active burrow numbers adjacent to the ATST construction site (Figure 2.). We found that the number of active petrel burrows actually increased in this area (Figure 7). Based on these petrel population trends, the decline of active petrel burrows recorded in the larger ATST HCP monitoring area probably occurred outside of the breeding colonies during nonbreeding season, and not while the petrels were in the breeding colonies near ATST construction activities.

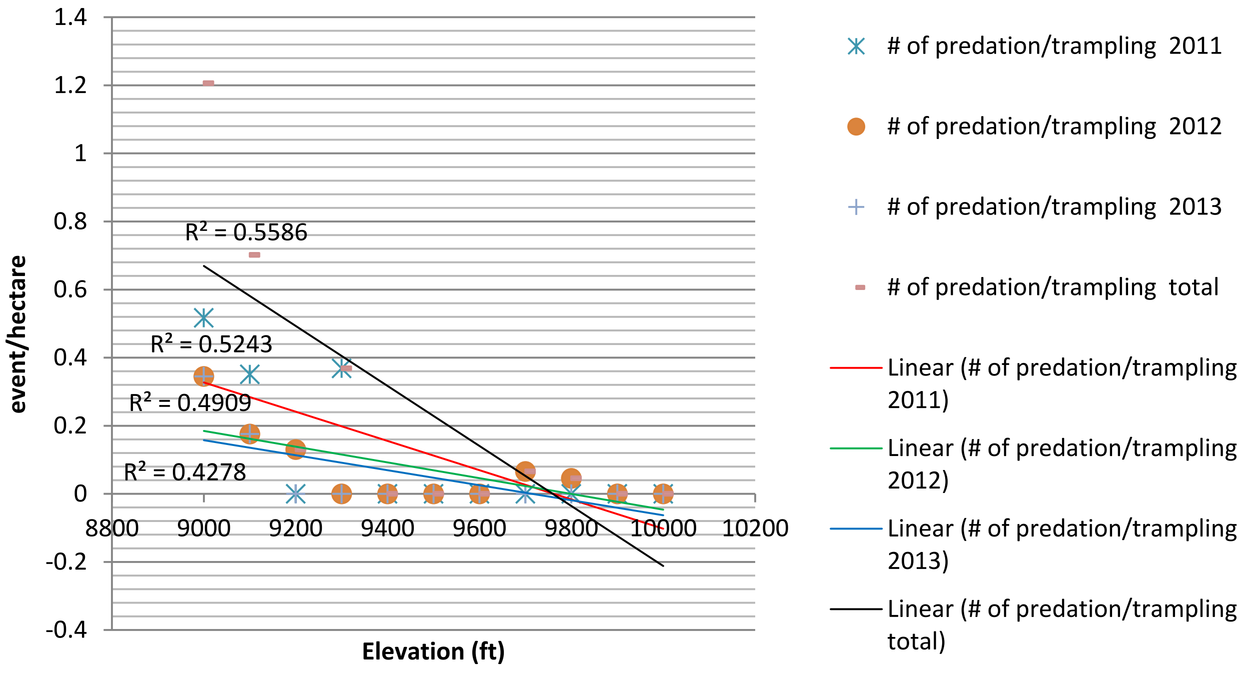


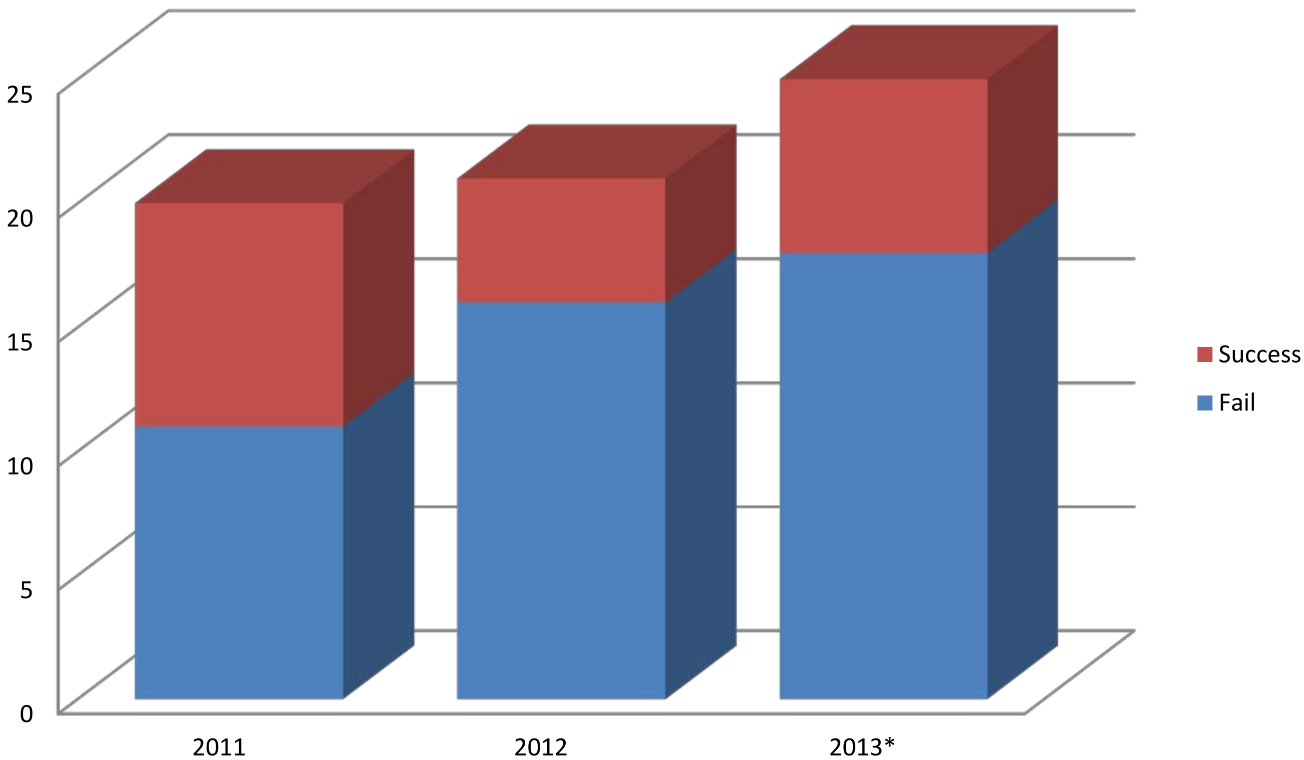
Figure 6. The Densities of Predation/Trampling Events and Elevation Recorded in ATST HCP Conservation Area From 2011 to 2013

Table 4. Hawaiian Petrel Mortality Events Recorded between 2011 and 2013 in ATST HCP Conservation Area and Control Site

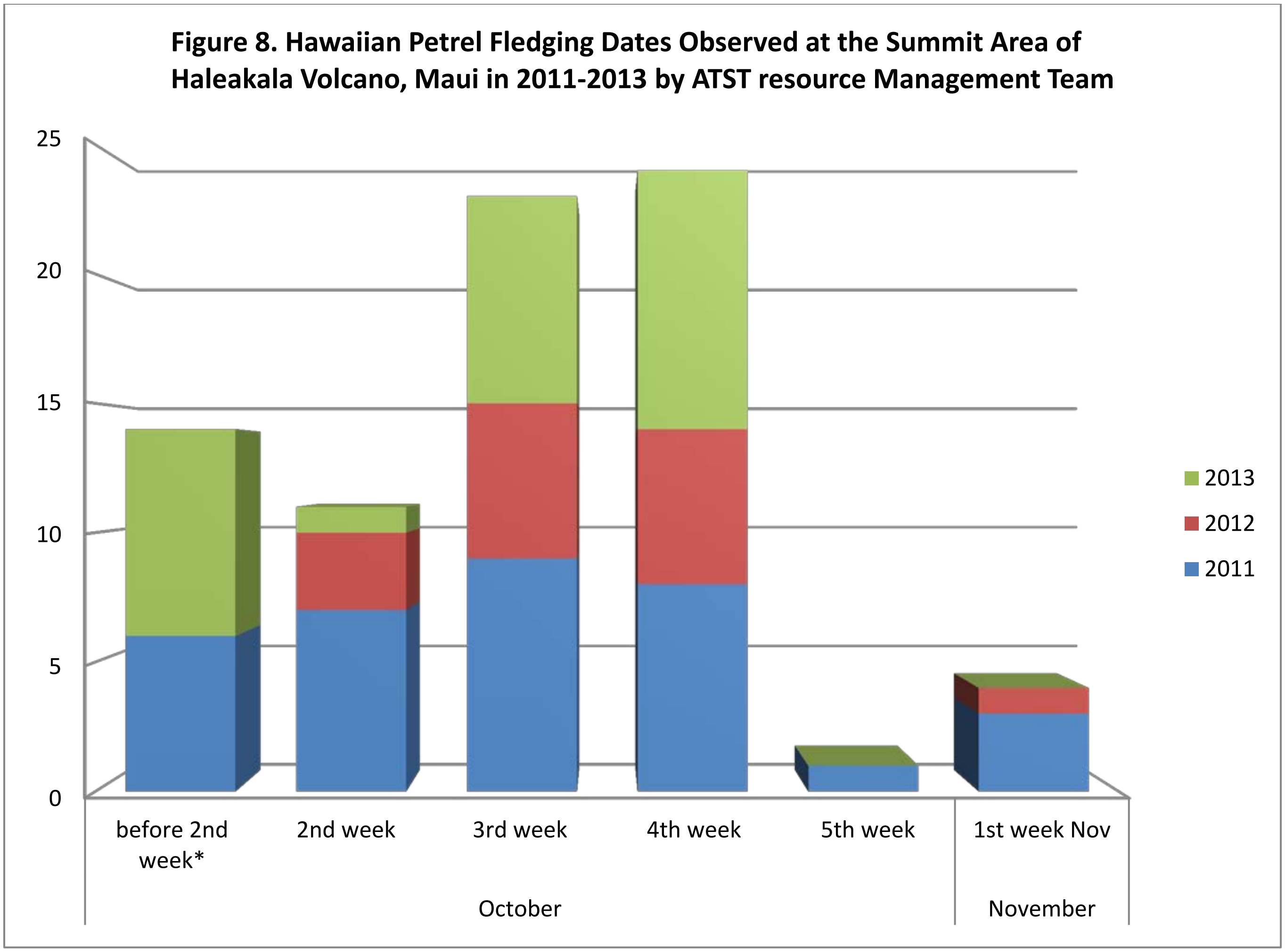
Year	2011		2012		2013*	
Site	Conservation Area	Control Site	Conservation Area	Control Site	Conservation Area	Control Site
Other						
Egg	4	0	1	0	1	0
Chick	2	0	0	0	2	0
Adult	1	0	0	0	3	0
Predation**						
Egg	1	0	2	0	0	0
Chick	6	3	1	0	3	0
Adult	1	9	3	1	0	0
TOTAL	15	12	7	1	9	0

*Not including a burrow trampled by ungulates in the early stage of breeding season, and an adult and a chick mortality event that occurred prior to 2013. ** including burrows trampled by ungulates

Figure 7. Number of Active Hawaiian Petrel Burrow Adjacent to ATST Construction Site at the Summit Area of Haleakala Volcano, Maui in 2011-2013



***ATST construction started**



***Including the last week of September and the first week of October (2 week period)**
Note: Figure presented includes possible success burrows

Fledgling Dates

2011 and 2012 Past History

In 2011, only eight of the 17 burrows that had cameras installed were successful. Based on the video recordings at the eight successful burrows around MEES Observatory, the earliest that petrel chicks first emerged from their burrows to exercise their wings was recorded on 09/29 and the last was on 10/13 (middle date: 10/ 07-08). The earliest fledging date was on 10/19 and the latest date was on 10/25 (middle date: 10/22). The adults stopped returning to their burrows between 09/30 and 10/14 (middle date: 10/05).

The average days between petrel chicks' first emergence and fledging was 15.71 days (7-25 days, SD=6.36). The average days between adults' last visit and chicks' first emergence was two days (-10 to11 days, SD=6.44). In other words, one adult's last return to the burrows was 11 days prior to its chicks' first emergence from the burrow and one adult's last return to the burrows was 10 days after its chicks' first emergence from the burrow, while the other's fell in between. The average days between adults' last return and chicks' fledge date was 17.63 days (11-22 days, SD=3.97).

In 2012, only six of the 18 burrows that had cameras installed were successful. Based on the video recordings at the six successful burrows around MEES Observatory, the earliest date petrel chicks first emerged from their burrows to exercise their wings was recorded on 09/19 and the latest was on 10/12. The earliest fledging date was on 10/12 and the last date was on 10/19. The average days between petrel chicks' first emergence and actual fledging was 18.2 days (7-26 days, SD=6.15).

The adults of the successful burrows stopped returning to their burrows between 09/25 and 10/03. The average days between the adults' last visit and the chicks' first emergence was -1.2 days (-11 to 11 days, SD=7.25). In other words, one adult's last return to the burrows was 11 days prior to its chicks' first emergence from the burrow and one adult's last return to the burrows was 11 days after its chicks' first emergence from the burrow, while the others fell in between. The average days between the adults' last return and the chicks' fledge date was 16.5 days (15-18 days, SD=1.26).

Fledging Dates in 2013

The recorded events of 2013 confirmed that Hawaiian Petrels begin fledging from their burrows during the last week of September, as was the case in previous breeding seasons. The 3rd and 4th week of October accounted for the largest number of fledged chicks. By the end of the first week of November, all chicks had already fledged and left the breeding colony. The 2013 breeding season ended two weeks earlier than the previous years (Figure 8).

Based on the 18 surveillance camera video data recorded in 2012, the adults of seven failed burrows were last seen between 07/25 and 08/10. These petrels may be ones that attempted to breed, but did not successfully lay eggs. Adults of the other five failed burrows stopped returning between 09/06 and 09/26. These adults may have produced eggs or hatched chicks; however, if they did, the chicks did not reach fledgling age for unknown reasons.

As in 2012, the adults of failed active burrows stopped returning to their burrows during two peak periods of time. Based on the 19 petrel burrows monitored by surveillance cameras in 2013, both adults died at SC 21 on 06/14. The male of SC 15 kept visiting the burrow until 07/27 even though its mate was killed on 05/05. The adults of the other eight failed burrows were last seen between 07/28 and 08/28. These petrels may be the ones that attempted to breed, but did not successfully lay eggs. Adults of the other 2 failed burrows stopped returning between 09/09 and 09/16. These adults may have produced eggs or hatched chicks; however, if they did, the chicks did not reach fledgling age for unknown reasons.

In 2013, only seven of the 19 burrows that had cameras installed were successful in fledging petrels. We also placed 16 camera traps at active burrow sites outside of the MEES Observatory area. Among these 16 additional camera traps, we recorded fledging dates at 10 burrows. Based on 16 image recordings, the fledging dates were between 10/10 and 10/24 (median date: 10/19). Based on the seven surveillance cameras near MEES, the earliest that petrel chicks first emerged from their burrows to exercise their wings was 10/01 and the last was on 10/10 (middle date: 10/06). The adults stopped returning to their burrows between 09/27 and 10/19 (middle date: 10/10).

The average days between petrel chicks' first emergence and fledging was 11.43 days (7-14 days, SD=2.5). The average days between adults' last visit and chicks' first emergence was -1.57 days (-12 to 9 days, SD=7.21). In other words, one adult's last return to the burrows was 9 days prior to its chicks' first emergence from the burrow and one adult's last return to the burrows was 12 days after its chicks' first emergence from the burrow, while the other's fell in between. The average days between adults' last return and chicks' fledge date was 9.86 days (1-21 days, SD=7.22).

Breeding Success

Based on the total number of active burrows and the subset of active burrows with a chick that survived until their fledgling date, the fledgling number and success rates for Hawaiian Petrels in the ATST Conservation Area and Control Site are presented in Table 3 and 5. In 2011 and 2013, some burrows were classified as "Possible Success" We performed two calculations; the first calculation included both "Successful" and "Possible Success" burrows, while the second calculation was performed using only the "Successful" burrows and the "Possible Success" were designated as failed. These two calculations reflect both the worst case and best case possible scenarios, based on our interpretation of the data collected during the last breeding seasons (Table 5).

Table 5. Hawaiian Petrel Burrows and Reproductive Success Rate (%) in ATST's HCP Encompassed Area in the Summit Area of Haleakala, Maui.

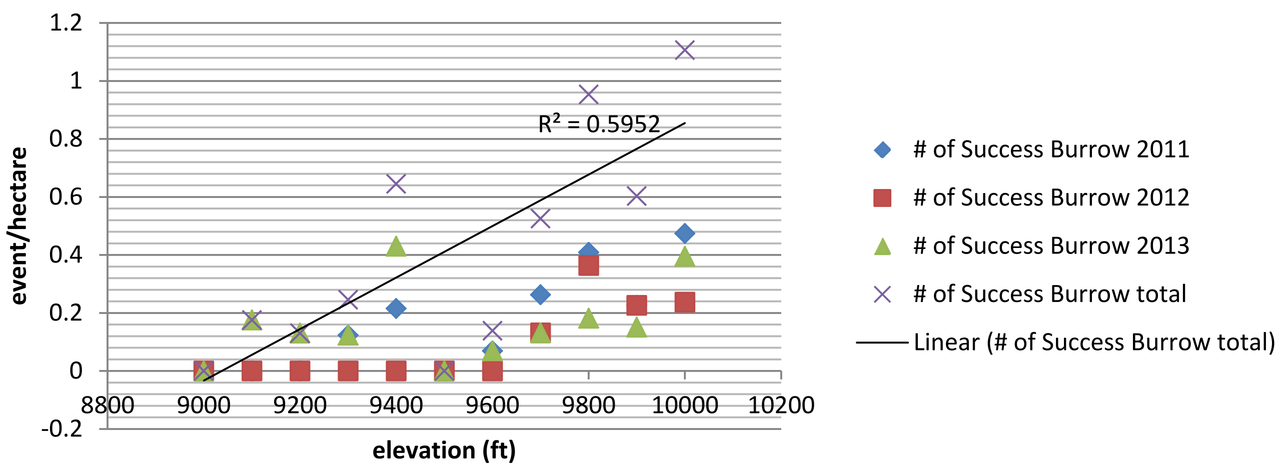
Year	2011		2012		2013	
Site	Conservation Area	Control Site	Conservation Area	Control Site	Conservation Area	Control Site
	15.48- 20.24	0	10.39	0	16.67-21.43	0
Overall	14.36-18.78		9.82		15.67-20.15	

2013 was the first year that any burrow successfully fledged a chick below 9,300 ft. elevation, probably due to the implementation of the predator control grid in the northern part of the Conservation Area and the ungulate fence construction activity (Figure 9). The data also showed a strong positive correlation (R^2=0.5952) between the density (per hectare) of successful burrows and elevation from 2011 to 2013. Although no significant correlation (R^2=0.2126) was found between the density of successful burrow and predation/trampling events, this phenomenon might be explained by the negative correlation between density of predation/trampling events and elevation (R^2=0.5586, Figure 6) in the same area.

Due to technical restrictions and annual fluctuation of active/breeding pairs recruited into the areas, the terms "breeding success" and "fledgling success" both seem to be an inappropriate indicator of the Hawaiian Petrel reproductive performance in our HCP monitored areas.

Burrow activity is difficult to quantify as there are many variables that affect outcome. Hawaiian Petrel burrows have been known to be visited by other animals; such as other bird species, rodents, mammalian predators and feral goats, all of which have knocked over our monitoring tooth picks in the past. Also, there have been Petrels looking for mates, prospecting for a nest, or just walking by burrow entrances that leave signs, such as foot prints, droppings or feathers, or knock over toothpicks. We may have classified these burrows as “Active” in the early stage of that season, but they were never truly “Active” or established burrows. These signs, which serve as our primary burrow status indicator, have resulted in false indications of true “burrow status”. These uncontrollable factors all affected our “Active Burrow” count, which in turn alters any definitive outcome in determining “Success Rate”.

Figure 9. The Success Hawaiian Petrel Burrow Density at Different Elevation From 2011 to 2013 in ATST HCP Conservation Area.



Note: Not including possible success burrows

Due to the limitations of the burrow scopes in burrows with acute angles, we do not have data on the actual number of petrel nest burrows that contained eggs in 2013. Since Hawaiian Petrels have a one egg clutch size and the monitored areas are in fixed locations, within a fixed area, along with the fact that ATST has been monitoring almost 100% of the active burrows in these areas, the density, i.e. the total number of fledglings produced/area in these monitored areas, seems to be a more reasonable indicator of Hawaiian Petrel productivity in the monitored area for future evaluation of reproductive success.

Silversword Monitoring

A cluster of 6 different age groups and 3 individual seedling Silversword (*Argyroxiphium sandwicense macrocephalum*) plants were located during the survey/monitoring trips in the last three seasons. One of the seedlings found in 2012 is now outside of ATST’s Conservation Area boundary (Figure 10 & 11). These plants demonstrated that there is a viable seed bank in local soil and future natural regeneration and seed collection for outplanting is possible.

[redacted]

Figure 11. Cluster of Six Haleakala Silversword *(Argyroxiphium sandwicense macrocephalum)* Found Within ATST Fenced Conservation Area as Shown in Figure 10

FUTURE HCP COMPLIANCE

Poly Tape Installation

Polytape installation on the completed conservation fence started on 12/16/2013, but due to the holiday season and adverse winter weather conditions, the progress has been slow. We are still anticipating completing the installation before the end of February, 2014.

Ungulate Eradication

Ungulate eradication will depend on the result of our predator/ungulate monitoring camera traps at the end of January 2014.

Predator control Grid

The traps in the southern part of Conservation Area will be installed in early 2014 after the ordered traps and transmitters arrive.

Hawaiian Petrel Social Attraction/Artificial Burrows

Current predation levels are still a concern for social attraction, therefore actions designed as social attraction are in abeyance at this time. Since more than a hundred non active burrows were recorded in the Conservation Area, artificial burrows may not be necessary due to an excess of unoccupied burrows.

Silversword Outplanting

The ATST resource management team will monitor natural silversword regeneration within the fenced Conservation Area to determine if outplanting is necessary. ATST will also cooperate with local native plant propagation facilities to collect seeds from the existing in situ silversword plants and use the propagated seedlings for future outplanting when it is necessary.

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