LANAI METEOROLOGICAL TOWERS

HABITAT CONSERVATION PLAN

SECOND ANNUAL REPORT

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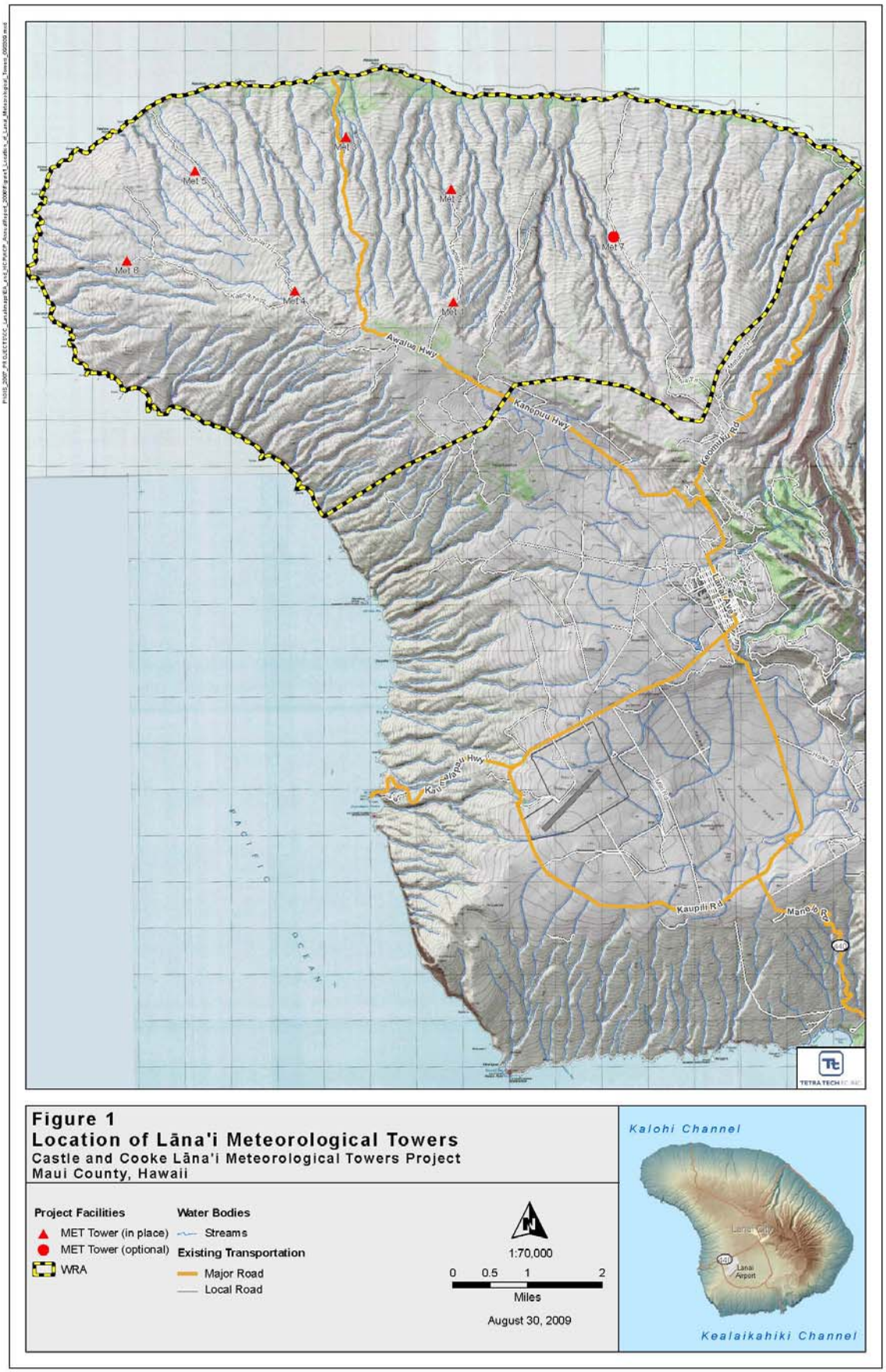
1.0 INTRODUCTION

Castle & Cooke Resorts, LLC (Castle & Cooke) and Tetra Tech EC, Inc. (TtEC) in cooperation with the U.S. Fish and Wildlife Service (USFWS) and the Hawaii Division of Forestry and Wildlife (DOFAW) developed a Habitat Conservation Plan (HCP) for the Lanai meteorological (met) tower project. The HCP was developed to obtain an incidental take permit/incidental take license (ITP/ITL) for the construction and operation of seven met towers on the island of Lanai, Maui County, Hawaii. The *Final Habitat Conservation Plan for the Construction and Operation of the Lanai Meteorological Towers, Lanai, Hawaii* (TtEC 2008) covers potential incidental take for four federally and state-listed species including the Hawaiian petrel (*Pterodroma sandwichensis*), the Hawaiian hoary bat (*Lasiurus cinereus semotu*), the Hawaiian stilt (*Himantopus mexicanus knudseni*), and the Newell's shearwater (*Puffinus newelli*). The HCP was finalized August 2008 and the ITP was issued by USFWS on September 26, 2008 followed by issuance of the ITL by DOFAW on October 10, 2008. The term of the HCP is through March 1, 2010 to accommodate the expected two-year time period the met towers will be in operation.

One of the HCP requirements is for Castle & Cooke to provide USFWS and DOFAW an annual report that summarizes the results of the post-construction monitoring and mitigation program. The annual reports are to be submitted to coincide with DOFAW's end of fiscal year October 1. This second report analyzes the results of the post-construction monitoring surveys from the second year of monitoring to date (March 16 - August 21, 2009) and provides summary information from the first year of monitoring (March 4 - December 15, 2008), for comparison. The report also summarizes the progress of the habitat restoration and predator control activities conducted between November 2007 and August 2009 as provided by DOFAW.

Between August 2007 and February 2008, Castle & Cooke installed six of seven 50-meter-tall (165-foot-tall) met towers on Lanai (Figure 1). Each met tower is stabilized with four sets of guy wires. Bird diverters and flagging were attached to the guy wires to increase their visibility to birds and bats. The purpose of the installation of the met towers is to collect data on wind speeds and patterns throughout the northwestern portion of the island. These data will be used to determine the suitability of the wind regime for development of a commercially viable wind energy facility on Lanai.

The HCP establishes an incidental take limit for each of the covered species for the two-year period the met towers will be in operation. Individuals of these species have the potential to fly in the vicinity of a met tower and could be injured or killed if one collides with a met tower or guy wire. Potential for incidental take of Newell's shearwater, Hawaiian hoary bat, and Hawaiian stilt is expected to be very low based on the lack of observations during visual and radar surveys within the wind resource area (WRA) and the lack of suitable habitat for these species within the met tower vicinity (TtEC 2008). Therefore, the incidental take limit established for the Hawaiian hoary bat, Hawaiian stilt, and Newell's shearwater is two individuals each.


Met 1
Met 2
Met 3
Met 4
Met 5
Met 6
Met 7
Awalua Hwy
Kaiopuu Hwy
Keomuku Rd
Lanai Ave
Kaumalapau Hwy
Kaupili Rd
Manele Rd
PACIFIC
OCEAN
Figure 1
Location of Lāna'i Meteorological Towers
Castle and Cooke Lāna'i Meteorological Towers Project
Maui County, Hawaii
Project Facilities
MET Tower (in place)
MET Tower (optional)
WRA
Water Bodies
Streams
Existing Transportation
Major Road
Local Road
1:70,000
0 0.5 1 2
Miles
August 30, 2009
Kalohi Channel
Lanai City
Lanai Airport
Kealaikahiki Channel

The potential for incidental take was considered greater for the Hawaiian petrel. In 2006, DOFAW rediscovered a colony of Hawaiian petrels at the Lanaihale. Radar surveys also documented petrels flying over the met tower project area. Therefore, a two-tiered take limit was established for the Hawaiian petrel. Tier 1 authorizes a take limit of seven petrels over the two-year project period and requires an initial level of mitigation. Tier 2 provides a contingency should Tier 1 take limits be reached. Tier 2 authorizes the take of up to 14 petrels over the two-year project period and triggers additional mitigation.

The HCP identifies two primary programs to be implemented as a result of issuance of the ITP/ITL: a post-construction monitoring plan (PCMP) and a mitigation plan. The PCMP was developed by TtEC for Castle & Cooke to determine whether any of the four covered species are impacted as a result of collision with one or more of the met towers and to ensure compliance with the provisions and limitations of the HCP and the ITP/ITL. The PCMP includes 1) standardized carcass searches to monitor injuries or fatalities of the covered species, 2) carcass scavenging trials to assess seasonal, site-specific carcass removal rates by scavengers, and 3) searcher efficiency trials to assess observer efficiency in finding carcasses. The survey protocol focuses on seabirds because the Hawaiian petrel is the species with the highest potential for incidental take, if take occurs. Although the carcass surveys are being conducted to document any potential incidental take of threatened or endangered species, non-listed species are also recorded for informational purposes.

The mitigation plan was developed to compensate for potential incidental take of the four covered species during the two-year project period. The mitigation plan was developed in consultation with biologists from DOFAW and USFWS and integrated into the on-going interagency seabird conservation project and the watershed enhancement program on Lanai. This mitigation plan consists of a combination of habitat restoration and predator control and is anticipated to result in a net benefit for the four covered species. Three (Tier 1) or six (Tier 2) acres of degraded habitat will be restored at Lanaihale adjacent to the petrel colony. Additionally, DOFAW's existing predator control program is being augmented at Lanaihale (20 additional traps). As mitigation for the potential take of Hawaiian stilts, a cat trapping program was initiated at the Lanai wastewater treatment facility (12 traps), the area where Hawaiian stilts are known to be breeding residents.

Castle & Cooke provided DOFAW the Tier 1 funds to implement the habitat restoration and predator control program. DOFAW is responsible for the design, implementation, and monitoring of this scope of work as outlined in the HCP. Castle & Cooke provided DOFAW with the funds for Tier 1, Year 1 mitigation in February 2008 so that the habitat restoration work could be initiated as soon as possible – prior to issuance of the ITP/ITL and paid the remainder of the funds for Tier 1, Year 2 before issuance of the ITP/ITL. Tier 2 mitigation will only be initiated if Tier 2 take limits are initiated.

2.0 STUDY AREA

The met tower project area is located on the northwestern portion of Lanai (Figure 1). Lanai is generally a hilly island that rises gradually to 1,027 meters (3,369 feet) above sea level at Lanaihale, or Mount Palawai. The Kalohi Channel separates the island of Lanai from the island

of Molokai to the north, and Auau Channel separates Lanai from the island of Maui to the east. The project area is remote, with a few dirt roads that allow access to the shoreline and the met tower locations. There are no nearby existing structures. Lanai City is located about five miles southeast of the nearest met tower (met tower 1).

Much of the terrestrial habitat for biological resources on Lanai has been disturbed by several factors, including the establishment of the Cook Island pine (*Araucaria columnaris*), 100 years of island-wide Dole pineapple plantations, cattle grazing, the intentional release of non-native game species, and the incidental release of non-native terrestrial species such as house cats (*Felis domesticus*), Norway rats (*Rattus norvegicus*), and black rats (*Rattus rattus*). All of these factors have negatively impacted much of the native species and have altered the ecology of the island. Habitat within the met tower footprints and surrounding areas ranges from barren eroded soils to shrub/scrub, interspersed with open grassland areas. The met tower footprint includes the 0.8 square meters (9 square feet) of the tower base plate and the anchor points for the four sets of guy wires that radiate from the tower pole approximately 30.5 to 33.5 meters (100 to 110 feet).

Vegetation within each of the met towers is variable and collectively they encompass the full range of vegetation types within the project area. A botanical survey of the project area was conducted in 2007 to document the vegetation communities at each of the met tower sites (AECOS 2007) and is summarized here.

Met tower 1 is in a badlands area and the central portion of the search plot consists of bare ground, beyond which is grassland where Angleton grass (*Dichanthium aristatum*) predominates. Grass height is approximately one meter or lower. Scattered shrub growth, located on the eastern and western margins of the search plot, consists of ʻaʻaliʻi (*Dodonaea viscosa*), lantana (*Lantana camara*), uhaloa (*Waltheria indica*), and Brazilian pepper (*Schinus terebinthifolius*). This vegetation typically ranges from approximately 1 to 2 meters (3 to 7 feet) in height.

The search plot around met tower 2 is characterized by heavily grazed grassland, consisting of bunch grasses interspersed with bare ground and low-growing shrubs. The grassland is dominated by Angleton grass and pili grass (*Heteropogon contortus*), with ʻaʻaliʻi common as a low shrub. Vegetation height is less than 0.3 meter (one foot). Patches of invasive shrubs are also located near the boundaries of the plot.

The search plot around met tower 3 is very open and dominated by a mix of pitted beardgrass (*Bothriochloa pertusa*) and native pili grass. There are some scattered shrubs including kiawe (*Prosopis pallida*) and Abutilon (*Abutilon incanum*) in the ravine located west of the search plot. Vegetation height within the search plot is less than 0.3 meters in height.

Met tower 4 has the densest vegetation of all the towers. The western and northern portions of the plot consist of dense Angleton grass, approximately 0.5-1 meter (2 to 3 feet) in height. The central portion of the plot is shrubland, consisting exclusively of low growing ʻaʻaliʻi mixed with Angleton grass. The eastern and southeastern portions of the plot consist of denser, taller (approximately 1.4 meter [4 to 5 feet]) Guinea grass (*Panicum maximum*) mixed with lantana and koa haole (*Leucaena leucocephala*). Badlands occur in the southwestern corner of the plot.

The search plot around met tower 5 is primarily open grassland of pili grass and pitted beardgrass. A shallow gulch with kiawe trees lies off to the west. The most common shrubs in this area are klu (*Acacia farnesiana*) and uhaloa.

Finally, the search plot around met tower 6 consists of koa haole shrubland. The dominant shrub is klu and the understory is a patchy interspersion of bare ground and areas of pitted beard grass and pili grass. With the exception of some shrubs that are 2.5 to 3 meters high (8 to 10 feet), most shrubs are approximately 0.6 meters high (2 feet).

The mitigation area includes two locations on Lanai. At Lanaihale, much of the potential nesting habitat for Hawaiian petrels and Newell's shearwaters has been degraded by the establishment of invasive species such as strawberry guava (*Psidium cattleianum*). Restoration of degraded habitat through the removal of invasive species and reintroduction of uluhe fern (*Dicranopteris linearis*) and other native species should benefit the Hawaiian petrel and Newell's shearwater populations. The restoration should benefit the Hawaiian hoary bat by increasing foraging and roosting habitat. Predator control of non-native species (cats and rats) is being conducted at Lanaihale and the wastewater treatment plant in Lanai City.

3.0 PCMP METHODS

Carcass searches were conducted to estimate the number of avian and bat fatalities attributable to the met towers, if any, and ensure compliance with the incidental take limits established in the HCP. Fatality estimation is based on the number of carcasses found during standardized searches and adjusted by estimates of searcher efficiency and scavenging rates. Both the ability of searchers to locate carcasses (searcher efficiency) and the length of time carcasses remain onsite before being removed by scavengers (a site-specific carcass removal rate) can bias the number of carcasses located during standardized searches. Therefore, trials were conducted to estimate searcher efficiency and carcass removal on Lanai.

The methods, timing, and duration of the carcass searches are described below, in the 2008 Annual report, and in the Final HCP (TtEC 2008). Prior to initiating surveys, permits required to implement the monitoring program were obtained. These include the USFWS Special Purpose Permit, issued as amended on April 21, 2008, and the Protected Wildlife Permit issued as amended by DOFAW on April 20, 2009.

3.1 Survey Intensity and Duration

DOFAW and USFWS required carcass searches be conducted while the met towers are in operation and during the seasons when seabirds are expected to be present on Lanai (March through December). According to the PCMP, the standardized carcass surveys were to be conducted initially two times per week. The PCMP provided for revising the survey frequency to reflect the project-specific scavenging rates and searcher efficiency. Based on demonstrated low scavenging rates and high searcher efficiency for seabirds on Lanai during three seasons of data collection in 2008, TtEC requested in October 2008, to reduce search frequency to every 10 days. The USFWS and DOFAW agreed with this request (pers. com. Paula Hartzell, DOFAW, and Bill Standley, USFWS, November 2008). On November 17, the Endangered Species Recovery Committee (ESRC) also approved the request to reduce the search frequency to every

10 days. Accordingly, after November 17, carcass searches were conducted once every 10 days and have continued at that search interval in 2009.

A complete round of searches (all six met towers) is typically completed in one day by two searchers. The following dates were used to define seasons: spring (March 15-June 15), summer (June 16-September 15), and fall (September 16-December 15). Carcass searches may end prior to December 15 if DOFAW has verified the seabirds have left the colony. Personnel discontinue surveys if the met towers are not accessible as a result of storm events or road conditions, and/or if staff safety is questionable.

3.2 Standardized Carcass Searches

Standardized carcass searches were conducted at the six met towers by personnel trained in proper search techniques. Boundaries of 126-meter by 126-meter (413-feet by 413 feet) square search plots were delineated by stakes, pvc, and/or flagging around each met tower. The corner stakes of each survey plot were located by Geographic Positioning System (GPS). Each search plot was separated into four quadrants to facilitate the ability of searchers to identify search plot boundaries and ensure complete and non-replicated coverage of the search area. Each member of a two-person team searched two adjacent quadrants. Transects within these search plots were spaced six meters (20 feet) apart, and searchers walked along each transect searching both sides out to three meters (10 feet) for casualties (Johnson et al. 2003). The number of searches is defined as the number met towers searched, multiplied by the number of surveys.

Upon discovery of a carcass, searchers recorded the species, sex and age when possible, date and time collected, location, condition and any comments that may indicate cause of death. Carcass condition categories were defined as: (1) Intact – a completely intact carcass that is not badly decomposed and showing no sign of being fed upon by a predator or scavenger; (2) Scavenged – an entire carcass that shows signs of being fed upon by a predator or scavenger, or portions of a carcass in one location (e.g., wings, skeletal remains, legs, pieces of skin, etc.); and (3) Feather Spot – 10 or more feathers at one location indicating predation or scavenging or two or more primary feathers. Protocol for documenting downed wildlife includes taking photographs, recording a GPS coordinate, and filling out a Downed Wildlife Incident Report.

Searchers may observe carcasses that are incidental to formal carcass searches (e.g., predation or while driving within the project area). For each incidentally discovered carcass, searchers identified, photographed, and recorded data for the carcass as would be done for carcasses found during formal scheduled searches.

3.3 Searcher Efficiency Trials

The ability of searchers to detect carcasses is influenced by a number of factors including the skill of an individual searcher in finding the carcasses, the vegetation composition within the search area, and the characteristics of individual carcasses (e.g., body size, color). The objective of searcher efficiency trials is to estimate the percentage of bird fatalities that searchers are able to find. Estimates of seasonal searcher efficiency are then used to adjust carcass counts for detection bias. Searcher efficiency trials were conducted during each season to account for any seasonal differences. At least three trials are conducted in each season, as identified in the PCMP.

Wedge-tailed shearwaters were the primary species used for searcher efficiency trials. These carcasses were provided by DOFAW and USFWS. Bat carcasses were unavailable; therefore, cat toys approximating the size and coloration of Hawaiian hoary bats were used as a substitute. Approximately three to five carcasses and/or toys were used per trial – depending on carcass availability. Each trial carcass had an identifying mark such as a twist-tie wrapped around its leg so it could not be confused with a fatality associated with a met tower.

All individuals participating in carcass surveys underwent searcher efficiency trials during each field season. Searchers did not know when trial carcasses were placed, under which towers trial carcasses were placed, how many towers the carcasses were placed, or how many carcasses were placed on a given day. Before standardized carcass searches began on a selected date, testers placed efficiency trial carcasses at random locations within search plots and recorded the number and location of each trial carcass to prevent erroneous reports of mortalities at the study site. Carcasses were gently tossed in a random fashion and allowed to hit the ground without being manipulated in order to give a realistic representation of how a carcass would fall if it hit a met tower or guy wire.

Vegetation management (trimming and cutting back grass and non-native shrubs) was conducted at each met tower to maximize searcher efficiency and reduce additional bias of dense vegetation. Tall vegetation can obstruct searchers view of the ground and can make it difficult to move through portions of the search plot. Vegetation was first cut back close to less than 6 inches in height at all met towers in the fall of 2008. Vegetation management was completed at all the met towers again in spring 2009 and will be completed on an as needed basis for the remainder of the 2009 survey period.

3.4 Carcass Removal Trials

Removal of carcasses by scavengers or predators from the survey area is a potential source of bias associated with fatality rate estimation. High scavenging rates could result in underestimation of mortality. Scavengers may either remove carcasses or make it difficult to identify remains and/or determine cause of death. Thus, seasonal differences in carcass removal rates (i.e., changes in scavenger population density) and possible differences in the size of animal being scavenged are typically taken into account when estimating fatality rates. Carcass removal rates can also be used to determine the frequency at which carcass surveys should be conducted to minimize loss due to scavenging.

The objective of the carcass removal trials is to document the length of time carcasses remain in the search area and are thus available to be detected by searchers. Carcass removal trials were conducted once per season to account for changes in weather, climate, and scavenger densities. Carcasses used in seabird trials were all wedge-tailed shearwaters. In the summer 2009 trial, a small number of mice were used to approximate bat carcasses for informational purposes.

The spring carcass removal trial was initiated on May 14 and conducted through June 7, 2009. A total of 18 wedge-tailed shearwater carcasses (three near each tower) were planted during the trial. The summer carcass removal trial was initiated on July 12 and conducted through August 8, 2009. Four mice, only ones collected during an initial trapping effort, were planted to simulate bat carcasses (placed near met towers 2, 3, 4 and 5). Ten wedge-tailed shearwater carcasses were placed during the summer trial. Fewer carcasses were used in the summer trial due to a dearth of

additional carcasses. In total, four towers had two carcasses and two towers had three carcasses placed near them. To avoid confusion with met tower-related fatalities, planted carcasses were not placed in carcass survey search plots but outside of the search area boundary at randomly generated distances and directions from a search plot corner. Trial carcasses were marked discreetly for recognition by searchers. Carcasses were checked for a period of 28 days: days 1-7, day 10, day 14, day 21, and day 28. Searchers recorded observations on the decomposition rate and evidence of scavenging (Young et al. 2003). At the end of each carcass removal trial period, all remaining carcasses or evidence of the carcasses were removed and properly disposed.

3.5 Statistical Methods for Mortality Estimation

Mortality rate estimates are based on observed number of carcasses found during standardized carcass searches, searcher efficiency rates, and carcass persistence.

3.5.1 Estimation of Searcher Efficiency

Searcher efficiency (p) is calculated as the proportion of the carcasses found by observers divided by the total number of carcasses available to find. Searcher efficiency rates were estimated by carcass type, by season, and as an overall average. To facilitate an evaluation of the effect of vegetation management on searcher efficiency, baseline met tower-specific searcher efficiency rates were also calculated. The values presented here are not intended for statistical comparison, given that some towers have had only one trial during summer; therefore, mean values do not represent the full range of variability in searcher efficiency. Any fatality estimates would be adjusted by overall estimates of seasonal searcher efficiency.

3.5.2 Estimation of Carcass Removal Rate

Carcass persistence is the average length of time a carcass remains onsite before it is removed by scavengers. The average number of days that a carcass remained on site was calculated as:

$$\bar{t} = \frac{\sum_{i=1}^{k} t_i}{k}$$

where t_i is the number of days each carcass remained on the study area and k is the number of carcasses evaluated. For this study, all carcass removal trials were terminated at 28 days, yielding censored observations at 28 days. Removal rates for birds were estimated by season, and as an overall average.

3.5.3 Estimation of Facility-related Mortality Rates

The estimated total number of fatalities is calculated by:

$$m = \frac{N * I * C}{k * \bar{t} * p}$$

where N is the total number of met towers, I is the time between searches (days), C is that total number of carcasses during the study period, k is the number of met towers searched, $\bar{t}$ is the mean length of time a carcass remained on the plot, and p is the searcher efficiency. Searcher

efficiency and carcass removal rates are not applied to the mortality estimate for bats and stilts pursuant to the conditions of the HCP.

4.0 PCMP RESULTS

4.1 Standardized Carcass Searches

4.1.1 2009 Standardized Carcass Searches

Met towers were searched once every 10 days resulting in a total of 102 searches (number of met towers multiplied by the number of surveys) conducted between March 16 and August 21, 2009 (Table 1). Search time per met tower ranged from 20 to 90 minutes depending on various factors such as terrain and weather conditions. One survey scheduled for August 11 coincided with Hurricane Felicia passing near the Hawaiian Islands and was postponed until the following day.

No bird or bat mortalities of any threatened or endangered species were detected during 2009 spring and summer carcass surveys. One gray francolin chick carcass (*Francolinus pondicerianus*) was observed outside the plot at met tower 1, during the June 24 survey. The chick carcass was verified by DOFAW and searchers photographed and recorded relevant data. The chick, that was still in its downy stage, had not been killed by the met tower and died by other causes.

Table 1. Summary of effort for standardized carcass searches conducted for the Lanai met tower project from March 16 to August 21, 2009.

Month	No. Towers Searched	No. Searches
March	6	12
April	6	18
May	6	18
June	6	18
July	6	18
August	6	18
2009 Total to Date		**102**

4.1.2 2008 Standardized Carcass Searches

In 2008, a total of 428 standardized carcass searches were conducted at the Lanai project area. No carcasses of any threatened or endangered species were found during any of the 2008 surveys. All surveys were completed within the established search intervals. Incidentally, during the survey conducted on December 6, a wing from a kolea (Pacific golden plover; *Pluvialis fulva*) was found within the survey plot at met tower 5.

4.2 Searcher Efficiency Trials

4.2.1 2009 Searcher Efficiency Trials

During spring (March 16 through June 15, 2009), a total of 66 carcasses were placed during 12 searcher efficiency trials. Carcasses included 46 wedge-tailed shearwaters (all adults) and 20 toy mice. For searcher efficiency trials, carcasses were used more than once. Toy mice were used to simulate bats during 4 of the trials. Overall mean searcher efficiency for birds during spring was

95.4 percent (SD = 8.5 percent; n = 8); searcher efficiency for bats was 70.0 percent (SD = 35.0, n = 4; Table 2).

During summer (June 17 through August 21, 2009), searcher efficiency trials conducted to date have involved the placement of 35 carcasses during seven searcher efficiency trials. Results from the summer season are preliminary due to the timing of the annual report submission prior to the completion of the summer surveys (two summer surveys not included). Carcasses included 20 adult wedge-tailed shearwaters, and 15 toy mice (to simulate bats). Preliminary overall searcher efficiency for birds during summer is 95.0 percent (SD = 10.0, n = 4); preliminary searcher efficiency for bats is 53.3 percent (SD = 11.5, n = 3; Table 2). Preliminary analysis suggests that searcher efficiency for birds was not significantly different between spring and summer ($t = 2.22$, $df = 10$, $p = 0.94$); a significant difference was detected between spring and summer searcher efficiency for bats ($t = 2.57$, $df = 5$, $p < 0.01$).

Table 2. Results of searcher efficiency trials conducted for the Lanai met tower project during spring and summer 2009[1], with 2008 searcher efficiency trial results for comparison.

Carcass Size Class	Season	No. Placed	Mean Percent Found
Birds 2009	Spring	46	95.4
	Summer[1]	20	95.0
	Overall	66	95.2
Bats[2] 2009	Spring	20	70.0
	Summer[1]	15	53.3
	Overall	35	62.9
Birds 2008	Spring	61	55.0
	Summer	44	86.7
	Fall	49	84.0
	Overall	105	70.5
Bats 2008	Spring	19	42.3
	Summer	14	35.0
	Fall	30	40.0
	Overall	63	40.7

[1] Results for the summer season are preliminary and include data through August 15; summer searcher efficiency trials will continue through September 15, 2009.
[2] Bat searcher efficiency trials used toy mice to simulate bats in 2009.

Searcher efficiency was also calculated by met tower to identify any differences between towers although vegetation management is being conducted within the search plots. Spring searcher efficiency for birds ranged from 82.0 percent at met tower 1 to 100 percent at met tower 2, 4, 5, and 6 for birds; spring searcher efficiency for bats ranged from 20.0 percent at met tower 4 to 100.0 percent at met tower 3. During summer, searcher efficiency for birds to date ranged from 80.0 percent at met tower 4 and 5 to 100.0 percent at met towers 1 and 2; summer searcher efficiency for bats ranged from 40.0 percent at met tower 4 to 60.0 percent at met tower 1 and 3.

4.2.2 2008 Searcher Efficiency Trials

In 2008, a total of 37 bird searcher efficiency trials were conducted. Searcher efficiency for birds ranged from 55.0 percent during spring to 86.7 percent during summer and 84.0 in the fall (Table 2). The overall mean searcher efficiency for birds for all trials conducted in 2008 was 70.5 percent (SD = 29.5). A total of 22 bat trials (using toy mice and shearwater chicks as surrogates) were conducted in 2008. Searcher efficiency was comparable during all seasons:

42.3 percent during spring, 35.0 percent during summer, and 40 percent during fall (Table 3). The overall mean searcher efficiency for bats was 40.7 percent (SD = 34.6).

4.3 Carcass Removal Trials

During the spring carcass removal trial, one carcass was scavenged. On day 7 this carcass was observed 5 feet southeast of its original location near met tower 5, without a head, but with no noticeable tracks. All other carcasses were intact for the length of the trial, with some scavenging by insects. Average carcass persistence during spring was 28.0 days (SD = 0 days; Table 4).

Table 3. Results of carcass removal trials conducted for the Lanai met tower project during spring and summer, 2009 with 2008 carcass removal trial results for comparison.

Carcass Size Class	Season	No. Carcasses Placed	Mean Persistence (days)
Birds 2009	Spring	18	28.0
	Summer	10	28.0
	Overall	28	28.0
Bats 2009	Summer	4.0	8.7
Birds 2008	Spring	18	26.8
	Summer	18	28.0
	Fall	18	28.0
	Overall	54	27.6

Of the 10 adult wedge-tailed shearwaters placed during the summer carcass removal trial, no carcasses were removed by scavengers. As during the spring trial, all carcasses were scavenged by insects within the first few days of the trial and one carcass showed evidence of more substantial scavenging. Scavenging, in which the head was removed, of one carcass was observed on day 7 near met tower 6. Average bird carcass persistence during summer was 28.0 days (SD = 0 days; Table 4).

The mice carcasses that were set out to simulate bat carcasses for informational purposes were removed more quickly than the wedge-tailed shearwater carcasses. Three of the four mice carcasses were removed by scavengers: 1) one on day two near met tower 5, 2) one on day three near met tower 3, and 3) one on day five near met tower 4. The fourth mouse carcass was scavenged (torn in half) on day 10 near met tower 2 but was not removed. Average mice carcass persistence during summer was 8.7 days (N = 4, SD = 11.2 days; Table 4).

4.3.1 2008 Carcass Removal Trials

Overall carcass persistence in 2008 was 27.6 days (N = 54, SD = 0.7 days). Only one carcass was completely removed during the three trials. The absence of this carcass, a wedge-tailed shearwater placed near met tower 1, was noted on day 7 of the spring trial. More substantial scavenging (i.e., head or wings missing and movement of a carcass from the initial location placed) of several carcasses was noted during all of the trials. Although portions of these carcasses were missing, none were completely removed from the area.

5.0 PCMP DISCUSSION AND CONCLUSIONS

5.1 Mortality

In 2009, as in the previous year, no carcasses of the four covered species or any other listed species were found during standardized carcass searches, or incidentally by searchers. The observation by searchers of two non-listed bird species carcasses in the project vicinity (a wing of Pacific golden plover and a gray francolin chick) indicates that searchers are finding carcasses when they occur. Therefore, the operation of the met towers does not appear to be having a direct effect on Hawaiian petrels, Newell's shearwaters, Hawaiian stilts, or Hawaiian hoary bats. The flagging and bird diverter hardware installed on all the met towers may be contributing to birds avoiding collision with the met towers.

5.2 Searcher Efficiency

Overall searcher efficiency observed at the Lanai met tower project area for the spring and summer 2009 season to date (94.3 percent) was higher than other published post-construction monitoring studies (Table 4). The higher searcher efficiency for birds observed during 2009 may be due to searchers becoming familiar with the search area, vegetation management and the greater number of carcasses that were placed during each trial in 2009 in an effort to improve the robustness of searcher efficiency estimates (e.g., 4 to 5 carcasses versus 2 to 3 carcasses). For example, if two carcasses were placed and only one is missed, searcher efficiency was 50 percent. However, if five carcasses were placed and only one was missed, searcher efficiency was 80 percent.

Table 4. Comparison of overall (seasons combined) carcass persistence, searcher efficiency, and mortality estimation between the Lanai met tower project and similar post-construction monitoring studies.

Study Site[1,2]	Carcass Persistence (days)		Searcher Efficiency Rates (percent)		Mortality Estimation (per tower or turbine)	
	Avian	Bat	Avian	Bat	Avian[7]	Bat
Lanai 2008	27.6	-	70.5	40.7	0.0	0.0
Lanai 2009	28.0	8.7	95.4	61.5	0.0	0.0
Buffalo Ridge[3, 4]	7	11	38.7	46.5	0.98	2.16
Stateline[5]	26	16	60	42	1.93	1.12
Foote Creek Rim[6]	29	20	80	63	2.04	2.38
Oklahoma[7]	-	-	-	-	-	1.19 – 1.71

[1] Sites used for comparison are operating wind farms and are most similar in habitat to Lanai among sites with published post-construction monitoring results (i.e., shrubland, short-grass prairie, and other grassland habitat types).
[2] Some comparison sites used a combination of small and large birds for trials and analysis.
[3] Johnson et al. (2002)
[4] Johnson et al. (2003)
[5] Erickson et al. (2004)
[6] Young et al. (2003)
[7] Piorkowski (2006)

Bat searcher efficiency was relatively low during both seasons when compared with birds, but comparable with other studies. Many studies use small birds as surrogates for bats to estimate searcher efficiency, which may be easier to detect due to feathers that often move in the breeze and draw the attention of trained searchers (e.g., Johnson et al. 2003; Erickson et al. 2003; Kerns

and Kerlinger 2004; Kerlinger et al. 2006). Toy mice were primarily used in this study (except for a few shearwater chicks used in spring 2008), which may have biased the estimate of searcher efficiency low because they are smaller and more cryptically colored than birds, they better approximate the size and shape of the Hawaiian hoary bat. Searchers may have learned to develop a search image for the small carcasses, however, given that searcher efficiency rates for bats improved in 2009 from 2008 levels.

Searcher efficiency results were similar across all towers, in both the spring and summer 2009 seasons. In 2008, there was greater variability in searcher efficiency between towers potentially due to tall grasses at some met towers. Vegetation management in fall 2008 and 2009 has reduced most of the differences between met towers. Met tower 4, which contains areas of quick growing guinea grass within the search plot, had lower searcher efficiency than other met towers, particularly for bats. Searcher efficiency may have been lower during times when grasses began to grow. Therefore, while vegetation management has been effective at reducing the biases between met towers, it will need to be continued in order to maintain high searcher efficiency, particularly in areas with fast growing vegetation.

5.3 Carcass Removal

The bird carcass removal rates for the Lanai met tower project area were low in comparison with other published post-construction mortality monitoring studies (Table 5). Although all of the carcasses were scavenged by insects relatively quickly, and two had their heads removed by scavengers (one in the spring 2009 trial, one in the summer 2009 trial), no carcass was completely removed. This is likely due to the few predators that live on the island. Feral cats and rats are the most likely scavengers in the project area and cat tracks and scat have been documented near the met towers.

The placement of four mice carcasses in the summer 2009 scavenging trial provides some evidence that these carcasses are removed more quickly by predators than seabirds are removed. The results from this small sample size may indicate that scavengers may take smaller carcasses faster than the larger seabird carcasses. However, at the time this report was prepared, only one scavenger trial with a small sample size had been conducted to simulate bats. As such, summer results should be considered preliminary. More scavenging trials with a larger sample size would need to be completed for robust results. It should be emphasized that the addition of bat carcasses in the summer carcass removal trial was for informational purposes only.

5.4 Vegetation Management

Vegetation management was identified in 2008 as being needed to increase searcher efficiency because some of the survey plots were densely vegetated or had patches of dense vegetation. For example, met tower 4 contained areas of high grasses (1 to 2 meters [3 to 5 feet] in height). Tall grass at the met tower site can obscure carcasses and decrease the likelihood that searchers will find carcasses. Work to cut back dense vegetation was conducted between August and November 2008 and again at the beginning of the survey season in 2009. Vegetation management continues at met towers, as needed, into the 2009 season.

5.5 Conclusions

The most substantial finding during the 2008 and 2009 monitoring seasons was that no carcasses of the four covered species or any other threatened or endangered species were found during standardized carcass searches, or incidentally by searchers. Overall, the results of 2009 post-construction monitoring for the Lanai met tower project demonstrate that under the current protocols, searcher efficiency has improved since 2008. The carcass persistence time and high searcher efficiency for birds also indicate that the 10-day search interval is a more than adequate time frame. The observation by searchers of two non-listed bird species carcasses in the project area (wing of Pacific golden plover and gray francolin chick) and higher searcher efficiency indicates that searchers are finding carcasses when they occur. Thus, the operation of the Lanai met towers does not appear to be having a direct effect on Hawaiian petrels, Newell's shearwaters, Hawaiian stilts, or Hawaiian hoary bats or any other flying wildlife species during its first two years of operation.

6.0 MITIGATION PLAN SUMMARY

During development of the HCP for the Lanai Met Tower project, DOFAW and USFWS determined that a combination of habitat restoration and predator control activities would mitigate potential incidental take and result in a net benefit to the Newell's shearwater, Hawaiian stilt, Hawaiian petrel, and Hawaiian hoary bat populations. DOFAW did not provide TtEC with an annual report for 2009 that summarizes work completed since August 2008. However, TtEC has summarized the progress of the mitigation work through August 21, 2009 from periodic reports provided by DOFAW between September 2008 and July 2009. Since initiating the mitigation work at Lanaihale, DOFAW has cleared a total of approximately 5.6 acres (1.2 acres total in 2008). The cleared area extends to the cliff edge of Hono'umi gulch. This opening provides the maximum open flyway for Hawaiian petrels to the adjacent Hono'umi gulch, and provides air flow to carry fog and cloud drip closer to ground level. In addition to clearing strawberry guava and pines in the restoration area, native species from propagation have been planted. Some native plants also emerged from the seed bank once the guava was removed. Ungulates are browsing on some of the new native plants. DOFAW will need to coordinate with Castle & Cooke on controlling ungulate browsing.

For predator control, DOFAW has been trapping feral cats and rats at Lanaihale and the Lanai wastewater treatment plant. Between September 1, 2008 and July 31, 2009, 14 cats have been removed from the Lanaihale area and 15 from the wastewater treatment plant as well as 17 rats from these two locations.

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