LANAI METEOROLOGICAL TOWERS

HABITAT CONSERVATION PLAN
2008 ANNUAL REPORT

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1.0 INTRODUCTION

Castle & Cooke Resorts, LLC (Castle & Cooke) 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 so an incidental take permit/incidental take license (ITP/ITL) could be issued 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* 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/ITL is expected to be issued in September 2008. The term of the HCP will be through March 1, 2010 to accommodate the approximate two-year time period the met towers will be in operation.

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 approximate two-year period the met towers will be in operation. Individuals of any of these species may 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. Therefore, the incidental take limit established for the Hawaiian hoary bat, Hawaiian stilt, and Newell's shearwater is two individuals each.

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. 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, Tetra Tech EC, Inc. developed for Castle & Cooke a PCMP. The PCMP includes 1) standardized carcass searches to monitor potential injuries or fatalities, 2) carcass scavenging

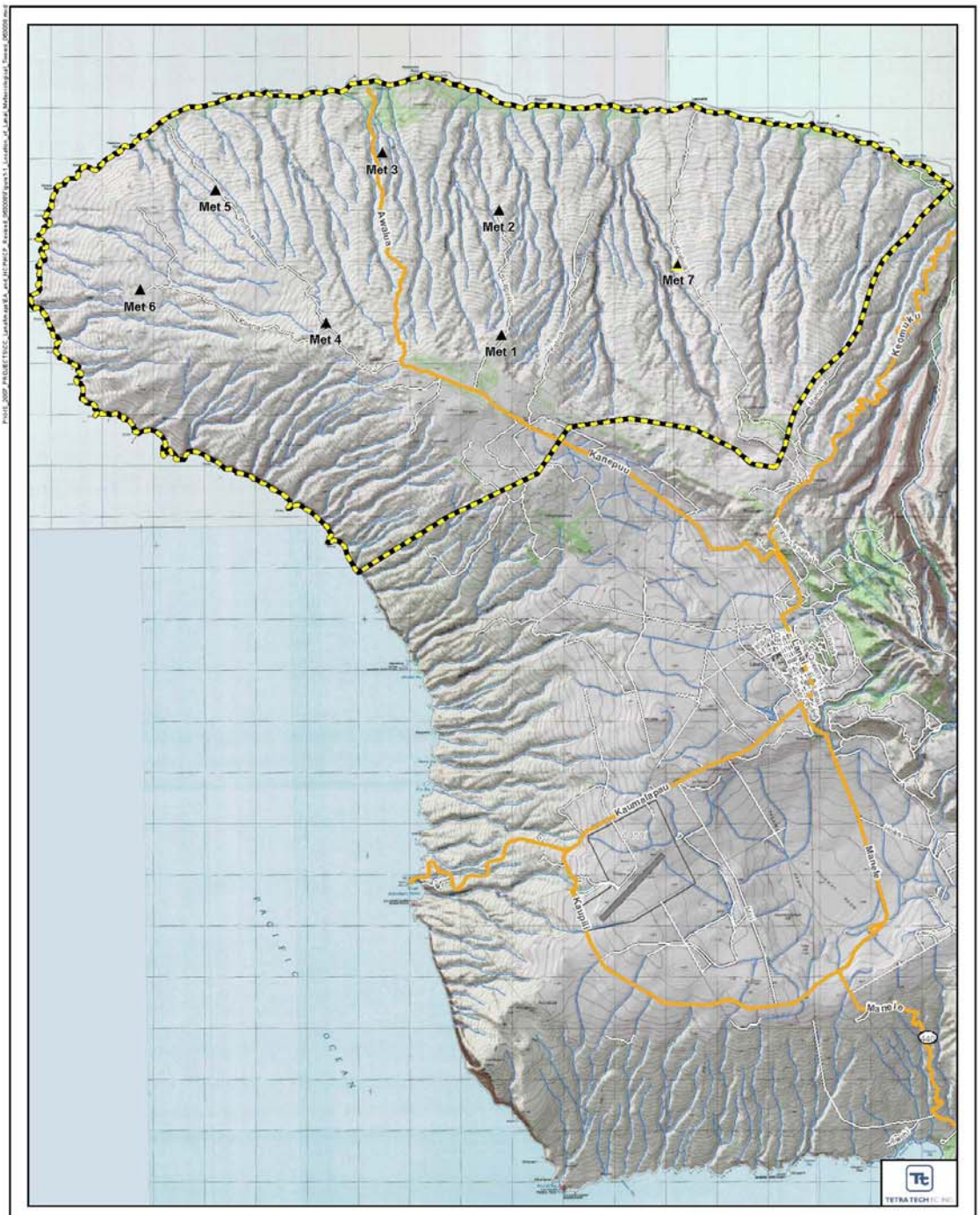

Figure 1. Location of Lanai Meteorological Towers
Castle and Cooke Lanai Meteorological Towers Project
Maui County, Hawaii

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 was developed to focus on seabirds because the Hawaiian petrel is the species with the highest potential for incidental take, if take were to occur. Although the carcass surveys are being conducted to document any potential incidental take of threatened or endangered species, non-listed species will also be recorded under this protocol.

The mitigation plan was developed to compensate for potential incidental take of the four covered species during the approximate two-year project period. This 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 or six acres of degraded habitat, under Tier 1 or Tier 2, respectively, will be restored at Lanaihale adjacent to the petrel colony. Additionally, DOFAW's existing cat trapping program at this location is being augmented. As mitigation for the potential take of Hawaiian stilts, a cat trapping program was initiated at the Lanai wastewater treatment facility, the area where Hawaiian stilts are known to be breeding residents. Should Tier 2 of mitigation for petrels need to be implemented, an additional three acres of habitat (six acres total) would be restored and the predator control program at the petrel colony expanded.

Castle & Cooke is providing the funds to DOFAW 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.

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. This first report summarizes the results of the post-construction monitoring surveys from March 4 through August 15, 2008, and the progress of the habitat restoration and predator control activities conducted between November 2007 and August 2008 as provided by DOFAW.

2.0 STUDY AREA

The met tower project is located on the northwestern portion of Lanai (Figure 1). Lanai is a generally 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 endemic 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 search plots, 126 meters by 126 meters (413 feet by 413 feet), 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 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 all 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 grassland, 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 mostly 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 and benefit the Hawaiian hoary bat by increasing foraging and roosting habitat. The wastewater treatment plant, where the Hawaiian stilts reside, is located within 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 and in the Final HCP dated August 2008. Prior to initiating surveys, permits required to implement the monitoring program were obtained. These include the USFWS Special Purpose Permit, issued on September 21, 2007, and the Protected Wildlife Permit issued by DOFAW in February 2008. Subsequent amendments have been made to each permit.

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). Initially, agencies required that survey frequency be no more than three days apart (approximately two times per week). However, survey frequency can be adjusted accordingly based on the results of the carcass removal trials and searcher efficiency rates. A complete round of searches (all six met towers) is completed in one to two days by two searchers. Carcass searches are not required between approximately December 15 and March 15, when seabirds are no longer present on the island. The following dates were used to define seasons: spring (March 15-June 15), summer (June 16-September 15), and fall (September 16-December 15). The exact day a new trial or survey begins or ends may vary a few days depending on when the seabirds arrive or leave the colony, site conditions, or carcass availability. In 2008, carcass searches were initiated on March 17 and will be conducted through December when 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, road conditions, and/or staff safety is questionable. Surveys would resume as soon as safely possible. However, no such adverse site conditions were identified during this survey period.

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 6 meters (20 feet) apart, and searchers walked along each transect searching both sides out to 3 meters (10 feet) for casualties (Johnson et al. 2003). Search area and speed were adjusted by habitat type, with transects more closely spaced in areas of dense vegetation. At met tower 4 and a portion of met tower 1, transects were conducted approximately 4 meters apart due to dense vegetative conditions.

Upon discovery of a carcass, searchers were to record the species, sex and age when possible, date and time collected, location, condition and any comments that may indicate cause of death (Appendix A). 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 include taking photographs, recording a GPS coordinate, and filling out a Downed Wildlife Incident Report (Appendix A).

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 were to identify, photograph, and record 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 spring and summer to account for seasonal differences in vegetation characteristics. Under the HCP, at least three trials were to be conducted in each season.

Wedge-tailed shearwaters were the primary species used for searcher efficiency trials. These carcasses were provided by DOFAW and USFWS. Cryptically colored domestic chickens were also used during some trials until the DOFAW Protected Wildlife Permit was amended to include new personnel. Bat carcasses were unavailable and therefore wedge-tailed shearwater chicks and 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 wire, tape, or flagging 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 had been 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. Carcass placement was selected in a stratified random fashion based on search plot vegetation to ensure that within each search plot the range of vegetation was accounted for. Thus, carcasses were placed in both dense vegetation and open areas. During spring, testers were hiding approximately half the carcasses (e.g., placing them, with wings tucked, under dense vegetation). This was done in an attempt to simulate the potential positioning of an injured bird, however, prior to the summer season it was determined that this was not presenting a realistic representation of how a carcass would fall if it hit a met tower or guy wire. Therefore, during the summer season carcasses were gently tossed in a random fashion and allowed to hit the ground without being manipulated.

Vegetation management was identified as a potential need to facilitate the ability of searchers to locate carcasses given that portions of search plots around some met towers support tall or 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 management was initiated in August, and will continue into the fall.

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 would 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. All carcasses used were non-domestic avian species; bat carcasses were not available for carcass removal trials and therefore no estimate of carcass removal specific to bats was calculated in 2008.

The spring carcass removal trial was initiated on March 4 and conducted through March 30, 2008. A total of 18 carcasses (three near each tower) were planted during each trial. Carcasses included 16 wedge-tailed shearwaters, one kolea (*Pluvialis fulva*), and one rock dove (*Columba livia*). The summer carcass removal trial was initiated on June 21 and conducted through July 19, 2008. Eighteen carcasses were also placed during this trial (three near each met tower), all of which were adult wedge-tailed shearwaters. 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 and therefore mean values do not represent the full range of variability in searcher efficiency. Any adjusted fatality estimates would be based on 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 HCP.

4.0 PCMP RESULTS

4.1 Standardized Carcass Searches

Met towers were searched twice a week resulting in a total of 264 searches conducted between March 17 and August 15, 2008 (Table 1). Search times varied depending on vegetation height and density, ranging from 25 to 112 minutes. During the study period, temperatures ranged from the low 70s to upper 80s. Weather did not delay or prevent any searches between March and August. No bird or bat mortalities were detected during spring and summer carcass surveys.

Table 1. Summary of effort for standardized carcass searches conducted for the Lanai met tower project from March 15 to August 15, 2008.

Month	No. Towers Searched	No. Plot Searches
March	6	30
April	6	48
May	6	54
June	6	54
July	6	54
August	6	24
2008 Total		**264**

4.2 Searcher Efficiency Trials

During spring, a total of 80 carcasses were placed during 31 searcher efficiency trials. Carcasses included 73 wedge-tailed shearwaters (61 adults, 12 chicks) and seven toy mice (note that for searcher efficiency trials carcasses were used more than once). Wedge-tailed shearwater chicks and toy mice were used to simulate bats during some of the trials. Overall mean searcher efficiency for birds during spring was 55.0 percent (SD = 30.5, n = 18); searcher efficiency for bats was 42.3 percent (SD = 40.0, n = 13; Table 2).

Through August 15, summer searcher efficiency trials have involved the placement of 53 carcasses during 11 searcher efficiency trials. Carcasses included 25 adult wedge-tailed shearwaters, 19 cryptically colored domestic chickens, and nine toy mice (to simulate bats). Preliminary overall searcher efficiency for birds during summer is 86.7 percent (SD = 22.4, n = 9); preliminary searcher efficiency for bats is 32.5 percent (SD = 10.6, n = 2; Table 2). Preliminary analysis suggests that searcher efficiency for birds was significantly higher during summer than spring ($t = 2.05$, $df = 25$, $p = 0.01$); no significant difference was detected between spring and summer searcher efficiency for bats ($t = 2.16$, $df = 13$, $p = 0.74$).

Table 2. Results of searcher efficiency trials conducted for the Lanai met tower project during spring and summer, 2008.

Carcass Size Class	Season	No. Placed	Mean Percent Found
Birds	Spring	61	55.0
	Summer[1]	44	86.7
	Overall	105	65.6
Bats[2]	Spring	19	42.3
	Summer[1]	9	32.5
	Overall	28	41.0

[1] Results for the summer season are preliminary and include data through August 15; summer searcher efficiency trials will continue through September 15, 2008.
[2] Bat searcher efficiency trials used toy mice and wedge-tailed shearwater chicks to simulate bats.

Searcher efficiency was also calculated by met tower to provide a baseline for evaluating the effects of vegetation management within the search plots on searcher efficiency (Table 3). Spring searcher efficiency for birds ranged from 32.0 percent at met tower 4 to 81.0 percent at met tower 6 for birds; spring searcher efficiency for bats ranged from 0.0 percent at met tower 1 to 67.0 percent at met tower 5. During summer, searcher efficiency for birds to date ranged from 40.0 percent at met tower 4 to 100.0 percent at met towers 1, 3, and 5; summer searcher efficiency for bats ranged from 25.0 percent at met tower 4 to 40.0 percent at met tower 6.

Table 3. Results of searcher efficiency trials conducted for the Lanai met tower project during spring and summer, 2008.

Carcass Size Class	Met Tower	Spring			Summer[1]		
		Mean Percent Found	SD	N (Trials)	Mean Percent Found	SD	N (Trials)
Birds	1	58.0	12.0	2	100.0	--	1
	2	50.0	24.0	2	93.3	11.5	3
	3	67.0	--	1	100.0	0.0	2
	4	32.0	30.0	5	40.0	--	1
	5	61.0	38.0	5	100.0	--	1
	6	81.0	17.0	3	60.0	--	1
Bats[2]	1	0.0	0.0	2	--	--	0
	2	50.0	71.0	2	--	--	0
	3	50.0	--	1	--	--	0
	4	50.0	0.0	2	25.0	--	1
	5	67.0	29.0	3	40.0	--	1
	6	33.0	58.0	3	--	--	0

[1] Results for the summer season are preliminary and include data through August 15; summer searcher efficiency trials will continue through September 15, 2008.
[2] Bat searcher efficiency trials used toy mice and wedge-tailed shearwater chicks to simulate bats.

4.3 Carcass Removal Trials

During the spring carcass removal trial, one carcass was removed by scavengers. The absence of this carcass, a juvenile wedge-tailed shearwater placed near met tower 1, was noted on day 7 of the trial. All other carcasses were scavenged by insects within the first few days of the trial. More substantial scavenging of one carcass near met tower 2 was noted on day 7, and scavenging of three carcasses (two near met tower 6 and one near met tower 5) was noted on day 10. Each of these carcasses had the head and/or wings missing and had been moved but all remained in the vicinity of where they had originally been placed. It is likely that this scavenging was by feral cats; cat tracks were observed near met tower 5 on day 5 of the trial. Average carcass persistence during spring was 26.8 days (SD = 4.9 days; Table 4).

Table 4. Results of carcass removal trials conducted for the Lanai met tower project during spring and summer, 2008.

Carcass Size Class	Season	No. Carcasses Placed	Mean Persistence (days)
Birds	Spring	18	26.8
	Summer	18	28.0
	Overall	36	27.4

Of the 18 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 three carcasses showed evidence of more substantial scavenging. Scavenging of two carcasses was observed on day 21 near met towers 1 and 3, respectively. The remnants of these carcasses (e.g., a feather spot and wings or bones) were present on day 28 a short distance from where carcasses had originally been placed. Scavenging of a third carcass near met tower 4 was observed on day 28; only a feather spot was present in the vicinity of where the carcass had originally been placed. Because all carcasses would theoretically have been available to be detected by searchers throughout the trial, either as intact carcasses or portions of carcasses, mean carcass persistence was 28 days (SD = 0 days; Table 4). No significant difference was detected between spring and summer carcass persistence ($t = 2.03$, $df = 34$, $p = 0.32$).

5.0 PCMP DISCUSSION AND CONCLUSIONS

5.1 Mortality

Based on the fact that no carcasses of the four listed species covered by the HCP were found during standardized carcass searches, or incidentally by staff onsite, 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. Spring and fall radar and point count surveys conducted in 2007, consultation with DOFAW and USFWS biologists, and available literature indicated Hawaiian petrels occur within the project area but that their avoidance ability could be high. The flagging and bird diverter hardware installed on all the met towers may be contributing to the apparent avoidance of the met towers by birds. As previously stated, surveys conducted within the project area indicated that Newell's shearwater, Hawaiian stilt, and Hawaiian hoary bat have a low likelihood of occurring in the project area. Therefore the potential for direct contact with the met towers by these species is also likely low, and this conclusion is supported by the results of the carcass surveys.

5.2 Searcher Efficiency

Overall searcher efficiency observed at the Lanai met tower project area for the spring and summer season to date (65.5 percent) was comparable to other published post-construction monitoring studies (Table 5). Results were highly variable due to the small number of carcasses used during each trial; however, this was due to the limited availability of carcasses. The higher searcher efficiency for birds observed during summer may be due to eliminating the bias of hiding half of the carcasses when conducting trials, greater experience of searchers, or due to the occasional use of domestic chickens which were larger and potentially more visible than the wedge-tailed shearwater carcasses. However, after their first use, the chickens were divided into smaller pieces to better represent the size of a seabird (i.e., only wings, or bodies without wings, were used). Also during summer 2008, a greater number of carcasses were placed during each trial 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 place and only one was missed, searcher efficiency was 80 percent.

Table 5. 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]	Carcass Persistence (days)		Searcher Efficiency Rates (Percent)		Mortality Estimation (per tower or turbine)	
	Avian	Bat	Avian	Bat	Avian	Bat
Lanai	27.4	-	65.6	41.0	0.0	0.0
Buffalo Ridge[2, 3]	7	11	38.7	46.5	0.98	2.16
Stateline[4]	26	16	60	42	1.93	1.12
Foote Creek Rim[5]	29	20	80	63	2.04	2.38
Oklahoma[6]	-	-	-	-	-	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., include shrubland, short-grass prairie, and other grassland habitat types).
[2] Johnson et al. (2002)
[3] Johnson et al. (2003)
[4] Erickson et al. (2004)
[5] Young et al. (2003)
[6] Piorkowski (2006)

Bat searcher efficiency was relatively low during both seasons. 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). The use of toy mice in this study during summer may have biased the estimate of searcher efficiency low because they are smaller and more cryptically colored than the wedge-tailed shearwater chicks used during spring but they are closer in size to a Hawaiian hoary bat. However, to date only two trials using bats (toy mice) have been conducted during the summer season. Additional trials will be completed over the remaining month of this season.

Tower-specific searcher efficiency results were generally indicative of the differences in vegetation at individual towers. In general, towers with the tallest and densest vegetation (e.g., met tower 4) had the lowest searcher efficiency, whereas towers with more open ground or low grass had higher searcher efficiency. Met tower 4, which has tall guinea grass in portions of the search plot, consistently had lower searcher efficiency. It is important to note that these tower-specific results are based on a very small number of trials per tower, and most trials, particularly for bats, consisted of less than 3 carcasses per trial. Thus results are highly variable (Table 3) and should not be used in fatality estimates. Additionally, at the time of the preparation of this report few summer trials had been conducted and as such summer results should be considered preliminary.

5.3 Carcass Removal

The carcass removal rates for the Lanai Met Tower project area were low in comparison to other published post-construction mortality monitoring studies (Table 5). Although all of the carcasses were scavenged by insect relatively quickly, and several were chewed on or moved by scavengers, only one carcass was completely removed. Carcasses that were torn apart during the trials were missing heads or wings, and some individual carcasses were moved and/or scavenged during the trial. However, all but one carcass remained in the search plot vicinity for the duration of the trial. 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 feral cats have been documented near the met towers through both tracks and scat. It is possible that carcasses the size of a bat might be removed more quickly by predators but we were limited in our ability to test this during these trials. These results indicate that the current search interval of two times per week as required by the agencies is oversampling (i.e., additional effort that provides no increase in accuracy). A less frequent survey interval such as once a week or even once every two weeks would still ensure that there is no loss in data (i.e., that dead birds remain unscavenged long enough to be found).

5.4 Vegetation Management

Vegetation management was identified at the beginning of the study period as a need to increase searcher efficiency because a few of the survey plots are densely vegetated throughout or have patches of dense vegetation. For example, met tower 4 contained areas of high grasses (1 to 2 meters [3 to 5 feet] in height). This makes searching difficult and decreases the likelihood that searchers will find carcasses. The use of grass trimmers and other equipment to manage vegetation was authorized by the Hawaii DLNR as of June 17, 2008. Work has begun to cut back dense vegetation from several of the met towers, starting with met towers 4 and 6. It is assumed that following vegetation management, overall searcher efficiency will improve visibility within the search plots that were previously densely vegetated.

5.5 Conclusions

Overall, the results of 2008 post-construction monitoring for the Lanai met tower project indicate that under the current protocol, effects to the four endangered species potentially occurring in the project area are being assessed accurately and that the sampling regime is most likely resulting in oversampling. The low carcass removal rate suggests that a larger search interval is warranted given that carcasses persist onsite for nearly four weeks. Preliminary estimates of searcher efficiency were highly variable but based on the bias (hiding half of carcasses during trials) incorporated into the spring season, more in line with the summer results of 86 percent. Searcher efficiency should continue to improve with vegetation management of the densely vegetated patches within the search plots and a larger number of carcasses used in trials (4 to 5 carcasses).

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. Castle & Cooke provided DOFAW with an initial payment for the Tier 1, Year 1 mitigation funds in February 2008 to begin the scope of work outlined in the HCP. The habitat restoration and predator control program were initiated by DOFAW in March 2008. Appendix 2 includes DOFAW's annual report that summarizes the progress of the mitigation work through August 15, 2008. DOFAW has cleared 1.2 acres of the 3 acre parcel that was to be restored in the Tier 1 mitigation plan. Six cats have been removed from the Lanaihale and three from the wastewater treatment plant since the trapping efforts were enhanced with these funds.

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APPENDIX A

STANDARDIZED CARCASS SEARCH SURVEY FORMS

Lana'i Downed Wildlife Survey

Location: _____ **Observer:** _____ **Date:** _____

Start Time: _____ **End Time:** _____

Environmental Conditions:

Cloud Cover:____ (**0**=about 25%, **1**=26-50%, **2**=51-75%, **3**=76-100%) **Temperature:**_____

Precipitation:____Rain____ Fog____Other____ (**0**=None, **L**=light, **M**=Moderate, **H**=Heavy, Other= Hail, Snow)

Wind:_____ **0**=<1 mph, **1**=1-3 mph (leaves barely move), **2**=3-7 mph (leaves rustle, small twigs move),
3=8-12 mph (sm. Twigs move), **4**=13-18 mph (sm. Branches move) **5**=12-24 mph (lg. Branches move trees sway)

Vegetation: Ave. ht. _____**(cm); Ave. vigor** _____ **(G**= Green, **M** = Mixed, **B** = Brown);
Cover _____% (% ground obscured by plant cover), record details in comments

Tower No.	Species	Sex	Age	Remains	Dir. From Tower	Dist. From Tower	UTM N	UTM E	Approx. Carcass Age	Photo nmbrs	Vegetation Type	Comments

Species: 4-letter code
Sex: sex of animal if known (**M** = Male, **F** = Female); **Age: A** = Adult, **S** = Subadult, **J** = Juvenile
Remains: E=Entire body, **W**=Wing, **F**=Feathers/Fur, S=feather spot (10 or more, or 3 primaries),**B**=Bones, **O**=Other (add to Comments)
Dir. From Tower: Compass direction of carcass from Tower base
Dist. From Tower: Distance (meters) of carcass from Tower
Carcass age: Approximate age in days of carcass remains
Comments: Print notes as needed

Downed Wildlife Incident Report

Location	
Date and Time Identified	
Species	
Probably Cause of Injury/Death	
Action Taken	
Other Comments	
Name of Observer	

APPENDIX B

MITIGATION PROGRAM ANNUAL REPORT AS PROVIDED BY DOFAW

LANA'I METEOROLOGICAL TOWERS PROJECT

HABITAT RESTORATION, PREDATOR CONTROL

AND MONITORING

2008 Annual Report

Covering November 1, 2007 to August 15, 2008

August 20, 2008

A Project of the Pacific Cooperative Studies Unit, University of Hawaii, Lana'ihale Forest and Watershed Project (LP), in association with Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife,1151 Punchbowl Street, Room 325, Honolulu, Hawaii 96813.

Annual Report to Castle & Cooke Resorts, LLC, P.O. Box 630310, 1311 Fraser Avenue, Lanai City, Hawaii 96763

1.0 Introduction

Castle & Cooke Resorts, LLC (Castle & Cooke) is currently conducting meteorological data collection throughout the northern portion of Lanai in an effort to determine whether existing wind resource in this area would support a commercial wind facility. This data collection entails establishing several meteorological towers throughout northern Lanai. These towers may cause incidental taking of birds. The area in question has been shown to serve as a corridor to breeding colony areas for Hawaiian petrel (*Pterodroma sandwichensis*). Newell's Shearwater (*Puffinus newelli*), Hawaiian hoary bat (*Lasiurus cinereus semotus*), and Hawaiian stilt (*Himantopus mexicanus knudseni*) have been observed in the area. The Division of Forestry and Wildlife (DOFAW) and the United States Fish and Wildlife Service (USFWS) have therefore requested that Castle & Cooke prepare a Habitat Conservation Plan (HCP) and acquire an incidental take license/permit (ITL/ITP) to allow for the potential incidental take of these federally listed threatened and/or endangered species. During the HCP planning process, Castle & Cooke, DOFAW and USFWS determined that a combination of habitat restoration and predator control actions would mitigate possible negative affects on populations and result in a net benefit to these protected species. Castle & Cooke is providing funds to DOFAW to implement the habitat restoration and predator control program. DOFAW is currently responsible for the design, implementation, and monitoring of this scope of work. This annual report describes DOFAW Habitat Restoration as Mitigation (HRAM) activities falling between November 1, 2007 and August 15, 2008.

2.0 Methods and Results

2.1 Habitat Restoration Activities: November 2007 to August 2008

A habitat restoration area was identified in order to mitigate the incidental take of Hawaiian petrel, Newell's Shearwater and Hawaiian hoary bat. Habitat restoration activities have been divided into Tier 1 and Tier 2, matching take limits. The Tier 1 and Tier 2 restoration areas are indicated on the attached map.

Current habitat restoration efforts focus on restoring a degraded area occupied in the past by breeding Hawaiian petrels. Several separate but related activities were conducted in November 2007 through February 2008 in an effort to expedite this restoration project. Activities included:

- Estimating total cost of site restoration.
- Delineating the habitat restoration site.
- Identifying and marking of all remaining native vegetation.
- Conducing tree-snail surveys of the habitat restoration site.
- Contracting a professional archaeological survey of the habitat restoration site.
- Creation of a Research Corporation University of Hawaii human resources position.
- Developing an invasive species control protocol.
- Procuring materials and supplies.
- Planning and scheduling.
- Hiring additional staff.

March 2008 marked the beginning of invasive species control utilizing mechanical and chemical techniques. All native plant elements were conserved to the fullest extent possible during all restoration activities. The Maui Invasive Species Committee (MISC) provided two weeks (some 400 person hours) of clearing to begin restoration efforts. New staff was hired and trained during the initial removal effort. Approximately one acre was cleared during March 2008. Staff training included pesticide risk reduction, firearms safety, Hawaiian petrel identification and biological survey methodology. Clearing of the restoration site continued in April 2008. Because large trees often function as Hawaiian bat nurseries, pup rearing sites, and roosting sites, large trees will not be removed between June 2008 and October 2008.

In May 2008 and June 2008, habitat restoration efforts continued with the re-treatment of areas first treated in March. Hand work progressed slowly, clearing with in uluhe patches, and carefully selecting the proper stems to cut to extricate entwined native plants from strawberry guava. Approximately 1.2 acres have been cleared as of August 2008. During June 2008, staff participated in Wild Land Fire Training conducted by DOFAW and Maui Fire Department staff. The first out plantings to the restoration site took place with akia (*Wikstromia bicornuta*) collected within the watershed protection fence and grown by Fern Duvall.

2.2 Predator Control

An active feral cat population has been identified on Lana'ihale, including the habitat restoration area. Feral cats have been shown to have severe negative impacts on native bird populations. Efforts have therefore been undertaken to reduce the feral cat population.

Per Appendix 7 of the draft Habitat Conservation Plan, the purpose of the predator control effort is to increase feral cat trapping efforts at the Lanaihale, as well as establishing a regular trapping effort at the wastewater treatment facility. Success of this portion of the project will be achieved when:

- Twenty additional cat traps have been added on Lana'ihale.
- Twelve cat traps have been deployed at the wastewater treatment facility.

In March of 2008, 20 cat traps were added to the existing Lanaihale Project trap lines. In May 2008 through June 2008 twelve cat traps were deployed in the waste treatment plant area for the protection of Hawaiian stilt and other native water birds. Cat trapping efforts on Lanaihale have increased 50% from the previous year. Approximately 60 traps are now in operation in Lanaihale and 12 traps are in place in the waste water treatment site. Data collected during monitoring of traps include: bait used, attractant used, trap closed or open, bait present or absent, animal caught or not, tracks or other sign present or absent around trap.

From January 2008 to August 2008 six feral cats were removed from Lanaihale and three feral cats were removed from the waste water treatment facility. However, traps in the waste water treatment site have only been in place since May 2008 because Lana'i Animal Rescue Committee (LARC) was given opportunity to remove colony cats from the area before trapping was initiated. Project staff worked

with C & C attorney, Gary Yokoyama, and representatives of LARC to formulate an island wide policy for feral animal care and population reduction.

3.0 Discussion and Future Plans

Clearing has been more difficult and proceeded more slowly than expected. Priority need is for the previously described Dodge Ram 3500. Project staff can no longer move the chipper to disperse chips and operate in the vicinity of the advancing cut line. As soon as a truck capable to do the work is available project staff will continue cutting and chipping strawberry guava. Activity until that time will continue re-treating cut areas and collecting seed and propagating native plants for out-planting in the site. Cat trapping will continue on Lāna'ihale and the sewer treatment facility.

Foliar treatment of re-growing areas of the restoration site is planned for early September 2008. As soon as C & C provides a truck capable of moving the chipper and providing safe transportation for staff, additional acreage will be cleared. Project staff plan to provide secure storage at the restoration site for tools and supplies as soon as an ordered container arrives. This will permit shorter set up and tear down times for field operations and improved productivity.

The strategy for any additional mitigation will be agreed upon by DOFAW, USFWS and C&C, based on adaptive management strategies and best science available, including but not limited to lessons learned from successes, challenges and needs presented during the restoration of the first three acres, predator control, and monitoring.