DRAFT Report on Seabird Searcher Efficiency Trials for the Kauaʻi Seabird Habitat Conservation Plan

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Executive Summary

Participants in the Kaua‘i Seabird Habitat Conservation Plan (KSHCP) are required to search their property for downed covered seabirds twice per night during the seabird fallout season from September 15 to December 15. The purported rate of discovery of downed birds varies among the KSHCP Participants. This project was designed in response to agency requests for data regarding searcher efficiency at covered properties.

This study assessed the effectiveness of these searches by placing 3D-printed Newell's Shearwater replica decoys around participating properties and asking participants to report them immediately when discovered. Decoy placements were based on randomly generated GPS points and also split roughly 50/50 between placements in fully open locations and placement in cover. The study was designed to reflect what is known of the behavior of the covered species: that there is a pulse of fledging in the first few hours after dark, and that downed birds always seek shelter before it gets light in the morning. This raised two challenges. Because it is not known how soon after landing birds seek shelter, half of the decoys were deployed at random points and the other half were deployed in the nearest cover to their random point. Results are reported separately by cover type. Second, while the KSHCP guidelines ask searches to be conducted before sunrise, decoys placed in the open could not move themselves into cover before it gets light to reflect the true behavior of a live bird. Ideally, all decoys deployed in open areas like lawns and empty lots would be collected at daybreak, but that was not feasible for my schedule at multiple properties a night. Regardless of what time I was able to arrive to retrieve decoys, the analysis considers discoveries as successful for decoys in cover if they are found by sunrise, and for decoys in the open if they are found by daybreak (here defined as 30 minutes before sunrise, by which time no live bird would remain out in the open).

Searcher efficiency trials are most informative if conducted as a blind trial, with participants unaware they are being tested. However, that was not possible due to the participants' request to be briefed on the methods before the start of the study, and the need for disclosed or approved access to some of the properties. This study was designed to reduce "exam bias," where searchers know they will be tested and thus may consciously or unconsciously increase their effort over the limited period of the study relative to the 30-year permit term of the KSHCP. Every effort was made to minimize participants' awareness of which nights decoy(s) were deployed on their property, so that searchers would not search with extra effort if they knew there were decoys to be found. This was done by randomizing the nights of decoy deployment for each property, the number and placement of decoys, and limiting the maximum number of decoys deployed each night.

Results - see also table below: Search efficiencies spanned a wide range, with properties seemingly either 1) actively searching for birds or 2) only encountering birds incidentally. The lowest performing properties each reported just 1 decoy: Sheraton and A&B's Hokulei. The highest performing properties reported 61-93% of decoys, including all or almost all decoys deployed in the open: HDOT's Port Allen Harbor and A&B's Port Allen and Kukuiʻula properties. Decoys in cover were categorized as being in either partial or full (dense) cover. Only 1 decoy in full cover was reported in the entire study. Also, even though some properties had a high searcher efficiency when combining evening and morning searches, many of their decoys were missed by their evening search, meaning that many decoys that were reported still went undiscovered for roughly 9 hours - a long time for a seabird to either find cover or be found by a predator. Several decoys were stolen from public areas and one was intentionally run over by a vehicle.

Property (all cover types combined)	Discovery rate	Estimated rate in PIP
A&B Port Allen	62%	50%
A&B Shops at Kukuiʻula	61%	50%
A&B Hokulei	6%	50%
A&B Waipouli	53%	50%
A&B (all combined)	47%	50%
County of Kauaʻi (*encounter rate)	*4% (*22% by 7:30am)	50%

HDOT Līhuʻe Airport	47%	75%
HDOT Port Allen Harbor	93%	50%
Kauaʻi Coffee factory	10%	50%
Marriott / Royal Sonesta	17%	50%
Sheraton Poʻipū	5%	50%

Vegetative or structural cover had considerable impacts on the results,. With rare exception, reported decoys were among those placed in the open, while almost all decoys placed in cover went undiscovered. There was significant variation in search efforts between properties. For example, the Port Allen properties were observed conducting regularly scheduled nightly searches and that diligence is reflected in the results. In contrast, at the Sheraton the only decoy or live birds reported were near the main lobby, while decoys in lawns and one on a sidewalk remained unnoticed all night.

Ideally this evaluation project would have covered the full seabird fallout season (September 15th - December 15th), but due to contracting delays it was not able to commence until October 27th, a time constraint that limited sample size to roughly 20 decoys per tested property. However, the results are sufficient to give an impression of each participant's searcher efficiency.

Recommendations:

- Properties with search efficiencies below the level approved in their PIP can request agency assistance to coordinate improved searcher training prior to re-evaluation. .

- Furthermore, properties that did not find decoys for many hours until their pre-dawn searches should also attempt to improve the effort of their first searches of the night so that birds can be found as soon as possible, before they go into hiding or are depredated.

- Properties that could not be included this year should be evaluated next season (i.e., Hotel 1 at Princeville, Plantation Core at Kukuiʻula, County of Kauaʻi night football games).

- Search efficiency evaluations should recur in multiple future years to maintain and improve search effort over the 30 years of the KSHCP.

- Searches before sunrise could be scheduled slightly earlier, to conclude 30 minutes before sunrise. This will increase the chances of birds still being in easy-to-find open areas, rather than already under cover once it gets light. The closer to sunrise the search, the more effort needed to thoroughly search all nooks and crannies.

- Making sure that vegetation is kept trimmed as much as possible during the seabird season would reduce available cover and so may help searchers find more birds.

Introduction

The Kaua‘i Seabird Habitat Conservation Plan (KSHCP) was developed to address light attraction impacts to the listed seabirds, and is structured to allow multiple permitted participants to share the costs and benefits of a collaborative mitigation project while maintaining individual responsibility for minimization actions on their covered properties. The KSHCP defines a set of actions to minimize effects of light attraction on the listed seabirds, including reduction in the amount and intensity of lighting, controlling predators, and recovering birds that have been impacted.

Fledgling seabirds are more affected by light attraction than adult seabirds, especially as they make their first flight from nesting sites to the sea. In the presence of light, the seabirds circle repeatedly and can become exhausted and often grounded as a result (commonly termed "fallout") or collide with structures in the process. Once grounded, the seabirds experience difficulty in resuming flight, and are vulnerable to introduced predators and vehicle traffic, such that unless rescued, they are assumed to have died. Some seabirds grounded by light attraction are found alive and are able to be rehabilitated for release back into the wild. Downed birds that are not found during the initial night will attempt to hide themselves in as dark and protected a space as possible before daylight and reemerge the next night; however, they are vulnerable to depredation during that time, and even if they are not discovered by a predator, the resulting delay in their reaching the ocean and the accompanying potential heat in the lowlands, dehydration, and lack of food would all reduce the fitness of that individual. It is therefore imperative that any downed birds be found promptly on the night they become grounded.

All participants are required to implement a formal, organized search strategy to find downed seabirds. Participant Inclusion Plans are required to include details on the annual training of searchers, search strategy, including a map or description of search routes, the frequency of searches, likely problem locations and how these locations will be searched, the personnel involved, time required to complete the searches, date(s) on which searching will be conducted, and how data will be collected and presented.

The KSHCP states that searchers will be trained prior to the beginning of the fallout season (September 15). Searches should be conducted a minimum of twice per night. Chicks have a fledging peak starting at sunset and lasting a few hours; therefore the first search should occur 3-4 hours after sunset to catch the initial pulse of fledglings that may have been brought down by lights as they make their way from burrow to ocean. A second search within an hour before dawn will have the highest chance of locating birds that have fledged throughout the night or at the second fledging peak a few hours before daybreak. As it gets light, any bird not already under dense cover will crawl into constrained and dark places to hide and is much less likely to be discovered.

Historically, even well-trained biologists conducting intense searching have been unable to locate many of the birds. The proportion of found to unfound birds is referred to as the discovery rate or searcher efficiency. The KSHCP estimates that for every bird found alive, another downed bird remains unfound, resulting in a default 50% discovery rate. Applicants to the KSHCP have the option of demonstrating that they have a better discovery rate than the 50% discovery rate found in the literature. In order to do so, an applicant must demonstrate with supporting information (1) that it has higher searcher efficiency than 50 percent and (2) that it has created a predator control program that sufficiently minimizes the chance that carcasses will be carried away by predators and not counted.

In the KSHCP, submitted estimates of searcher efficiency ranged from 50% up to 100% within searchable areas. However, evidence to support these numbers was limited, and the Endangered Species Recovery Committee (ESRC) desired more information.

Pursuant to the KSHCP, this discovery rate validation study has been developed and implemented to assess the efficacy of the participants' searching efforts. This study is a form of compliance monitoring, conducted to ensure that authorized amounts of take are not exceeded.

Literature in the searcher efficiency field highlights multiple factors that each influence detectability and which should be considered by any search efficiency study, chiefly the location/environmental conditions, the behavior and appearance of taxa searched for, the rate of decay/scavenging, and whether searchers are aware they are being evaluated, known as "exam bias" (Dolan et al. 2013, Gómez-Catasús et al. 2021).

For this study, the location and environmental conditions of the properties vary significantly in the amount of vegetation and infrastructure, which can provide additional hazards and hiding places for birds. The taxa being searched for is known to seek cover when on the ground, and is colored black on most of the back, further complicating searches done at night. The rate of scavenging was not studied as part of this project; each participant is required to implement a predator control program and conduct monitoring to assess the depredation risk to downed birds. The final factor, exam bias, could only be partly minimized. The number and locations of decoys deployed each night were randomized, but it was not a blind study because participants were aware they were being tested and were briefed on the study and methods prior to implementation.

The KSHCP states that if the results from the validation program indicate a participant's discovery rate is lower than the discovery rate identified in their approved PIP, the agencies will recommend measures that could be undertaken to raise the discovery rate to the approved level (i.e., updated search protocols, staff training, predator control actions). This report is meant to inform those recommended measures. Following implementation of adaptive management measures, a follow-up validation trial will be conducted to determine whether the measures were effective in raising the discovery rate to the approved level.

Methods

Locations and sample size

Repeated visits were made to the properties of 6 KSHCP participants (Table 1) with a goal of 12 visits and 20 decoy deployments per property (except for County of Kauaʻi which has 100+ properties). The study was conducted from the night of October 27th through the night of December 14th, 2021. The order in which participants were visited was randomized by region, because for logistical reasons it was necessary to visit properties in the same region on the same night.

Not all participants could be included in this year's study. For Norwegian Cruise Lines, their ship was not present in Kauaʻi in 2021. For Hotel 1 at Princeville, their property was closed for construction in 2021 with lighting and search staff levels not representative of typical levels. The searcher efficiency of those two participants will be evaluated in the next study. Also, because no night football games at County of Kauaʻi light category 5 sites were played in 2021, the county's search efforts there could not be assessed, but that should be done the next year that night games are played. Also, of the included participants, not all of their properties could be included. For Alexander and Baldwin (A&B), of their 12 currently owned parcels (Port Allen Solar Farm has been sold), only those with permanent lights and searches were included, excepting the very private and jointly owned Plantation Core at Kukuiʻula which was not included because access could not be arranged in the limited time of the study. Of the 8 A&B parcels included, the 5 at Port Allen were considered as one because they were searched as a single unit. For the County of Kauaʻi, of their 100+ properties, only properties in lighting categories, 3, 4, or 5 were considered for inclusion, and of those I chose to place decoys at properties that seemed to have the brightest lights (see results). Even of the chosen county properties, I was not able to access the inside of fenced areas (such as the brightly lit county bus and police parking lots, and Kapaʻa New Baseyard). For HDOT, in the limited time of the study I could not obtain the necessary security clearances to access Nāwiliwili Harbor and fenced areas of Līhuʻe airport. For Kauai Coffee, while the area around their factory was included, harvested field areas were not included because I was informed that no searches were being done in harvested fields and that it was too dangerous to be alone on foot in the fields at night.

Only 1 seabird model (or "decoy") was deployed during the initial visit to each property. This was meant to lessen the chance of my appearance being associated with the presence of the bird decoy, if it was discovered. On each subsequent visit, a randomized number of decoys from 0 to 3 were deployed. I conducted "blank" visits where I would walk around the property without deploying any decoys. A maximum of 3 decoys per night per property was chosen to minimize the influence of a searcher finding one decoy and knowing there must be more that should be

found on that specific night. This number was also selected as a tradeoff to increase sample size. It was also only just higher than the maximum previously documented nightly fallout of 1-2 live birds.

Table 1. KSHCP participants, their properties, and whether each was included in the 2021 study.

KSHCP Participant	Property
Alexander & Baldwin Inc. (A&B)	Port Allen (5 parcels combined)
	The Shops at Kukui‘ula
	Kukui‘ula Plantation Core / The Club *(not studied this year)*
	Hokulei Shopping Village
	Waipouli Town Center
County of Kaua‘i	60 properties in lighting category 3 or greater *(10 studied, unfenced areas only, see results)*
	Night football games *(not studied this year)*
Hawai‘i Department of Transportation (HDOT)	Līhu‘e Airport *(unfenced areas only)*
	Port Allen Harbor
	Nāwiliwili Harbor *(not studied this year)*
Kauai Coffee	Factory area
	Harvested fields *(not studied this year)*
Marriott / Royal Sonesta	Marriott / Royal Sonesta
Sheraton Po‘ipū	Sheraton Po‘ipū
Hotel 1 at Princeville	Hotel 1 at Princeville *(not studied this year)*
Norwegian Cruise Lines	Norwegian Cruise Lines *(not studied this year)*

Seabird decoys

Each seabird model, aka decoy, had a unique identification number written in permanent marker on its underside. Identification numbers were random 3 digit numbers to preclude reports of guessed identification numbers (e.g., someone finding decoys numbered 3 and 5 and claiming they found 3, 4, and 5). Each decoy also had a laminated card with printed instructions attached to the bottom such that the edge was visible just enough so people might know to pick it up to read it but not so much as to substantially increase the decoy's detectability. The text of the label read:

Visible upper side white text on red background:

"**Yay! You found me! Next...**"

Text on the underside:

"Please send a photo (or text or voicemail) right now with my **ID #**____ and the **time** you found me to Stephen (24hrs a day) at **(415) 439-0622.**

Then please put me back. I am part of a study by the Division of Forestry and Wildlife. (but please bring real birds to an SOS aid station saveourshearwaters.org)

Mahalo nui loa!"

And in smaller print:

"I am a model of a native ʻAʻo (Newell's Shearwater). On its first-ever flight, each ʻAʻo must fly all the way from its nest in the mountains to feeding grounds in the ocean. But some get confused and grounded by artificial lights. (They navigate by the bright moonlight reflecting off the ocean, but too many "moons" causes confusion!) If they are not found and rescued by humans, grounded birds will die.

ʻAʻo are a part of what makes Kauaʻi special because they are found almost nowhere else on Earth. This DOFAW study aims to find out how long it takes for grounded chicks to be discovered."

A change implemented early in the study was the addition of a roughly 1 inch square white laminated tag tied around the necks of the decoys with black text reading "Read under bird." This change was made after an angry voicemail from a member of the public who spent an hour waiting by one decoy around 1 am in the airport parking lot, waiting for someone to come help them with what they thought was a live bird. This change slightly increased the detectability of the decoys.


Yay! You found me! Next...


Please send a photo
(or text or voicemail)
right now with my ID # 742 and
the time you found me to Stephen
at (415) 439-0622.
Then please put me back. I am part of
a study by the Division of Forestry and
Wildlife. (but please bring real birds
to an SOS aid station -
saveourshearwaters.org)
Mahalo nui loa!
I am a model of a native 'A'o (Newell's
Shearwater). Chicks fledge at night, which 'A'o
must fly all the way from its nest in the
mountains to feeding grounds in the ocean.
But some get confused and grounded by
artificial lights. (They navigate by the bright
moonlight reflecting off the ocean, but too
many "moons" causes confusion.) If they are
not found and rescued by humans, grounded
chicks will die.
'A'o are a part of what makes Kaua'i
special because they are found almost
nowhere else on Earth. This DOFAW
study aims to find out how long it takes
for grounded chicks to be discovered.

The decoys themselves were 3D printed out of white PLA plastic painted to match the black and white color pattern of a sitting Newell's Shearwater. The decoy was created starting from a 3D scan of a duck decoy (Vintage Duck Decoy 3D Scan by3DWP, licensed under the Creative Commons - Attribution - Share Alike license, available on Thingverse.com.) and modified by the author using the sculpt tools in Meshmixer software to come as close as possible to both the dimensions of a taxidermied sitting Newell's Shearwater and the size impressions of three seabird biologists who frequently handle live individuals of this species (front of breast to tail tip = 28cm, chest width = 10cm, chest height = 7.5cm). Given the overall similarity in size and color pattern between Newell's Shearwaters and Hawaiian Petrels, it is assumed that detectability would not differ meaningfully between these two covered seabirds. However, Band-rumped Storm Petrels are much smaller and rarer and so the searcher efficiency estimate from this work should not be assumed to be equal for this harder-to-see species.

The final decoy design erred on the side of being slightly larger than a live shearwater, meaning decoys would also be slightly more detectable than a live shearwater. One other key difference was the neck of the decoy was not moveable, meaning its head could not be lowered to fit through a very small hole, like a live bird can do. This meant that the decoys could not be placed in as tight spots as a real bird. This was only a notable problem at HDOT's Port Allen property where the forklift holes in the many large yellow concrete barriers would easily fit a live bird but not a decoy. There, live birds could also easily crawl inside the main warehouse building by fitting through rust holes beside the doors.

Seabird decoy placement

Birds that are grounded because of lights do not always land directly beneath a light (Deppe et al. 2017, M. Travers, pers. comm.). Then, wherever they land, some birds seek cover almost immediately (for example, the live bird that Sheraton found on October 26th, 2021 was already under a baggage trolley by 7:18pm), while others may spend a prolonged period sitting in the open, but eventually all birds will seek cover before daybreak (Reed et al. 1985, M. Travers and A. Raine, pers. comms.). It is also not well known how far these birds may travel after being downed, though one downed Newell's Shearwater was observed 200 ft from where it was first seen (M. Travers pers. comm.). Because of:

1) the behavior of these species to land various distances from lights and that participants are asked to search as much of the property as possible,
2) the behavior and ability of these species to move and seek cover after landing, and
3) the influence of the density of vegetation/cover on birds' detectability (Morrison 2002) and thus the ease of executing a search,

the locations of decoys deployed in this study were determined starting from random points, with some decoys placed at their point out in the open and some placed in the nearest available cover. Basing deployments on randomized locations also functions to reduce the potential for both searcher and deployer bias across a property.

Points/decoy placements were limited to the search area noted in each participant's PIP, if any. A randomized point was generated for each placement and then it was determined whether that decoy would be placed on the random point's exact location or whether the decoy would be placed in the nearest available cover that a live bird could walk to, such as concealing vegetation or a dark nook or cranny. Within each property, decoys deployed were alternated 1:1 between in-open and in-cover placements to achieve a 50/50 ratio.

In the cases where points determined to be placed in cover fell in places with no cover nearby (within roughly 100 ft), such as the middle of large paved areas, the decoys were placed up against a curb, a wall, or under a vehicle, etc. For all decoy placements, the amount of cover at the actual placement point was recorded as:

1) the maximum distance away that a person could stand and still see the decoy,
2) the minimum distance away that a person could stand and look in the direction of the decoy and be blocked from seeing it,
3) whether there was cover within a few inches above the decoy's head,
4) a subjective assessment of the amount of artificial light illuminating the decoy (low, med, high), and
5) based on the previous metrics, a subjective categorization summarizing the placement as in the open, partially in cover, or fully in cover. For example, a decoy visible from a distance from all sides would be considered open, a decoy visible from a distance but with some overhead cover would be considered in partial cover, and a decoy not visible from a distance from any angle would be considered in full cover. (See photo examples below. None of the decoys depicted in these examples were reported.)

Thus, whether an in-cover decoy was categorized as in full or in partial cover was primarily a result of the cover near the random point (i.e., I did not choose the ratio of decoys in full to partial cover).

Participants were told that placements would be spatially randomized but were not told that 50% would be placed in the open and 50% in covered positions. Given that the participants were obligated to thoroughly search open, covered, and vegetated areas, I disclosed as little as possible to prevent exam bias (i.e., increased effort compared to the implemented search strategies described in each participant's PIP).

Open - in a lawn, in an empty parking lot


Partial cover - in a bare area under a trimmed hedge, under a small overhang


Full cover - in a Naupaka shrub, under a parked lawnmower


Placement limitations

Several location types were not included in this study even though those are areas where birds could be grounded. Some of those areas are meant to be searched while others are excluded from the search areas in the PIPs.

Decoys were not placed:

- Within controlled-access fenced areas (part of the airport and harbors, County police and bus depots, Port Allen Steel Warehouse, Hokulei abandoned construction site). Some of those areas are searched and some are not (in the case of Port Allen Steel Warehouse the fenced area is not searched due to a dangerous guard dog which is likely a danger to downed birds as well as searchers).
- On steep vegetated slopes that are not searched for human safety reasons, though live birds are likely not deterred from landing or walking on such terrain, given the extreme steepness of their mountain nesting habitat.
- On flat or gently sloping roofs for logistical reasons - although live birds can and do land on roofs (M. Travers pers. comm.). If a random point ended up on a more-than-gently-sloped roof, the decoy was placed on the ground below the nearest downslope roof edge to that point. The outcome of fledglings that come down on roofs is unknown.
- Inside buildings, even when live covered seabirds could certainly crawl into those buildings (e.g., the Port Allen Harbor warehouse).
- In swimming pools (Marriott/Sonesta and Sheraton only) because the decoys are not necessarily watertight, although live birds can land in pools.
- In the middle of driving paths for both the safety of drivers/vehicles (if run over by a car, the decoys are mostly hollow and likely to break into small pieces rather than damage the car, but even so we wanted to minimize this risk) and to prevent the potential accidental destruction of decoys. It was fairly common for random points to end up in the middle of a driving lane in a parking lot, given how much of participants' properties are parking lots. When this occurred, I placed the decoy closer to a curb or the head end of a parking space - where a vehicle's tire would not be likely to go, but where the decoy was still as similar as possible in terms of visibility. However, this does bias our results against decoys getting run over by vehicles, which is known to be a common cause of death for grounded seabirds near roads (Travers et al., 2012, M. Travers, pers. comm.).
- Off of participants' properties, even when the property boundary was very near to light fixtures and a live bird could easily land or seek cover beyond the property line (particularly true at A&B's Waipouli and A&B's Port Allen Marina Center where the property ends at the end of the pavement and the neighboring property has thick vegetation).

Photographs of decoy placements

A photograph of each decoy was taken in situ after deployment, unless the placement location was too dark for my camera and/or the use of the camera's flash or a flashlight or being seen to be taking a picture at all would draw extra attention to the decoy's location. I also photographed decoys in situ if they were still there when I arrived for retrieval (except for the first deployment which I forgot to photograph).

Deployment times

The guidelines in the KSHCP document (in its Table 6-4) are for a minimum of two searches nightly, with the first search occurring 3-4 hours after sunset and a second search within 1 hour before sunrise. To capture both of the expected search time windows, decoys were deployed either in the evening or around midnight. Most evening placements were deployed after it had gotten fairly dark, between 30 minutes and 2 hours after sunset, but before searches should start. For midnight deployments, I aimed to deploy decoys between 5 and 7 hours after sunset. The goal, based on accepted seabird biology, was 90% evening placements (to represent the peak time of fledging) and 10% midnight placements (to represent late-night fledglings that become grounded in the early morning hours, which happens less often (A. Raine and M. Travers pers. comms.).

Retrieval times and closing of the search window

The instructions printed on the decoys stated that decoys should be reported right away and for the report to include the time the decoy was found. If a time was not included in the report, the decoy was considered as "found" at the time the report was received. Decoys could be reported multiple times per deployment, but only needed to be reported once to be considered found.

For the purposes of this study, decoys were only considered found until a certain time, determined by two factors. First, according to the signed Participant Inclusion Plans (PIPs), and subsequent verbal and written confirmation, all but 1 (County of Kaua'i) of the 8 participants planned to follow the HCP guideline of 2 searches per night, with the first search occurring 3-4 hours after sunset and a second search within 1 hour before sunrise. Second, live seabirds always seek cover in thick vegetation or a dark nook or cranny and become almost impossible to find after it gets light (Reed et al. 1985, M. Travers and A. Raine pers. comms.) and it gets very light by about 30 minutes before sunrise (here termed daybreak). Therefore, for the purposes of this

study, decoys placed in cover were included as found if they were reported by sunrise. Decoys placed out in the open were included as found if they were found prior to 30 minutes before sunrise (daybreak), since no live birds would still be out in such open locations by that time. The presence of decoys in the open after daybreak was a logistical limitation of the study, as it would have been more realistic for decoys in the open to move themselves into cover by daybreak, but that was not possible.

The exception is the County of Kaua‘i. According to their PIP, their searches, if triggered by a report of a downed bird, start at the start time of employee shifts, generally 6:00-6:30 am. Therefore, the cutoff time for reporting found decoys was 7:30, allowing at least 1 hour for searches commencing at the start of employee shifts.

Decoys were retrieved as soon as possible after sunrise, or 7:30am at county properties, to minimize the real potential for them to be stolen or destroyed by 3rd parties (8 decoys were stolen or destroyed during the study). Any decoy not reported by searchers and not recovered by me the next morning was assumed to have been stolen or otherwise interfered with and was not counted in the results analysis. Any decoys present after sunrise were only present because they couldn't all be picked up simultaneously. Any report received after sunrise before I was able to retrieve all the decoys was not included in the results analysis.

Controlling for exam bias

The goal of the study design was not to make it intentionally hard for participants, but rather to replicate a realistic level of required effort. And while it was not assumed that participants would try to find shortcuts to achieve a higher result, the design of the study was intended to prevent that in as many ways as possible because that makes the results easier to interpret.

To reduce experimental biases that arise from a participant’s expectations or awareness, I made an effort to conceal my identity and purpose from the staff of the properties, especially where the same security staff are responsible for both monitoring visitors and also conducting the downed bird searches. I would appear in different types of clothing and sometimes take different vehicles, park in different places, and walk different routes. Decoys were always concealed while walking, such as in a backpack or beach bag. In case I was being watched by someone or by security cameras, I did sometimes mime placing a decoy in multiple other places.

I made these efforts not to be observed or recognized while deploying or retrieving decoys so that my presence would not indicate that there were decoys to find. To that end, I always tried to have another plausible explanation that an observer might think of for my presence somewhere,

such as someone who is: a tourist, a downed bird searcher, a food deliverer, distracted on their phone, lost, or on their way to meet a friend.

On 8 occasions during the study I postponed the deployment of a decoy at a location because groups of people were gathered right at or beside the point and they would surely see me place the decoy. Six of those were at Port Allen Harbor a few nights after the crushing of a decoy there.

Participant notification and review

On October 18, 2021, participants were briefed about the study methods and goals. The meeting included a discussion of access to the various properties, and the start and end dates of the study, somewhat increasing the possibility of exam bias. Although participants requested immediate notification when they failed to discover a decoy, in a blind study, information which may influence the participants of the experiment is meant to be withheld until after the experiment is complete. Immediate notification that would have interfered with the discretion needed to conduct the study with minimal awareness of my presence and methods. However, as specified in the HCP, I sent weekly notifications of results to each participant's selected contact containing the number of decoys that were missed at each of their properties during the prior week. These notifications provided each participant with an ongoing assessment of their searcher efficiency and opportunities to improve searcher strategy and/or training, thus their overall result should be viewed as a hybrid of before- and after-study conditions. It is not known whether participants changed their search effort during the study, except for communications received from the Marriott/Sonesta team, which indicated their search effort was increased mid-season. Some participants also requested the specific locations of missed decoys so that they could better focus their searchers efforts. This information was not provided during the study because decoy locations were random and independent and thus searching more where one decoy was missed would not necessarily make them more likely to find future placements. Per the PIPs, the participants are meant to search with the same level of efficiency throughout their property.

Prior to beginning the study, it was agreed that participants would be given the chance to review this draft report in order to verify that locations where decoys were placed were within their property boundaries.

Reporting hotline

I used a free account with the Google Voice telephone service. This allowed me to create a new phone number that would receive and store voicemails, text messages, and picture messages in a format accessible through a web browser. I tried to never answer calls so that the information would be preserved in a voicemail, unlike a phone conversation which is not recorded or saved. The only call I accidentally answered was the report of the first decoy found by HDOT Port Allen on 10/28/2021 6:10 am. Almost every day around 9 pm I placed a call to the hotline and left a voicemail from my personal phone to test that the reporting system was working. All of my tests were successful.

Results and Discussion

The following results and discussion are specific to each permittee. Photos of deployments and the raw data tables can be found in appendices A and D, respectively.

Guide to interpreting result tables

The table for each property shows the number of decoys deployed at a property in each of the 3 types of placement: in the open (e.g., lawn, parking lot), in partial cover, or in full cover (e.g., in bushes or under some shelter). Example photos are provided in the Methods: Seabird decoy placement. Decoys stolen before being reported are not included in the result tables.

Caution should be used when interpreting results based on these small sample sizes of under 10-20, as a difference of one would swing the result by at least 5-10%. A longer study would be required to get an optimal sample size for each property.

For maps of deployment locations, numbers correspond between the maps, photos (Appendix A) and the "point #" column in the data table (Appendix D). Icons in blue indicate reported decoys while those in red indicate decoys that were not reported. Circles indicate decoys in the open while squares indicate decoys in either partial or full cover. Green triangles indicate stolen decoys. Decoys were stolen (i.e., deployed and never seen again) on 7 of 192 deployments (4%) and 1 was intentionally run over by a vehicle (see results page for HDOT Port Allen).

Graphs of time durations between decoy deployment and the first report are sorted by deployment order.

Alexander & Baldwin

The discovery rate across all A&B properties was 47% (33 of 70 decoys deployed). However, because searches across those properties were conducted by 4 different teams, results are reported separately by those 4 properties below.

Note that while the PIP for Alexander & Baldwin states that their second searches will occur within 3 hours after sunrise, this has been superseded by the addendum to their 2020 annual report which indicates that their second searches are undertaken within 1 hour before sunrise.

Port Allen properties

Summary: The search efforts at A&B's Port Allen properties resulted in a discovery rate among the highest in the study. Almost all of the plainly visible decoys were discovered, as well as some of the partially covered decoys, and all those were discovered rapidly. For context, no participant found more than 1 decoy in full cover. No searchers at any property seem to be pawing through shrubbery. By hiring interested students from a local high school, A&B has shown that it is possible to achieve good searching and effective positive community outreach simultaneously.

Search effort: A&B's PIP and their Downed Seabird Searching and Monitoring Plan states that searches include 100% of the property (except for the fenced area with a potentially dangerous dog - dangerous to people and downed seabirds - comprising 20% of the Steel Warehouse parcel). Searches occur 3-4 hours after sunset and within 1 hour before sunrise.

Discovery rate: The overall discovery rate was 62% (13 of 21 decoys deployed).

All but one of the open decoys were reported. No decoys in full cover were reported, but 3 in partial cover were.

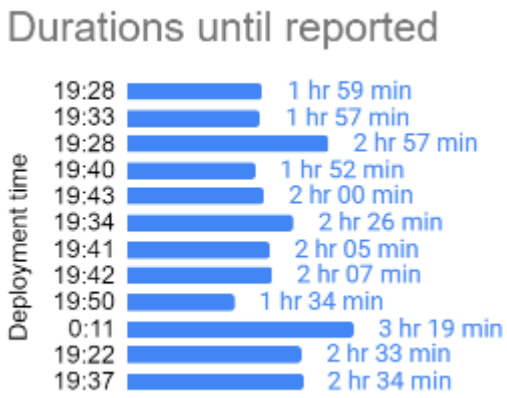
Port Allen Properties	Deployed	Discovery rate	
	#	#	%
Open	11	10	91%
Partial Cover	5	3	60%
Full Cover	5	0	0%
Total	21	13	**62%**

Legend: Decoys reported in blue, decoys not reported in red, ◎ = open, ⧈ = cover.

No decoys were stolen.

Time until reported: All 13 decoys reported were reported by the first possible search. Of the 12 decoys with a known deployment time (a member of the public removed one from the neighboring HDOT pier and placed it on A&B land where it was reported), the median time from deployment to first report was 2 hours.

While participants were not asked to report decoys multiple times, some participants did. While it is possible that first searchers alerted second searchers to decoys, the fact that 2 decoys were only reported by the first search and not the second, suggests this is not the case. Of the 12 decoys that stayed in place all night, 10 were reported by both the first and the second search of the night.



Who reported: Of the 13 decoys reported, A&B searchers or tenants reported 12 and members of the public reported 1. The decoy reported by the public was otherwise not reported by A&B searchers (decoy 220 was deployed at midnight and reported on 11/29 at 3:30 am from point #17). Also, a shop owner in the Marina Center parcel also found a decoy and placed it in a cardboard box outside the door of the local A&B office, where it was then reported by A&B's first search. That is considered a "report" for this study.

Suggested improvements: Beware complacency in the years to come, because the results from this year indicate a good and commendable search program! Searchers could be reminded to check more under edges and into and under vegetation where practical. Also, keeping potentially concealing vegetation/groundcover trimmed as much as possible through the seabird season would reduce the amount of available cover and help searchers find more birds.

Also, and though this only affects a very small area, I was told by a neighboring HDOT searcher that they wonder if the roughly 20 x 200 ft strip on top of the boulder wall above the HDOT parking lot may not be searched because it is difficult to walk there.

Also, continue with efforts to find birds beyond the strict property boundaries where possible. The fact that A&B searchers have found downed birds beyond A&B property is very good. If not already included in searches, it would be good to include the vegetated area northwest of the Marina Center parcel, due to the lamp posts along the edge of that parking lot which is also the property boundary.

The Shops at Kukui‘ula

Summary: The search efforts at A&B’s The Shops at Kukui‘ula resulted in a discovery rate among the highest in the study.

Search effort: A&B’s PIP and Downed Seabird Searching and Monitoring Plan states that searches include 100% of the property and occurs 3-4 hours after sunset and within 1 hour before sunrise. However, based on the timing of the reports and the knowledge that the search team is the security staff, it appears that searching may be more frequent, closer to once per hour, at least in the evenings.

Discovery rate: The overall discovery rate was 61% (11 of 18 decoys deployed).

All of the decoys placed in the open were reported. One decoy in partial cover and 1 decoy in full cover were also reported. That was the only decoy in full cover that was reported by any participant. However the other 2 and 5 decoys in partial and full cover respectively were not reported before sunrise.

One random point landed on a flat roof, but because there is no public access to that, no decoy was placed there.

The Shops at Kukui‘ula	Deployed	Discovery rate	
	#	#	%
Open	9	9	100%
Partial Cover	3	1	33%
Full Cover	6	1	17%
Total	18	11	**61%**

Legend: Decoys reported in blue, decoys not reported in red, ◎ = open, ⧈ = cover.

No decoys were stolen.

Time until reported: 9 of the 11 decoys reported were reported by the first possible search. Of the 11 decoys reported, the median time from deployment to first report was 2 hours.

Who reported: Of the decoys reported, all were reported by A&B searchers. One decoy that was reported by searchers was also reported by 2 separate members of the public.

Suggested improvements: Beware complacency in the years to come, because the results from this year indicate a commendable search program! Searchers could be trained to check more

under edges and into and under vegetation where practical. While not much of the property is vegetated, the vegetation that is present is dense, so if a bird were to move into one of the vegetated areas it would require more probing searching to find it. Keeping potentially concealing vegetation/groundcover trimmed as much as possible through the seabird season would reduce the amount of available cover and could help searchers find more birds.

Hokulei Shopping Village

Summary: In contrast to Kukui'ula, the search effort at A&B's Hokulei Shopping village had a near-zero discovery rate, one of the lowest in the study. No reports came from Hokulei's search staff. The 1 report of a decoy came from a member of the public. Several of the decoys were in seemingly obvious very open locations (2 of which were so obvious that someone stole or moved the decoy - those cases were not included in the analysis). I often saw a security guard walking around the property during my evening visits, but it's possible that they were mostly walking direct lines between what appeared to be QR codes placed on the walls that they had to scan - rather than walking in the search pattern.

Search effort: A&B's PIP and Downed Seabird Searching and Monitoring Plan states that searches include 100% of the property and occurs 3-4 hours after sunset and within 1 hour before sunrise.

Discovery rate: The overall discovery rate was 6% (1 of 16 decoys deployed).

The one decoy that was reported was in the open, but the other 7 in the open were not reported (photo example below). No decoys in cover were reported.

Unreported, pt 13

Eight random points landed on flat roofs, but because there is no public access to the roofs, decoys were not placed there. Two random points landed inside a fenced area (the vacant lot site, just north of Safeway) which was inaccessible, so decoys were not placed there even though it is part of the property intended to be searched.

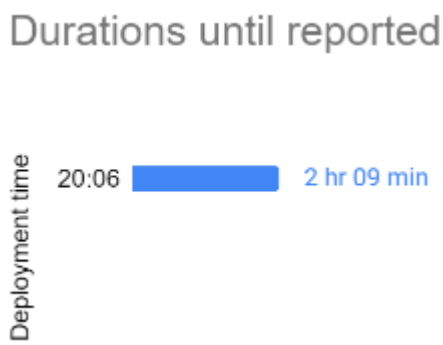
Hokulei Shopping Village	Deployed	Discovery rate	
	#	#	%
Open	8	1	13%
Partial Cover	4	0	0%
Full Cover	4	0	0%
Total	16	1	**6%**

Legend: Decoys reported in blue, decoys not reported in red, ◎ = open, ⧈ = cover. Green triangles indicate stolen decoys.

Two decoys were stolen from open positions and thus excluded from the analysis (green triangles on map). Both were stolen before they were reported[1] so both are excluded from the analysis.

[1] The decoy at point #11 was reported before it was stolen, but that report was made just 2 minutes after it was deployed, indicating the reporter must have watched me deploy it and for that reason it is excluded from the analysis. The reporter was the same HT Harvey searcher who reported the only other decoy from this property.

Time until reported: For the 1 decoy reported, the actual time from deployment to the report was 2 hours, 9 minutes.



Who reported: The 1 decoy that was reported was not reported by a member of A&B staff, but rather by a person who works for HT Harvey as a downed seabird searcher at the Līhu‘e airport, who happened to be shopping here.

Suggested improvements: Intervention is needed to determine and rectify why none of the decoys were discovered by A&B staff at any point during the night.

Keeping potentially concealing vegetation/groundcover trimmed as much as possible through the seabird season would reduce the amount of available cover and help searchers find more birds.

Waipouli Town Center

Summary: While the overall discovery rate at Waipouli Town Center was in the middle, compared to other participants, it was concerning that most decoys were missed on the first search. Even decoys in the open in the empty parking lot were either missed or not reported until the pre-dawn search. This is even more concerning given that 3 decoys were stolen from this property, indicating that birds are likely to be encountered by members of the public before they are found by searchers. The fact that multiple decoys were stolen may indicate that birds would be found by members of the public who may not rescue them, or who may even wish to harm them. If birds are found by trained searchers before members of the public, then their safety can be assured.

Search effort: A&B's PIP and Downed Seabird Searching and Monitoring Plan states that searches include 100% of the property and occurs 3-4 hours after sunset and within 1 hour before sunrise.

Discovery rate: The overall discovery rate was 53% (8 of 15 decoys deployed).

Of decoys placed in cover, 2 of 6 were reported. Although 8 random points were intended to be for in-cover placements, only 6 decoys ended up being placed in cover because this property has very few places where a bird could conceal itself. That is partly because the large grocery store had closed, meaning the large parking lot was mostly empty. That could change if a new business opens in the large store and attracts lots of parked cars again, under which birds could hide.

Twelve random points landed on the flat roofs, but because there is no public access to the roofs, no decoys were placed on the roofs.

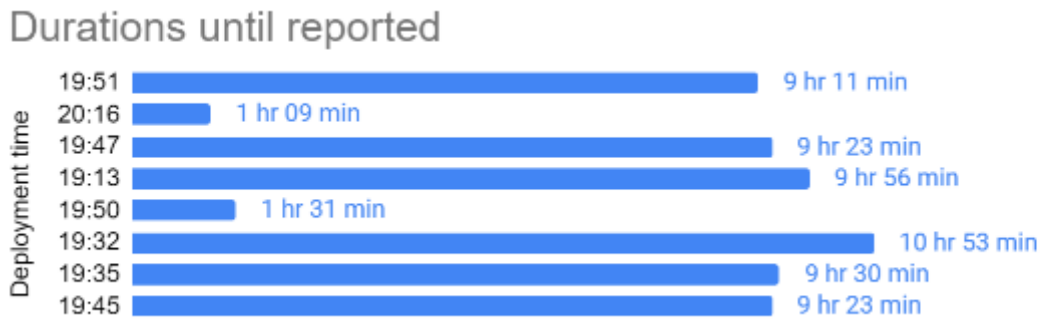
Waipouli Town Center	Deployed	Discovery rate	
	#	#	%
Open	9	6	67%
Partial Cover	5	2	40%
Full Cover	1	0	0%
Total	15	8	**53%**

Legend: Decoys reported in blue, decoys not reported in red, ◎ = open, ⧈ = cover. Green triangles indicate stolen decoys.

Three decoys were stolen from open positions (green triangles on map). Two of those were stolen before they were reported so those were excluded from the analysis. I watched the decoy at point #1 for 30 minutes after deploying it in the parking lot near the exit of the McDonalds drive thru. Several cars drove past it, but no one interacted with it. I left, and returned after another 30 minutes and by then the decoy had been stolen.

Time until reported: 2 of the 8 decoys reported were reported by the first possible search. Of the 8 decoys reported, the median time from deployment to first report was 9 hours.

While participants were not asked to report decoys multiple times, some participants did. The 1 decoy that was reported by the first search and was not subsequently moved was also reported by the second search.



Who reported: Of all decoys reported, all were reported by A&B's searchers. No decoys were reported by a member of the public.

Suggested improvements: Intervention is needed to determine and rectify why so few of the decoys were discovered by the first shift of searchers.

For the second shift of searchers, fighting complacency is a goal (see an example told in dewy grass in Appendix A).

Also, cat control efforts should be continued. I was told that at this property, cat traps were being stolen or sabotaged, complicating control efforts. Still, one of the decoy locations (point #3) ended up about 30 feet from a group of 4 cats (1 of the cats, left arrow, and the decoy, right arrow, both in my headlights, are pictured below).

County of Kaua‘i

Search effort: The County of Kaua‘i is something of a special case, because their PIP states that, besides at category 5 night football games which were not played this year, searches are not required unless a member of the public notifies staff of a downed bird at a property that night (details in their PIP Table 8). In that case, staff then search that property at the start of their shift. An email from the county on Oct. 22nd, 2021 indicated that the start time of the employee shifts in question was usually from 6:00 to 6:30 am. Thus birds/decoys should be found by 7:30 am, but only if they were already notified of a downed bird.

Because the county is not regularly searching for birds, as consistent with their PIP, here we report the discovery rate as an encounter rate - the rate at which decoys on county property were encountered and reported by members of the public or county staff.

Because there were so many properties that could be evaluated, I chose to place decoys at properties that seemed to have the brightest lights - still bright enough to potentially bring down a bird. I deployed 4 decoys (2 open, 2 cover) at the well-lit Wailua Golf Course’s clubhouse/parking/putting green area and another 4 at the lit parking lot of Vidinha stadium. I placed 2 decoys (1 open, 1 cover) at each of the following: Civic Center / Pi‘ikoi building parking lot, Kapa‘a New baseyard (unfenced area only), Waimea Theater (due to its tower’s lit light feature), War Memorial Convention Hall, Police Department HQ (unfenced area only), the County Transit Authority building (bus depot - unfenced area only), the Kōloa Neighborhood Center (while there are lights here, they are well minimized), and Salt Ponds Park (lights well minimized but they still reflect off the water).

Encounter rate: The overall rate of decoys reported was 4% (1 of 23 decoys deployed).

However, it should be noted that an additional 4 decoys may have been found by county staff but were not reported for some reason, thus it cannot be known whether they were found before daybreak (here defined as 30 minutes before sunrise). All 4 were in the open and thus a live bird would not remain in these locations to be found after daybreak. Below are the details of the additional decoys:

- A decoy on the pavement in the Vidinha Stadium parking lot (point #1) had been moved up onto a curb by the time it was collected at 7:40am and county maintenance staff were working nearby.
- A decoy on the golf cart pavement at the Wailua Golf Course (point #5) had been moved up onto a railing by the time it was collected at 7:34am, likely by the golf cart management staff who would’ve had to avoid it on the pavement.

- A decoy on the lawn at Salt Ponds Park (point #1) was discovered, picked up, and read at 7:18am by the County maintenance worker. But then they put it down in the same place and did not report it. I saw this occur from a distance while waiting to collect the decoy at 7:30am.
- A decoy in the gravel side parking lot at Waimea Theater (point #1) was not moved, but as I was picking it up at 8:02am, someone who works in the building flagged me down and told me that they saw it, but that they did not go over to investigate it until it got light.
- An additional deployment to the bus depot (point #1) was excluded from the analysis because a staff member saw me deploy the decoy. That staff member then (commendably) placed the decoy in a cardboard box and delivered it to the Līhu'e fire station that evening with a note attached saying they saw it being deployed.

All decoys that were reported or moved were in the open. No decoys in cover were reported.

All evaluated county properties combined	Deployed	**Encounter rate** before 7:30 AM		**Encounter rate**	
	#	#	%	#	%
Open	11	5	45%	1	9%
Partial Cover	8	0	0%	0	0%
Full Cover	4	0	0%	0	0%
Total	23	5	22%	1	**4%**

Maps are displayed at the end of this section.

One decoy was stolen from the parking lot at Wailua Golf Course (green triangle on map). It was stolen before it was reported so it is excluded from the analysis.

Another decoy was unintentionally crushed by a semi trailer in the Vidinha stadium parking lot. The trailer had been parked all night and was driven away, crushing the decoy in cover between the rear wheels just moments before it was retrieved at 7:33am (see photos in Appendix A).

Time until reported: The 1 decoy that was reported was reported 4.5 hours after deployment.

Who reported: The 1 decoy that was reported was reported from the parking lot at Kapa‘a New Baseyard, likely by a police officer (because squads often park there and the report used 24 hour time notation).

Suggested improvements: Lighting could be further minimized at least at the following properties: Wailua Golf Course (why are the putting greens brightly lit at Wailua Golf Course for instance), Kapa‘a New Baseyard (could be minimized/shielded), the bus depot (all the light reflecting off the white roofs of all the busses), the Police Headquarters (well lit by necessity), the Pi‘ikoi/ Civic buildings area (lit parking lots especially), and the Waimea theater (large decorative tower light was not always turned off during the seabird season).

Or if lighting cannot be reduced, then employees should specifically search for birds whether or not they are first reported to county staff by a member of the public. Searches should occur at the end of employee shifts if after dark and at or before the beginning of employee shifts before daybreak. If no searching can be done until the start of employee shifts, which roughly coincides with daybreak (30 minutes before sunrise) by which time all birds in the open will have moved to find cover, then those searches should be very thorough in order to find well-hidden birds. This would likely require searchers to crawl through bushes and bend down repeatedly to look under objects or into any hole into which a bird could fit.

Also, feral cat control efforts should be continued at county properties. Multiple cats were seen incidentally during the course of my work at Wailua Golf Course, Salt Ponds Park, and Kapa‘a New Baseyard. In the latter case, 7 cats were seen within 50 ft of a decoy’s deployment location.

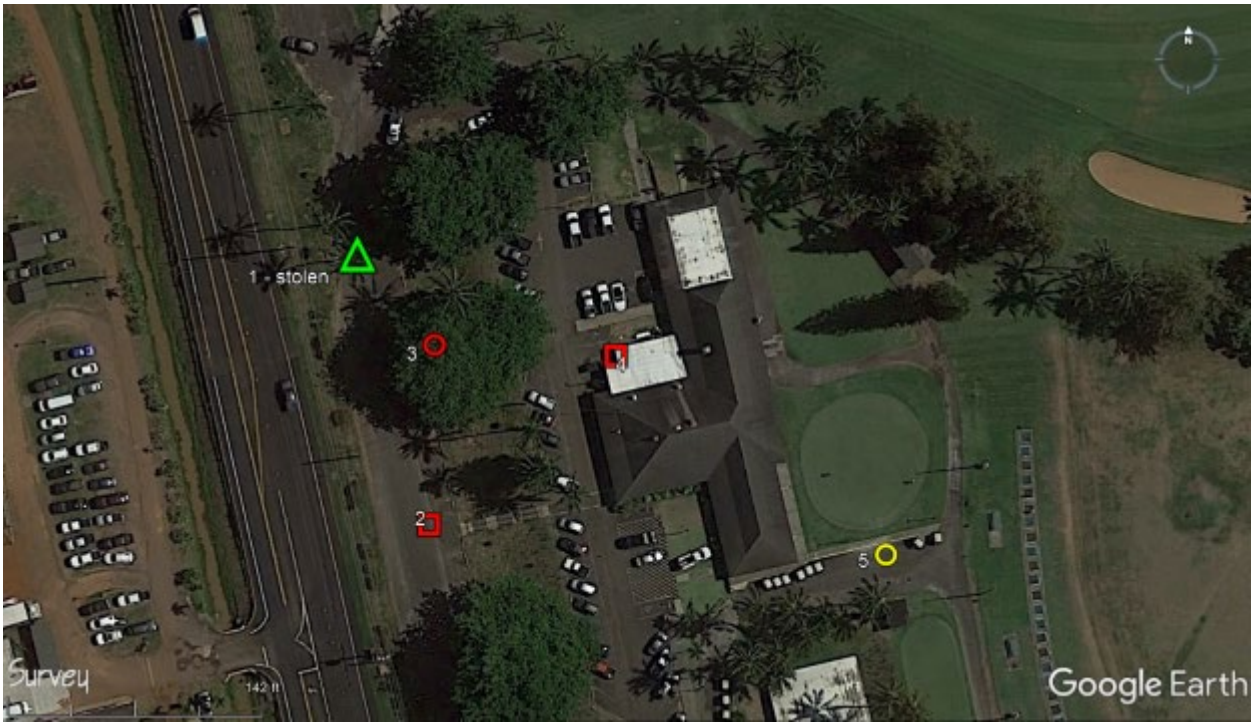
Efforts to reach and educate county workers and the public about rescuing seabirds should be continued and improved, given that although 5 decoys were encountered by county workers, just 1 was reported.

Lastly, searcher efficiency trials should be conducted at each game the next season that night football games are played.

County maps by property

Legend: Decoys reported in blue, decoys not reported in red, ◎ = open, ⧈ = cover. Green triangles indicate stolen decoys.

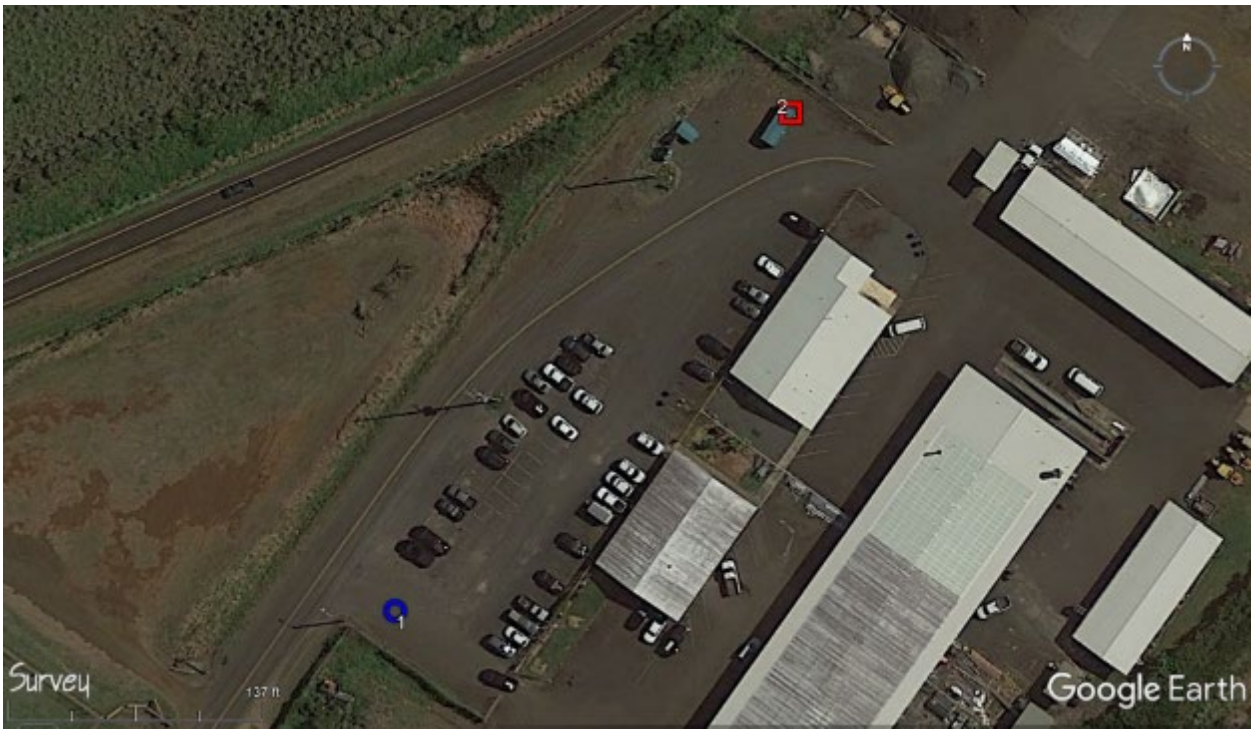
Wailua Golf Course (lit parking/clubhouse area only)



Vidinha stadium (unfenced parking lots)

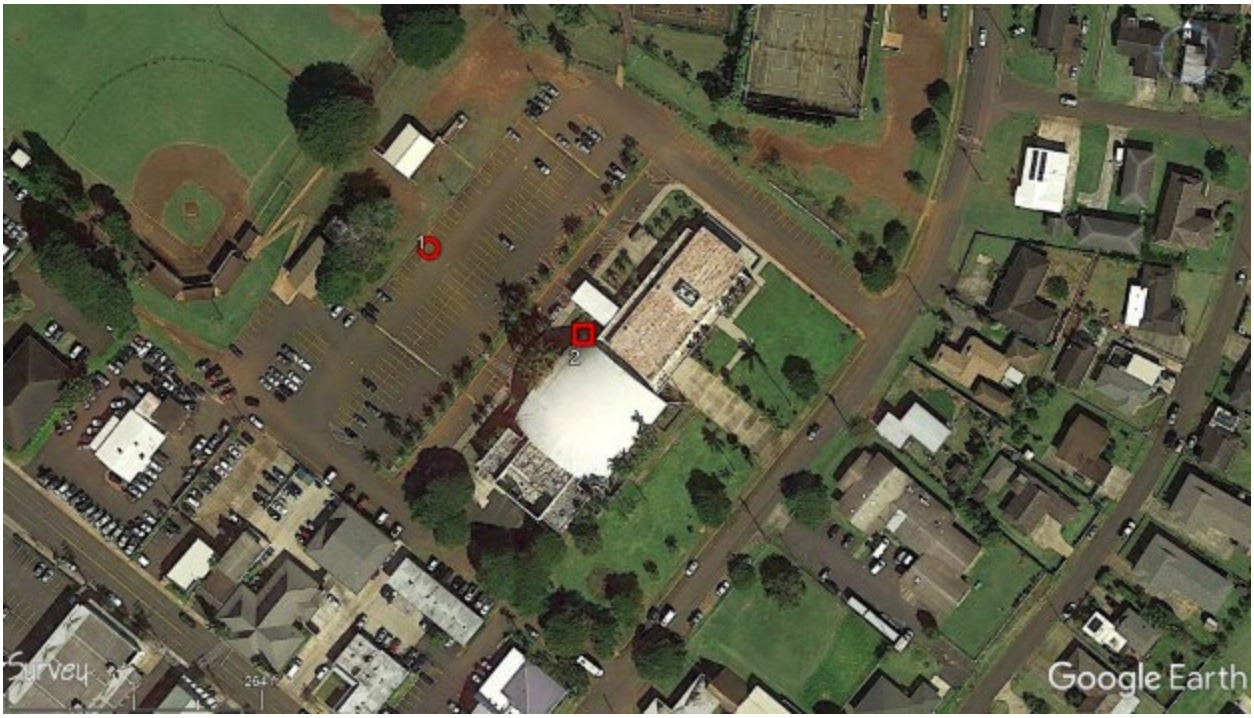
Civic Center / Pi‘ikoi building parking lot

Kapa‘a New Baseyard (unfenced area only)

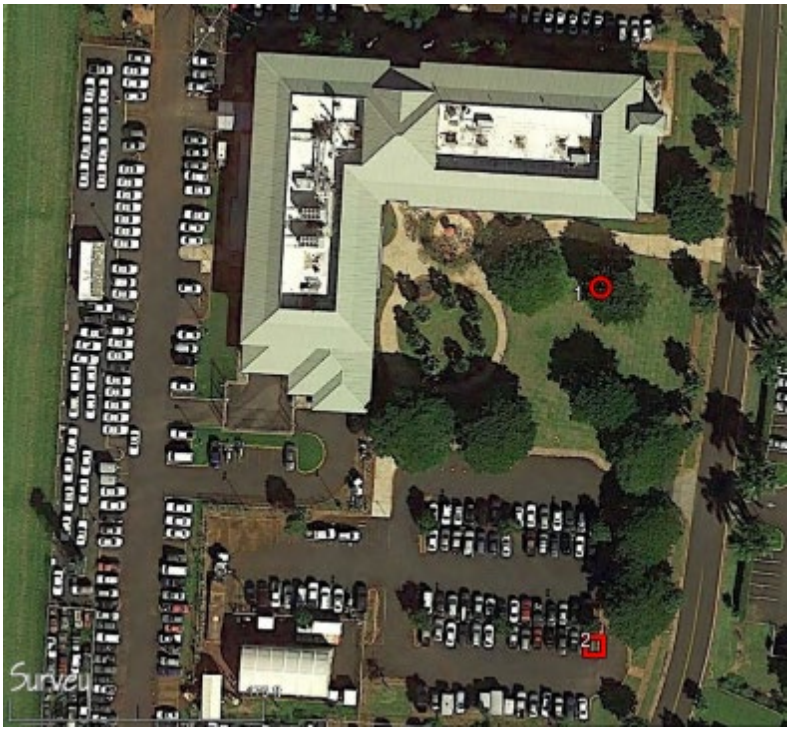


Waimea Theater (due to its tower's light feature)

War Memorial Convention Hall



Police Department HQ (unfenced area only)



County Transit Authority employee building (bus depot - unfenced area only)

Kōloa Neighborhood Center (some lights, but well shielded)

Salt Ponds Park (lights well minimized but they still reflect off the water)

Hawai‘i Dept. of Transportation

Līhu‘e Airport

Summary: In the public / unfenced areas that this study evaluated, the search at the Līhu‘e airport was very good at detecting decoys in the open, however the second search may be occurring slightly too late, as some of the open decoys were detected after a live bird would have moved to seek cover.

Search effort: HDOT's PIP states that searches include effectively all of the property, including 100% of public access areas, conducted by many departments at various times but at least 2-4 hours after sunset and during the 2 hours before sunrise. Much of the searching in public areas is conducted by the contractor HT Harvey & Associates.

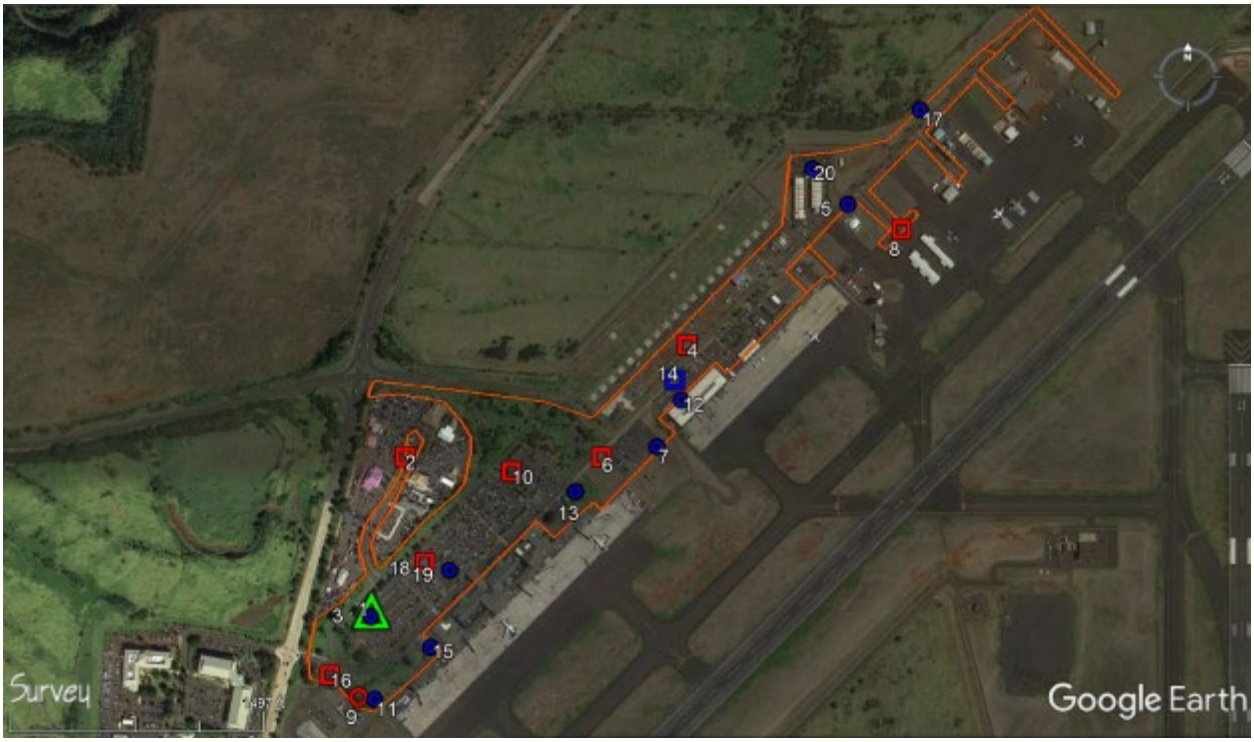
Precisely, the PIP states:
Area: 1. USDA WS or other contract wildlife monitor: Driving and foot searches of lighted portions of airport, including main apron (ramp), main terminal (exterior) main cargo apron (ramp), heliport, maintenance compound, parking lots, Ahukini Road public access areas (see survey route map in Appendix B). 2. DOT-A security staff: Driving survey of 100% of public access areas. Security staff will be trained to recognize seabirds and how to address if a downed seabird is encountered. Opportunistic encounters of seabirds during the fallout season. 3. HDOT-A operations staff and tenants: Will be provided with information regarding seabirds and given instruction as to how to address downed birds. Opportunistic encounters of seabirds in active work areas during the fallout season. 4, Employees must search underneath all vehicles before they are moved at night and first thing in the morning. 5. Intensive monitoring will be implemented in areas containing vegetation/landscaping and various types of vehicles and moveable equipment, and facility vegetation maintenance will include vegetation trimming to help locate fallout birds.
Timing: 1. USDA WS or other contract wildlife monitor: Once-daily dedicated search of property during the fallout season, 2-4 hours after sunset. 2. USDA WS staff: Routine regular patrols by WS staff in morning, during the 2-hour period before sunrise, and throughout the day. 3. HDOT-A security staff: Hourly driving survey, including the 2-hour period before sunrise. 4. HDOT-A operations staff and tenants: Opportunistic encounters of seabirds in active work areas during the fallout season.

Discovery rate: The overall discovery rate was 47% (9 of 19 decoys deployed).
This rate excludes 2 decoys in the open that were only noticed after daybreak (less than 30 min before sunrise, see methods). The behavior of these species is to always seek cover before it gets light so no live bird would still be out in such an open location by the time this was found. The

fact that decoys were still present in the open after daybreak was a technical limitation of this study and does not reflect realistic seabird behavior.

The majority of the reported decoys were in the open. Neither of the 2 decoys in full cover were reported (there are few fully covered places available, except underneath the many parked cars), but 1 of the 6 decoys in partial cover was reported.

Līhu‘e Airport (unfenced areas only)	Deployed	Discovery rate	
	#	#	%
Open	11	8	73%
Partial Cover	6	1	17%
Full Cover	2	0	0%
Total	19	9	**47%**



Legend: Decoys reported in blue, decoys not reported in red, ◎ = open, ⧈ = cover. Green triangles indicate stolen decoys.

One decoy was stolen from between parked cars in the main parking lot (green triangle on map). It was stolen before it was reported so it is excluded from the analysis.

Time until reported: 3 of the 11 decoys reported were reported by the first possible search. Of the 11 decoys reported, the median time from deployment to first report was 9 hours.

While participants were not asked to report decoys multiple times, some participants did. Two decoys were reported by both possible searches. No decoy was reported by the first search but not the second, while 7 decoys were reported by the second but not the first search.

Who reported: 9 of the 11 decoys reported were reported by HT Harvey searchers. The other 2 reports were likely not from searchers, but other staff who work at the airport. 3 decoys that were reported by HT Harvey searchers were also reported by members of the public or other airport staff.

Suggested improvements: Intervention is suggested to determine and rectify why so few of the decoys were discovered by the first shift of searchers. Given the large area of parking lots to be searched, the use of a camera or mirror on a pole to ease searching underneath parked vehicles may be useful if not used already.

Increasing public outreach and education would also increase the chances that any bird grounded in a parking lot, or anywhere else on the island, would be found by a member of the public who knows what to do.

Nāwiliwili Harbor

This facility could not be tested without extreme exam bias. It is fenced, requires security clearances for access, and even then would also require me to be escorted. Access to properly evaluate this property could not be arranged in the limited time of this study. It should be noted that a searcher efficiency study was previously conducted here by the consulting firm HT Harvey & Associates.

Port Allen Harbor

Summary: The search effort at Port Allen Harbor resulted in a discovery rate among the highest in the study. The search is conducted by HT Harvey & Associates, and one individual searcher was particularly effective. That said, there is likely still some room for improvement as some places where live birds might be found could be not fully included in this study (boats moored along the pier overnight, the ubiquitous forklift slots in the concrete barriers, and inside the main building via rust holes beside doors). Birds that land in the parking lot also face considerable risks from some members of the public.

Search effort: HDOT's PIP states that searches include a foot survey of 100% of the property 2-4 hours after sunset and during the 2 hours before sunrise. Much of the searching is conducted by the contractor HT Harvey & Associates.

Precisely, the PIP states the following:
Area: 1. USDA WS or other contract wildlife monitor: Foot searches of harbor property during the fallout season. Foot survey to cover 100% of harbor property. 2. HDOT-H operations staff and tenants: Harbor agent conducts a walk-through of the south pier facilities each work day (weekends and State holidays are not included); if harbor agent is on leave, Kaua'i harbor master deploys another employee to conduct the walk-through. Tenants report opportunistic encounters of seabirds when commercial vessel operations are in progress. 3. Employees must search underneath all vehicles before they are moved at night and first thing in the morning. 4. Intensive monitoring will be implemented in areas containing vegetation/landscaping and various types of vehicles and moveable equipment, and facility vegetation maintenance will include vegetation trimming to help locate fallout birds.
Timing: 1. USDA WS or other contract wildlife monitor: Twice-daily searches of property during the fallout season, 2-4 hours after sunset and during the 2-hour period before sunrise. 2. HDOT-H operations staff and tenants: Harbor agent conducts a walk-through of the south pier facilities each work day (weekends and State holidays are not included) at 7:00–7:30 a.m.; if harbor agent is on leave, Kaua'i harbor master deploys another employee to conduct the walk-through. Tenants report opportunistic encounters of seabirds in active work areas when commercial vessel operations are in progress.

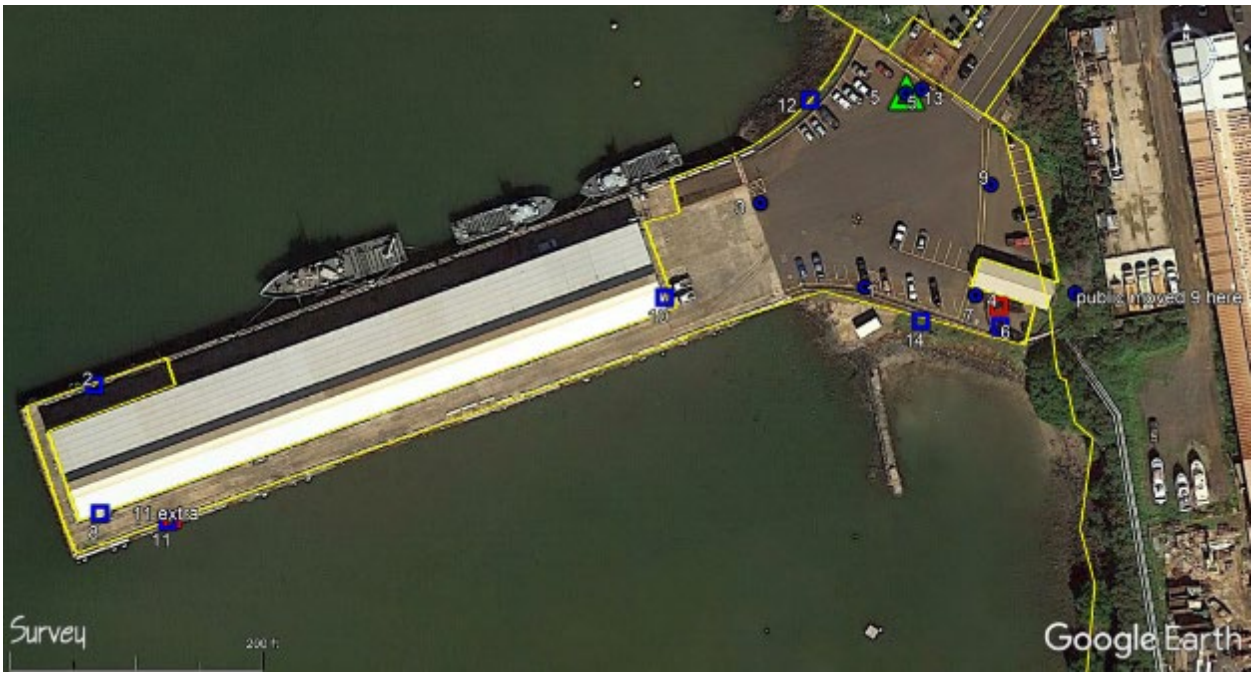
Discovery rate: The overall discovery rate was 93%* (13 of 14 decoys deployed).

*However, the true rate may be lower because the decoys could not fit into the full cover of the ubiquitous forklift holes that a live bird could fit inside. So those places could not be properly included in this evaluation. The decoys used in this study had necks that were rigid and in an upright position. However, live birds often extend their necks and heads straight forward to balance while walking. This means that a live bird can fit into smaller spaces than the decoys

could. The harbor has large yellow concrete blocks with forklift holes lining the entirety of the pier. Those holes could fit a live bird, but not the head of the decoy. As such, no decoys could be placed in full cover in these holes, despite their ubiquity at the site (some of the decoys in partial cover were placed half in these holes with their head sticking out). As a non-standard test, the decoy that had been intentionally run over in this site's parking lot and as a result was missing its head (see below), that decoy was placed inside one forklift hole. It was not reported by either of the two searches that night. However, it was not included in the analysis as its shape was slightly mangled. However, the searchers at this property were otherwise so good that I would have expected them to discover it anyway. This indicates that the many forklift holes might not be fully searched. The use of a mirror on a pole, like a vehicle inspection mirror, could solve this issue.

All of the decoys in the open and in partial cover were reported. The 1 decoy that was deployed in full cover (in the tire pile) was not reported.

Port Allen Harbor	Deployed	Discovery rate	
	#	#	%
Open	6	6	100%
Partial Cover	7	7	100%
Full Cover	1*	0	0%
Total	14	13	**93%***



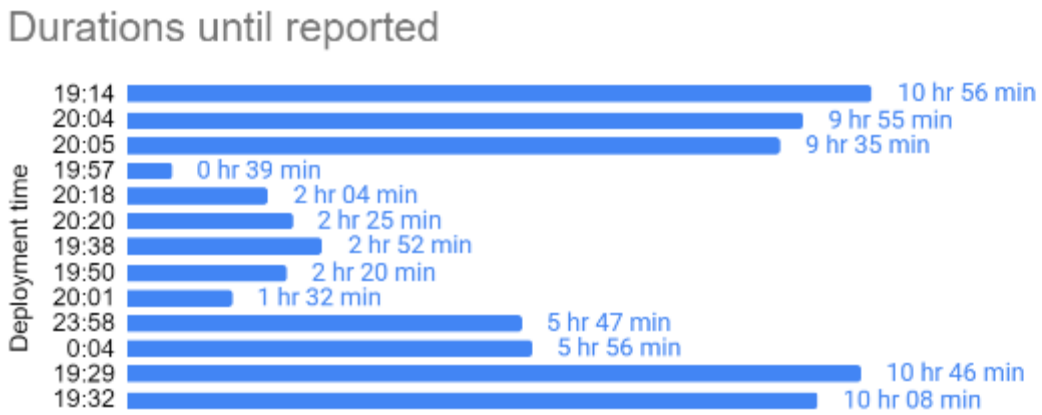
Legend: Decoys reported in blue, decoys not reported in red, ◎ = open, ⧈ = cover. Green triangles indicate destroyed decoys.

No decoys were stolen.

I witnessed one decoy get intentionally run over by a vehicle in the Port Allen Harbor parking lot (green triangle on map). A few minutes after deploying the decoy, I returned in my vehicle to watch from a distance to see if the decoy would be found, because there were many people hanging out in the parking lot. A few minutes later, a lifted pickup truck approached the parking lot. It slowed to a stop as it approached where the decoy was on the ground (near the main entrance but off to the side of the main direction of travel). The truck then reversed a few feet, turned slightly, and then slowly moved forward to run over the decoy. The truck then stopped and a man got out from the passenger side. He picked up the crushed decoy and appeared to read the text on the bottom before putting it back down, but the decoy was not reported by anyone except the HDOT and A&B searchers after that (pictured below after retrieval by A&B staff). The truck then parked next to the group of 5 or so other vehicles with people hanging out on the north side of the parking lot. I did not approach the truck out of an abundance of caution.

Time until reported: 7 of the 13 decoys reported were reported by the first possible search. Of the 13 decoys reported, the median time from deployment to first report was 6 hours.

While participants were not asked to report decoys multiple times, some participants did. Three decoys were reported by both possible searches. One decoy was reported by the first but not the second search and 5 decoys were reported by the second but not the first search. (The other 4 decoys were either moved or deployed between the searches.) The second search reported 11 of 13 possible decoys. The excellent performance of the second search is almost all due to one searcher, who seemed to be exceptionally thorough.



Who reported: Of the decoys reported, all were reported by HT Harvey searchers. One decoy was also reported by a member of the public (who may also have moved it from point #9 off the property, where it was still found by the particularly thorough searcher, point #"public moved").

Suggested improvements: If not already done, the use of a mirror on a pole would allow searchers to check the many forklift holes without having to bend down for each one.

Another improvement would be to seal the rust holes in the main building beside many of the large doors (example picture below). A bird making its way along the wall could easily fit through many of these holes and then it would find itself inside a building with a myriad of nooks and crannies that would be highly impractical to effectively search. No decoys were placed inside the building.

Another under-searched area in which no decoys were placed was all the tour boats moored beside the pier overnight. By chance this year, one live bird was discovered tucked inside a wiring panel area behind a toilet compartment in the bottom deck of one of those tour boats.

Increasing the education outreach to the staff of the tour boats might increase their likelihood of finding live birds as they walk from the pier through the parking lot to their cars after their shifts end most days around 8:00 pm - a time well before the first search but when downed birds may be more vulnerable to being run over by members of the public that use the harbor parking lot as a nighttime hangout spot.

Lastly, attempt to recruit motivated searchers or train searchers to do as well as the highly effective searcher.

Kaua‘i Coffee

Factory area

Summary: Despite advanced notice of each of my visits, the search performance here was among the lowest of all participants. No decoys were reported by the first search, but if the second search had been conducted at 5:30 am as stated in their PIP, rather than after sunrise, they may have found the decoys in the open in time.

Search effort: See map of the search area around the factory complex in Appendix A. Unlike the strategy described in Kauai Coffee's PIP of searches at 10 pm and 5:30 am, I was informed that searches around the factory area were taking place between 7:30-9:00 pm and 7:30-9:00 am. This was a convenient time as it was when the employee shift change occurred, but that time for an evening search may be so early that it may finish before some birds become grounded and the morning search is so late that all live birds would have found a place to shelter by then. And with piles of equipment, pallets, and tall vegetation abundant in the search area, any live bird that landed would not have to go far to find a fully covered place to shelter where it would be exceedingly difficult for searchers to find it. Still, to allow for a complete test of their search, I made sure all deployments here were completed prior to 7:30 pm and I did not retrieve decoys here until after 9 am.

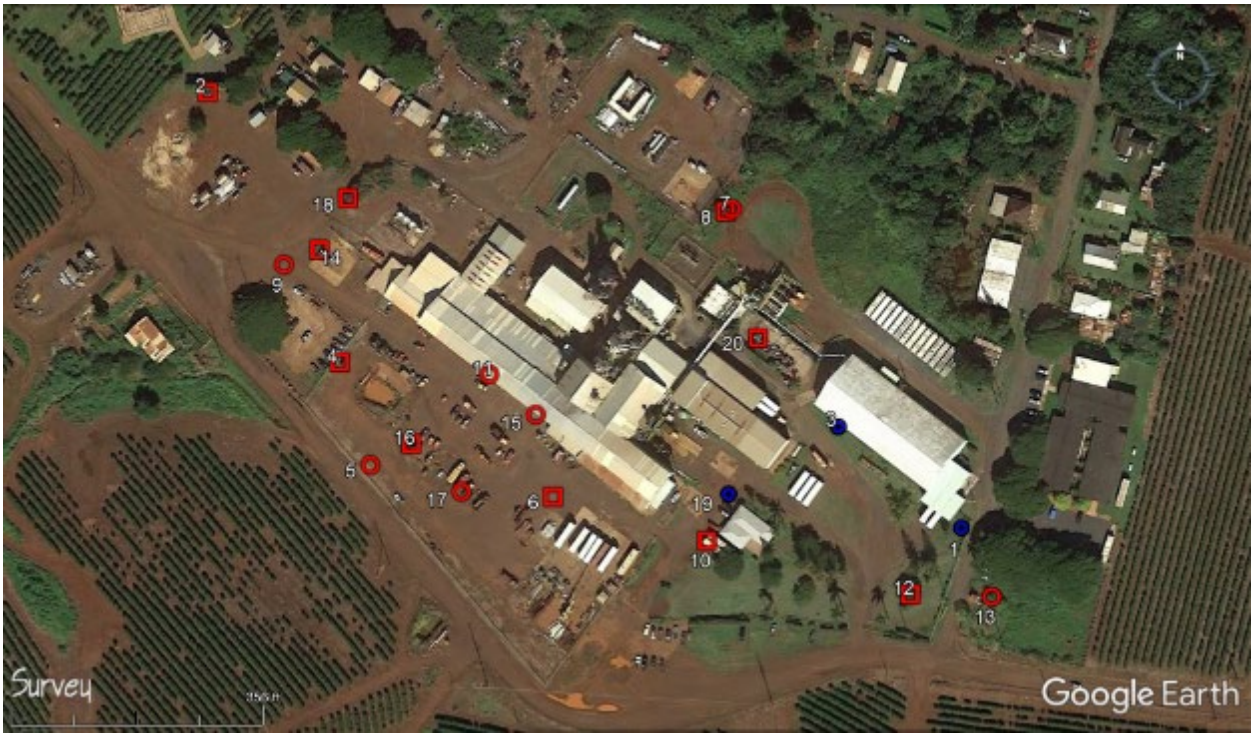
Because the factory area is closed to the public, I had to give 1 hour notice to a group of security staff and some supervisors before entering the area. To compensate, I made more blank visits (where I deployed no decoys) than initially planned.

Discovery rate: The overall discovery rate was 10% (2 of 20 decoys deployed).
This rate excludes 1 decoy in the open that was only noticed after daybreak (less than 30 min before sunrise, see methods). The behavior of these species is to always seek cover before it gets light so no live bird would still be out in such an open location by the time this was found. The fact that decoys were still present in the open after daybreak was a technical limitation of this study and does not reflect realistic seabird behavior.

Only decoys placed in the open were discovered. No decoys in cover were reported.

Two random points landed on roofs that sloped down towards areas of internal factory machinery, so no decoys were placed there.

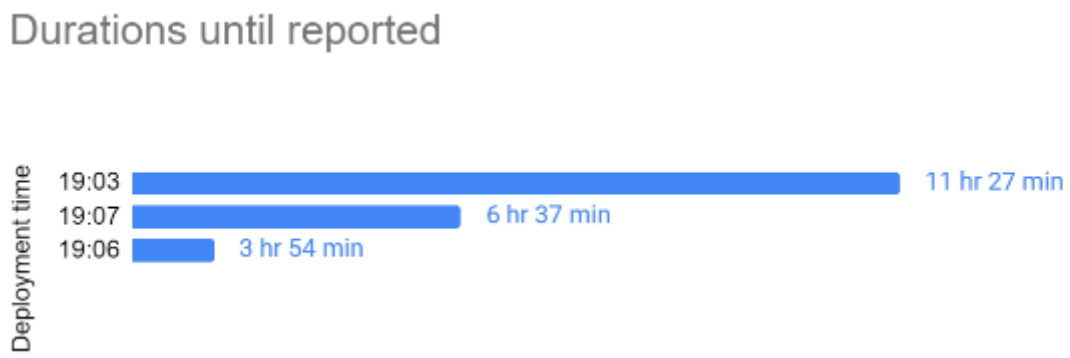
Kauai Coffee factory area	Deployed	Discovery rate	
	#	#	%
Open	10	2	20%
Partial Cover	3	0	0%
Full Cover	7	0	0%
Total	20	2	**10%**



Legend: Decoys reported in blue, decoys not reported in red, ◎ = open, ⧈ = cover.

No decoys were stolen (though one was taken to someone's home after it was reported earlier).

Time until reported: None of the 3 decoys reported were reported by the first possible search. I made sure to deploy decoys there before 7:30 pm, so they would be available to be found by the first evening shift-change search between 7:30-9:00 pm. Of the 3 decoys reported before sunrise, the median time from deployment to first report was 7 hours. One of the 3 was in the open and not found until after daybreak the next day and so is not included in the discovery rate.



Who reported: There is no public access, so all reports were made by Kauai Coffee staff. Decoys reported during the middle of the night were in obvious open locations and were most likely discovered incidentally, rather than during specific searches.

Suggested improvements: The times of the searches should be returned to those in the PIP: around 10pm, thus after the evening fallout peak, and again around 5:30am, before sunrise.

To make it easier to effectively search the area around the factory, all weedy vegetation should be kept cut short during the seabird fallout season. Also, piles of stored/spare equipment/parts/containers/pallets should be moved away from lighted areas as far as possible or covered with tarps held tight to the ground around the edges to prevent birds from hiding in them.

An alternative way to rectify this situation (and perhaps easier, given the thousands of places a bird could find to hide on the property) would be to go much further minimizing the lights. Some of the lights placed high up on the mill itself are still old-style unshielded street lights which are angled higher than horizontal and are visible over a mile away. Changing those lights to only illuminate what is necessary and/or enclosing more of the upper mill structure around those lights would help. So would changing more of the wall mounted area floodlights to be motion-activated.

Harvested fields

Unlike the strategy described in their PIP, on Oct 19th I was informed that no searches were taking place in the fields that had just been harvested, besides by the drivers of the harvesters from the cabs as they harvested. It was also deemed too dangerous to be on foot in the same field as a harvester at night, so no decoys were deployed in harvested fields.

Suggested improvements: Searches should be conducted as described in the PIP because presumably harvester's or other field truck lights are still bright enough to bring down birds and the birds may land in areas where the harvester operators are unable to see them. Also, because harvester operators are instructed to watch for birds circling their lights, they should also be instructed that, if they see a circling bird, they should turn off their lights for 5 minutes to allow the bird to fly away.

Marriott / Royal Sonesta

Summary: The search effort of the Marriott/Royal Sonesta produced one of the lowest results in this study.

Search effort: The Marriott / Royal Sonesta's PIP states:
Area: The entire built upon portion of the property is inspected each day year round. Rooftops are checked by engineering, housekeepers check balconies, and grounds are checked by security and groundskeepers. Groundskeepers also check shrubbery and bushes (laua'e fern and naupaka). All open areas are visually checked by all associates and guests.
(A phone conversation confirmed that the steep and thickly vegetated slopes on the property are not searched for safety reasons and it was agreed that no decoys would be placed there.)
Frequency and timing: At least once a day for all built-upon areas, more frequently for other areas. Inspections are conducted throughout the day.
An email on December 9th from a Sonesta representative clarified that "trained searchers continue to search twice per night, including 3-4 hours after sunset and 1 hour before sunrise."

The search effort at this property did increase during the study. Their email on December 9th stated that "Sonesta's team has undertaken several responses since the first decoy was missed. Extra training was provided for staff, and certain employees now devote extra time solely to search activities." While the entire built-upon property is noted as searched in the PIP, an email on December 29th stated that "they increased the (search) areas for this season once the decoys were not being found". So, while improving search efforts is always to be commended, this result cannot be considered representative of the search effectiveness prior to this study. (Note: It would be helpful to know how the improvements made for this season have been documented and will be preserved through the many remaining years of the HCP.)

Discovery rate: The overall discovery rate was 17% (3 out of 18).
This rate excludes 1 decoy in the open that was only noticed after daybreak (less than 30 min before sunrise, see methods). The behavior of these species is to always seek cover before it gets light so no live bird would still be out in such an open location by the time this was found. The fact that decoys were still present in the open after daybreak was a technical limitation of this study and does not reflect realistic seabird behavior.

The majority of decoys placed in open locations were not discovered (photo example below). No decoys in partial or full cover were reported.

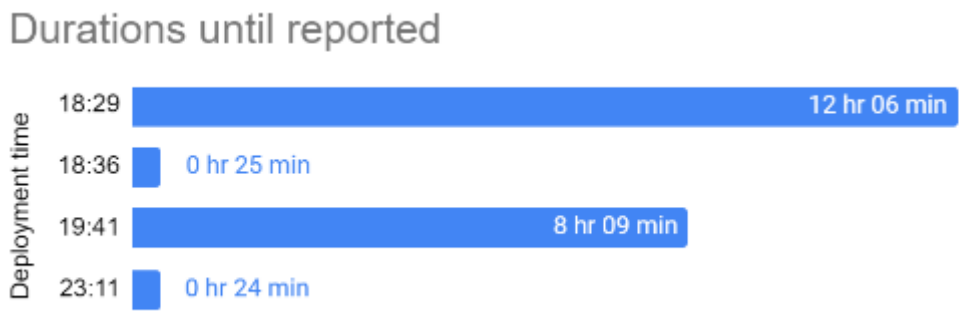

Unreported, pt 9

Decoys were not placed on the 2 random points that landed in the swimming pool, nor the 9 points that landed on roofs, although the Sonesta PIP does claim that rooftops are included in searches. An additional 5 deployment points landed on steep and thickly vegetated cliffs, within ~150 ft of the tower buildings; decoys were not placed there for my safety and because I was informed those areas were not searched. There were 7 random points on the property in borderline areas, near the property boundary, and quite far from lights and so decoys were not deployed there.

Marriott / Royal Sonesta	Deployed	Discovery rate	
	#	#	%
Open	10	3	30%
Partial Cover	4	0	0%
Full Cover	4	0	0%
Total	18	3	**17%**

Legend: Decoys reported in blue, decoys not reported in red, ◎ = open, ⧈ = cover.

Time until reported: 2 of the 4 decoys reported were reported by the first possible search - actually before that, both within 30 minutes of deployment. Of the 4 decoys reported, the median time from deployment to first report was 4 hours, one of which was in the open and not found until after daybreak the next day and so is not included in the discovery rate.



Who reported: Of the decoys reported, all were reported by or through security staff. No decoys were reported by members of the public.

Suggested improvements: Marriott should clarify the PIP statement "Inspections are conducted throughout the day." Searches specifically focused on finding downed birds should be conducted rather than relying on staff and guests to encounter birds incidentally, unless this improvement was already made mid-season. Preferably those searches should be done with people particularly invested in good outcomes for the birds. Asking for volunteers from staff members might help find those that show the most interest. They should then be given the time and equipment (good flashlights) necessary to conduct a good search.

Given the large size of the property, and the amount of it covered by difficult-to-search vegetation, it should not be assumed that birds only land directly under bright lights. Search efforts should be extended to cover areas beyond the most obvious open areas. Searchers should also be asked to search into and under vegetation when practical. Keeping potentially concealing vegetation/groundcover trimmed as much as possible through the seabird season would reduce the amount of available cover and help searchers find more birds.

Sheraton Poʻipū

Summary: It is clear that this property is not being formally searched for downed seabirds, or if it is searched, that search is completely ineffective. While at least 2 live seabirds were found this season, only 1 decoy was reported of 21 deployed. The live birds that were found were in very obvious locations. One was in an emptied swimming pool and another was under a luggage cart beside the bell desk - coincidentally just about 60 ft from, and on the same sidewalk as, the location of the only decoy from this study that was reported. Decoys were not reported even from multiple open locations such as open lawns and on paved walkways (photo example below). As such, there is no evidence that any dedicated searching was implemented at all throughout the season.

Search efforts described in the Sheraton's PIP:
Area: The entire built upon portion of the property is inspected each day, year round. Rooftops are checked by engineering, housekeepers check balconies, and grounds are checked by security and groundskeepers. Groundskeepers also check shrubbery and bushes (lauaʻe fern and naupaka) located around the buildings. All open areas are visually checked by all associates while conducting their respective duties while on the site.
Frequency and timing: The Resort is formally searched eight times a day by security, additional Seabird Awareness based searches are made 24/7 by associates. Inspections are conducted throughout the day.

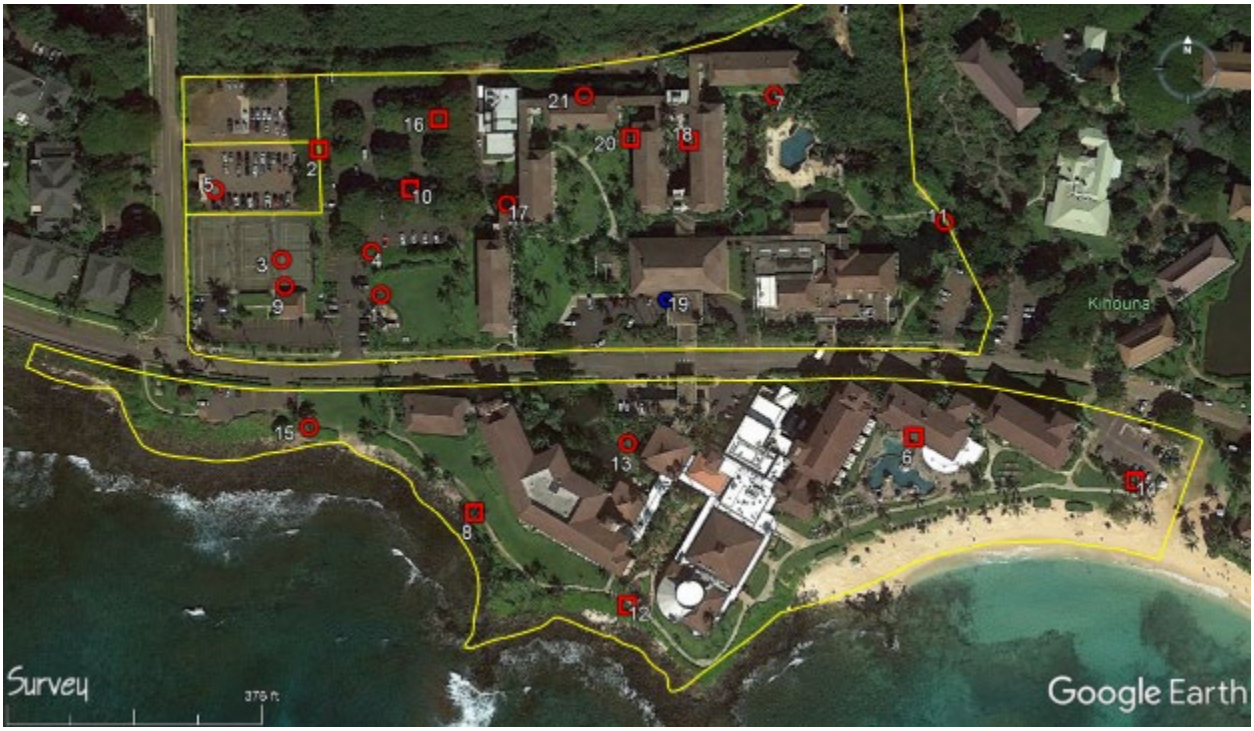
Discovery rate: The overall discovery rate was 5% (1 of 21 decoys deployed).

The 1 decoy that was reported was in the open, on a sidewalk near the bell desk. 11 others in full view went undiscovered (photo example below). None of the 9 decoys in cover were reported.


Unreported, pt 11

One random point landed in the swimming pool, but a decoy was not placed there.

Sheraton Po‘ipū	Deployed	Discovery rate	
	#	#	%
Open	12	1	8%
Partial Cover	2	0	0%
Full Cover	7	0	0%
Total	21	1	**5%**

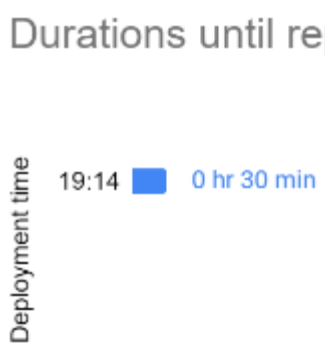


Legend: Decoys reported in blue, decoys not reported in red, ◎ = open, ⧈ = cover.

No decoys were stolen.

Time until reported: For the 1 decoy reported, the time from deployment to reporting was 30 minutes (though it was in such an obvious location on the sidewalk of the valet area that I watched from a distance and, even though I'm confident I was not seen while deploying it, I saw a member of the valet team investigate the decoy within 2 minutes of its deployment).

While participants were not asked to report decoys multiple times, some participants did. The one decoy that was reported was reported 3 times.



Who reported: For the 1 decoy that was reported, each of its 3 reports seemed to come from a member of the resort staff, perhaps with changes in bell/valet staff shifts.

Two decoys in the open were moved slightly but not reported (possibly after daylight) and so was 1 decoy in full cover under a cart (possibly by someone who may have seen me bending down to deploy the decoy there, as I was in full view of some diners in the nearby restaurant). Besides being moved at an unknown time (potentially after daylight, because decoys were not collected until later than that), the lack of a report may indicate that they were found by persons (more likely a tourist than a member of staff) who would not know to, or would not take the time to, report a live bird and see that it was transported to an SOS aid station.

Suggested improvements: Intervention is needed to determine and rectify why no decoys were discovered by Sheraton staff except for the one placed in the open within 50 ft of the bell desk.

If staff are generally unable to search for downed birds, more pervasive/effective education about the urgency of rescuing these birds should be directed at guests, who may be more likely to first encounter a downed bird.

That said, searches specifically focused on finding downed birds should be conducted. Preferably those searches should be done with people particularly invested in good outcomes for the birds. Asking for volunteers from staff members might help find those that show the most interest. They should then be given the time and equipment (good flashlights) necessary to conduct a good search.

Given the amount of the property covered by difficult to search vegetation, searchers should also be asked to search into and under vegetation. Keeping potentially concealing vegetation/groundcover trimmed as much as possible through the seabird season would reduce the amount of available cover and help searchers find more birds. The use of a camera or mirror on a pole may also increase the effectiveness of the search under vehicles in the large parking area (or a first-person video setup on a mini remote controlled car).

Overall Conclusions

The two types of searching

From this study, it became apparent that properties fell into 2 broad categories: between *searching* to find birds wherever they may be, versus doing what you were going to do anyway and *recognizing* a bird when it is in front of you.

The obviousness of some of the unreported decoys raises serious questions. In contrast, we know that good searching is possible because other properties have implemented a strategy that led to both their evening and pre-dawn searches reporting almost all decoys in the open and even some of the decoys partially in cover.

It is important to remember that the job of searching is not just about regulatory compliance. It's about saving the lives of endangered birds and with each one saved, we increase the population with all the potential offspring of that bird, eventually increasing the population to the point where these species will not need such intensive protective efforts (i.e., perhaps eventually more night football games).

Other factors limiting search success

Even including the highest-performing participants, search efforts were not sufficient to find decoys in fully covered locations. Only 1 of the 41 decoys in full cover was reported in the entire study. Furthermore, this illustrates how difficult, and perhaps how impractical in terms of cost and searcher motivation, truly thorough, 100% effective searching is.

That said, searches do not need to be 100% effective because participating properties can compensate by estimating the proportion of downed birds that are not discovered. The results suggest two factors that - besides overall searcher skill and motivation - were affecting whether a decoy would be found: A) the amount of a property with vegetation or other cover and B) the amount of overnight foot traffic in each part of the property. The time elapsed until a downed bird is found is also important and is discussed further below.

A) The results show that effectively zero decoys were found in full cover (and very few in partial cover). While several participants state their search area is the entire property, in practice that seems limited to open areas where a bird is easily noticed. However, we know that birds move to find cover; they are attracted to covered areas away from open areas. So the impact per-area of

covered areas on detectability of birds is greater than just the fraction of the surface area that they cover. This also has to be considered on a very fine spatial scale because even one small shrub can be enough to fully cover a bird.

B) For properties with low discovery rates and thus presumably low search efforts, another way of estimating potential search effort is to consider the amount of foot traffic across different parts of a property. The decoys in this study that were in the open and were not reported generally seemed to be in places where people (both tourists and staff) probably wouldn't go regularly at night (unless they were conducting a seabird search), whereas the decoys in the open that were reported were generally in more heavily trafficked spots and hard to overlook (by hubs of employee activity). That said, some decoys in seemingly obvious locations were still not reported.

An additional situation where birds may not be findable unless there is extra search effort is where they are attracted by lights on a property (and thus subject to that property's take calculations) but become grounded beyond the property, especially in cases where lights are near the property boundary. For example, two decoys near the boundary between A&B and HDOT properties in Port Allen were each reported by both participants' search teams. This study was limited to only placing decoys within participants' property boundaries; however, it is important to note that this was not always representative of live birds' behavior.

Decoys found in the open after daybreak

This study is only evaluating the search efficiency over the period of the initial night a bird would become grounded until the following sunrise, because the KSHCP guidelines ask that adequate searching is done before sunrise, and indeed some participants have shown this is possible.

While my goal was to retrieve all decoys at sunrise, I was not always able to. Morning discoveries were credited as successful until sunrise if the decoy was covered. Decoys left in the open and discovered later than 30-minutes before sunrise were not credited, as there is no evidence to suggest that a real live bird would still be in the open by then. All expert observation of these species indicates that downed birds will seek dense cover before daybreak. (Reed et al. 1985, M. Travers, pers. comm.). They do not remain sitting in wide open areas like lawns and parking lots after daybreak like our plastic bird decoys did, and so any "discovery" of a decoy in the open at that time is not included in the results analysis. While the text of the KSHCP says that the second search should be conducted "within 1 hour before sunrise", if it is already light by the time of the search, then it is very important that searchers focus their efforts on areas of vegetation or other hiding places.

We also recommend (based on expert seabird biologists' recommendations) that participant's second searches of the night be adapted by being scheduled earlier enough to conclude searches of open areas before daybreak, roughly 30 minutes before sunrise. This would maximize the chances of searchers encountering easy-to-find birds in the open, before they would be certain to have sought cover.

Behavior of downed fledglings

While we do know that downed fledglings move to seek cover before daybreak, their behavior between their grounding and daybreak is not well known. This is because we cannot know what they do before they are detected, and once they are detected they are usually promptly rescued. Thus, how quickly they seek cover on their own is not well known. However, interpreters of this situation should be careful of survivorship bias. Survivorship bias is when incorrect inference is made from considering only the visible or surviving individuals. In our case, birds found in open areas may be found because they are in the open, while birds in cover may not be found and thus not known about. So it would be improper to assume that at night downed birds are only present in open areas immediately under bright lights.

The use of a 50/50 ratio of decoys deployed in the open to those deployed in some amount of cover was a choice we had to make. Because the behavior is not known, we present results separated by cover type so that the deciding agencies could choose to weight the results according to different percentages if better data comes to light in future. However, we do know that some birds can seek cover almost immediately, for example, the live bird that Sheraton found this year that was already under a baggage trolley by 7:18 pm. ("1918 hrs. Bellman Shawn Garcia informed Security of a Shearwater Bird down under a luggage cart." - 10/26/2021).

The longer the time between deployment and discovery, the more likely a live bird would be to explore its surroundings and find a place with partial or full cover. Similarly, the more of a property that is occupied by partial or full cover (the Marriott/Sonesta is a good example of a well-vegetated property), the more likely a live bird is to find itself already in or near a position of cover. We did not directly control for this, although this can be seen somewhat in the ratio of decoys deployed in full cover versus in partial cover, because decoys were deployed in the cover available. And in cases where a property was mostly pavement, like A&B's Waipouli Town Center, there were sometimes no places near the random point where a decoy could be placed in cover (within the property boundary) so a few decoys meant to be placed in cover ended up in the open.

Time elapsed until discovery

Some of the properties that had a high overall discovery rate still missed most of the decoys on their first chance to find them, and downed birds are intended to be found by the first possible search.

The greater the time elapsed between the decoy deployment (or a bird landing) and its discovery, the more likely that a live bird would not still be sitting at the spot it landed, but would move and have a chance to find a covered location. As discussed above, once in a covered position, it is much less likely that even a high-performing search team will find it. While it is relatively easy to scan an open area with a flashlight, it takes far more time and effort (e.g., getting down onto hands and knees) to search under bushes or in ground level nooks and crannies. Thus, while some decoys in this study were reported after they had sat in the same spot all night, roughly 9 hours, live birds may not be as easy to find after the same duration and thus the discovery rates presented here may be an overestimate. (This would have the biggest effect on the rates for HDOT's Līhu'e Airport and A&B's Waipouli Town Center, as they both had a median time until discovery of 9 hours.)

Also, the more time that passes before a bird is found, the more vulnerable that bird is to depredation by cats or potential harm by some members of the public. If birds are not found fast enough, they then become subject to scavenging rates and carcass detection rates. Those rates were not included in this study, but further study on the effectiveness of predator control would be beneficial.

Public interaction with decoys - Stolen and crushed decoys

The case of the intentionally run-over decoy in the parking lot at HDOT's Port Allen Harbor and the 7 other decoys which were stolen, possibly by people who would have chosen to harm a live bird, indicate the importance of finding downed birds quickly, especially in areas frequented by the public. Given the controversial history of seabirds on Kaua'i, it is unfortunate but realistic to consider that some members of the public may choose to harm grounded seabirds rather than report them. Several seabirds found during extensive driving surveys around Kaua'i in 2011 had been run over intentionally (Travers et al, 2012, M. Travers, pers. comm.). If birds are found by trained searchers before members of the public, then their safety can be assured.

For the decoys that were not stolen, they were rarely interacted with by members of the public. Only 8 reports were received from the public. Maybe it was obvious enough that they were plastic rather than a live bird, or maybe few members of the public would stop even for a live

bird. But on some occasions (because I was worried about decoys being stolen from high traffic areas such as parking lots) I would watch the decoys from my vehicle at a distance. At A&B's Hokulei and Waipouli shopping centers at night, and at the county's War Memorial convention hall parking lot in daylight, each time I saw tens of people or vehicles pass without stopping to investigate the decoys, even though the placements were quite obvious. Also, on at least 5 other occasions, birds in parking lots were not reported despite cars arriving or leaving from right next to a decoy on the white line between spaces or in the neighboring space.

The need for reevaluations

6.9.1 of the KSHCP states:
Participants will also identify the need for Adaptive Management of minimization measures in their Participant Annual Reports, and suggest options to alter currently implemented measures. These will be discussed during the KSHCP Annual Review Meeting or in individual meetings with the regulatory agencies, and will be implemented as soon as reasonably possible.

Several properties need to improve their search efficiency. So on-the-ground training, followed by practice search efficiency tests, would likely be a better way for searchers to really learn where birds are likely to hide and how to find them in the dark.
Those improvements should be made and then the search efficiency of those properties should be reevaluated in the upcoming 2022 fallout season.

This study should also be resumed in 2022 at participant properties that could not be completed this year: Hotel 1 at Princeville, Plantation Core at Kukuiʻula, and night football games at County of Kauaʻi light category 5 sites. Areas that were not accessible due to logistical constraints this year could also be attempted in 2022: the areas that need security clearances/badges (HDOT's Nāwiliwili Harbor and fenced areas of Līhuʻe airport), areas needing special safety considerations (Kauai Coffee's harvested fields), and fenced county properties (the brightly lit county bus and police parking lots, and Kapaʻa New Baseyard).

It would also be prudent to repeat this type of searcher efficiency monitoring in multiple future years, because it is conceivable that if population declines continue over the future 30 years of the KSHCP, then properties will be less likely to have birds fall out, not just from lighting improvements, but also because there would be a smaller population of birds to fall out. If that is the case, it is conceivable that searcher motivation may decrease after longer periods between discovering birds, which in turn could decrease the likelihood that a bird would be found. It would be beneficial if participants arranged for recurring third-party evaluations of their search staff.

New search methods, such as specially trained bird-sniffing dogs, may also warrant reevaluation of search efficiency estimates. Dogs are much faster and more efficient, and would be most helpful during the high risk nights around the new moon. Another technological option would be a survey tracking app that documents the routes and times of searches to show which areas are well covered and which areas could use additional effort.

Opportunities for training

Given the difficulties with setting up effective search programs, it would be beneficial going forward, especially for the underperforming properties, for participants to coordinate with the agencies for improved training. Not all participants have the same level of time and expertise available to set up a quality search program, so to be able to receive expert training would likely boost search efficiencies. That would also facilitate better communication between agencies and participants and likely smooth the process of any adaptive management in future. Utilizing training from agencies would enable participant searchers to better know what is required for a good search.

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