2024 Report on Seabird Searcher Efficacy Trials for the Kaua‘i Seabird Habitat Conservation Plan

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Executive Summary

The Kaua‘i Seabird Habitat Conservation Plan (KSHCP) was developed to address light attraction impacts on the listed seabirds in several fallout hotspot areas on Kaua‘i. All participants permitted under the KSHCP are required to monitor the number of birds impacted by the lights in their premises and implement a formally organized search strategy to find grounded seabirds twice per night during the fallout season.

This study was developed to perform the seabird search efficacy validation at three participants of the KSHCP: 1 Hotel Hanalei Bay, Kauai Coffee Company, and The Royal Sonesta Kaua'i Resort Lihue. All three participants were involved in the same study in the past; the 1 Hotel Hanalei in 2023, Royal Sonesta in 2021 and 2022 and Kauai Coffee in 2021. Twenty model birds (decoys) were installed in participants' premises in randomly selected locations within their search area. The participants were asked to find and report decoys throughout the seabird fallout season. Participants' searcher efficacy was measured through the number of decoys reported in various cover types and the time until the decoy was found.

In 2024, 1 Hotel Hanalei reported 10 decoys, resulting in a 50% searcher efficacy rate (CI 30% - 70%). Kauai Coffee reported 11 decoys, resulting in a 55% searcher efficacy rate (CI 35% - 75%). Royal Sonesta reported 6 decoys, resulting in a 30% searcher efficacy rate (CI 10%- 50%). Overall, all participants showed a similar pattern that was observed in past years: decoys placed in open were reported more frequently than decoys placed in cover. The time that passes until the decoy is found after its deployment is an important parameter as live seabirds are known to seek cover after becoming grounded. Time until the decoy was found was more than a few hours on average for each participant, even for the decoys placed in open. The consistency in searcher efficacy throughout the seabird fallout season is important as the fledgling season for many seabird species on Kaua‘i spans months and participants are dealing with more than one covered species with different breeding schedules. 1 Hotel Hanalei and Royal Sonesta did not report the last four decoys, which corresponds to the tail end of fallout season, potentially pointing out to an inconsistent search effort throughout the season.

We think that the result of this study provides unbiased information on the search efficacy of these three participants in 2024 fallout season. Although we emphasize that the researchers had to check in or pass through a path with security personnel to access all three sites, potentially increasing the cognitive bias of the participants. 1 Hotel Hanalei showed a significantly lower searcher efficacy rate than the 90% estimated in the Participant Inclusion Plan whereas Kauai Coffee met their estimated rate. Royal Sonesta showed poorer performance in 2024 when compared to 2022 and stayed under their estimated searcher efficacy rate given in the Participant Inclusion Plan. We recommend the participant improve their search effort and methods in covered areas and areas off designated pathways. Finally, the searcher efficiency can be changed in time depending on several different factors, and therefore the results of this study should not be assumed as the fixed searcher efficacy and validation studies should be carried out periodically for all KSHCP participants.

Introduction

One of the major threats to breeding seabirds on Kauaʻi is light pollution. Artificial lights at night cause young seabirds to become disoriented and become grounded (fallout) when they leave the colonies for the first time. The fallout started to be recorded intensely after the 1960s (Banko, 1980), coinciding with the increased tourism on Kauaʻi (Bardolet & Sheldon, 2008). The Kauaʻi Seabird Habitat Conservation Plan (KSHCP) was developed by the State of Hawaii, Department of Land and Natural Resources (DLNR) with technical assistance from the U.S. Fish and Wildlife Service (USFWS), and in consultation with various scientific experts in the field of seabird and turtle biology. The KSHCP aimed to address light attraction impacts on the listed seabirds in several fallout hotspot areas. Accordingly, multiple non-Federal entities (participants) that have the potential to cause unavoidable take of Kauaʻi's listed seabirds applied for an incidental take permit (ITP) and an incidental take license (ITL) under KSHCP and were asked to follow mitigation and minimization measures. To minimize the impact of light attraction on the endangered seabird populations, all participants permitted under the KSHCP are required to monitor the number of birds impacted by the lights in their premises and implement a formally organized search strategy to find grounded seabirds twice per night during the fallout season (between September 15 and December 15).

Historically, even well-trained biologists conducting intense searches have been unable to locate many of the birds. Therefore, KSHCP estimates that for every bird found alive, another downed bird remains unfound, resulting in a default 50% discovery rate (i.e., searcher efficacy). In the KSHCP, submitted estimates of searcher efficacy by the participants ranged from 50% up to 100% within searchable areas, but with little evidence to support these proposed numbers. KSHCP Administration developed and conducted a searcher efficacy validation study for various participants in 2021, 2022 and 2023. The results of these studies showed varying actual discovery rates ranging from 5% to 93% (Rossiter, 2021). The KSHCP states that if the results of 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).

We conducted studies at 1 Hotel Hanalei Bay, Kauai Coffee Company, and The Royal Sonesta Kaua'i Resort Lihue premises to document their searcher efficacy. This report presents the results of these studies and makes recommendations to increase the seabird search performance of these participants.

Methods

The searcher efficacy study was carried out following the methodologies set in the 2021, 2022 and 2023 studies (Rossiter 2021; Shepherd and Sahin, 2022) with no major changes. The study was focused on three participants: 1 Hotel Hanalei Bay, Kauai Coffee Company, and The Royal Sonesta Kaua'i Resort Lihue.

This study was conducted between October 6 and December 15, which coincides with the seabird fallout season on Kaua‘i that runs from September 15 through December 15. As in the previous studies, the participant was informed about the implementation of this study, potentially creating experimental biases that arise from a participant’s expectations or awareness. In addition, participants received a weekly update on the number of decoys deployed and found in 2024. Moreover, the researchers deploying the decoys had to use access paths that were visible or reported to all participants’ staff, potentially increasing the experimental bias. Every effort was made to minimize these biases and replicate the realistic level of required effort in seabird searches. Deployment date, number of decoys deployed per visit, decoy location, and cover type were randomized, and the number of blank visits was increased.

Seabird Decoys

Seabird decoys were 3D printed out of white PLA plastic and painted to match the black and white color of a sitting Newell’s Shearwater (Figure 1). Given the overall similarities in size and color pattern of two of the covered species, Newell’s Shearwater and Hawaiian Petrel, the decoy serves as a rough analog for the detectability of both species. However, Band-rumped Storm-petrels are much smaller and rarer, so the searcher efficiency estimate from this work should not be assumed to be equal for this more elusive species.

Figure 1 Seabird decoy modeled after a sitting Newell’s Shearwater or Hawaiian Petrel

Printed instructions on the underside of the decoy provided detailed information on how to report the decoy, such as a phone number to call or text and where to find the decoy ID number to report.

Sample Size and Decoy Deployment Schedule

A total of 20 decoys were deployed at all three participants' premises in 2024. A stratified randomization was used in deployment dates to replicate the fluctuations in fallout intensity and required search effort throughout the fallout season. The deployment schedule was designed to mimic Newell's Shearwater fledging period, which begins in late September and continues through early December with peak fledging levels in October (Raine et al., 2023). Data from the Save Our Shearwaters program also shows a marked increase in the number of Newell's Shearwater fledglings rescued in October compared to other months (Raine et al., 2017, 2023). We followed the fallout trends of fledging Newell's Shearwater as they are the listed species and age group most impacted by light attraction and constitute the highest levels of take in the KSHCP. Accordingly, we divided the season into time periods ("blocks") and distributed the number of decoys in each block.

For Hotel 1 Hanalei, four time blocks were scheduled (Table 1). For Kauai Coffee and Royal Sonesta, the deployment period was divided into three blocks due to the delayed start of the study. In these cases, the first and second blocks were combined, and 10 decoys were deployed in this combined block.

Table 1 Stratified randomization was followed and deployments were implemented in three blocks throughout the fallout season.

Block	Date Range	Number of Decoys Placed
1	October 4 - 15	5
2	October 15 - 31	5
3	November 1 - 23	5
4	November 24 - December 15	5

Our goal was to ensure the peak fallout period (i.e., October) gets at least half of the decoys. We limited the number of visits in each block to seven. This arbitrary cutoff was set based on staffing needs. We follow the condition of one decoy on the first visit and a maximum of three decoys at any visit as in previous years. The use of blocks was made to ensure testing of properties' search efficacy throughout the fallout season, to increase the number of deployment visits, and to account for extremes in randomization; e.g., all 20 decoys being deployed in consecutive visits or three decoys deployed on each visit thus a site only being visited seven times etc. A detailed schedule with the number of decoys deployed at each visit is given in Appendix 1.

Decoys were deployed between 30 minutes and two hours after sunset, but before the first scheduled downed bird search, as recommended by the KSHCP (three to four hours after sunset). This deployment schedule ensures that decoys are in place by the hours of peak Newell's Shearwater fledging (Raine et al., 2023).

In all three sites, the researchers who deploys the decoys needed to check in or use routes either going through or visible to security personnel before entering the premises. Therefore, extra measures were taken to prevent potential biases. One to four 'blank' visits were made in each block for all sites where the researchers would walk around the premises without deploying a decoy. As an additional measure, and whenever possible, the researchers used the public access paths more than the route going through the security.

Decoy Locations

Decoy placement points were randomly generated in QGIS V3.28.3-Firenze (QGIS Development Team, 2024). The study area was determined by property maps provided by the participant at the beginning of the study. A total of 20 random points were generated with 10 points "in cover" following the assumption that grounded birds will seek cover, and 10 were "no cover". Points that fell on flat or gently sloping roofs, in swimming pools, steep slopes hazardous to human safety, fully fenced areas, inside buildings, and in the middle of driving paths were discarded from the survey. A new randomized point was then created in its place so that the total number of deployments remained the same. Although live birds can and do fallout in all of these areas, the logistical constraints associated with placing a decoy in these locations necessitated their exclusion.

Points that fell onto a location opposite the designated cover type (i.e. an "in cover" point in the middle of a lawn or conversely a "no cover" point in vegetation) were moved to the nearest possible location that fulfilled the necessary cover type description. For all decoy placements, the amount of cover at the actual placement point was judged based on:

- The maximum distance away that a person could stand and still see the decoy,
- the minimum distance away that a person could stand and look in the direction of the decoy and be blocked from seeing it,
- whether there was cover within a few inches of the decoy's head
- subjective assessment of the amount of artificial light illuminating the decoy (none, low, med, high)

Based on these metrics, a subjective categorization summarizing the placement as in the open (no cover), partially in cover, or in full cover was made. For example, a decoy visible from a distance from a majority of angles would be considered open, a decoy either shielded from view from more than 50% of angles or with some overhead cover would be considered partial cover, and a decoy not visible from a distance from any angle and/or close overhead cover would be considered in full cover (see visual examples below). Decoys considered to be in full cover often require changing stances (crouched or on knees), moving raised cover items (valet trolley, wheeled dumpsters, etc.), or searching under dense vegetation to find. There was no predetermined ratio of partial cover vs. full cover, and the ensuing cover type was a result of the closest available cover to the randomized point.

Participants were told that placements would be spatially randomized but not told that 50% would be placed in the open and 50% in covered locations.

Decoy Retrieval and Reporting

The reporting cut-off time for decoys was 40 minutes before sunrise for decoys in the “open” category and sunrise time for decoys in the “cover” category. Decoys were retrieved as soon as possible after sunrise, which varied throughout the season from 06:30 to 09:55.

A free Google Voice account was created specifically for reporting purposes. Text instructions printed on the underside of the decoy instructed finders to either send a picture of the decoy or a voicemail with relevant information proving a decoy was found. The time of discovery was determined either by the time indicated in the message or, if no time was stated, the time the message was received. The phone line was tested by calling at the beginning of every deployment night.

Discovery Rate and Confidence Intervals

The discovery rate (i.e., the searcher efficacy) was calculated as the number of successes in finding the decoy divided by the number of deployments.

With the assumption that finding the decoy (X) is a Bernoulli random variable; the probability of success in finding a decoy is the same for each deployment, and the deployments are statistically independent, interval estimate of a success probability (i.e., binomial proportion confidence interval) based on the observed data is constructed. Based on maximum likelihood estimates, the Wald method was employed to construct confidence intervals at a 95% level for the probability of finding the decoy. All calculations are implemented in base R (R Core Team, 2024).

Results and Discussion

1 Hotel Hanalei Bay

Discovery Rate

Of the 20 decoys placed at 1 Hotel Hanalei during the 2024 fallout season, the seabird searchers and hotel staff reported a total of 10 decoys, resulting in a 50% searcher efficacy rate with confidence intervals of 30 and 70%. 1 Hotel Hanalei reported 70% (7 of 10) of the decoys placed in open areas and 30% (3 of 10) of the decoys deployed in covered, vegetated areas in 2024 (Figure 1 and Table 2). Of the three decoys that were found in coverage, two were categorized as “partial cover”, leaving one decoy found in full coverage. One additional decoy in an open area was found after the reporting window closed and is thus excluded from this research study.

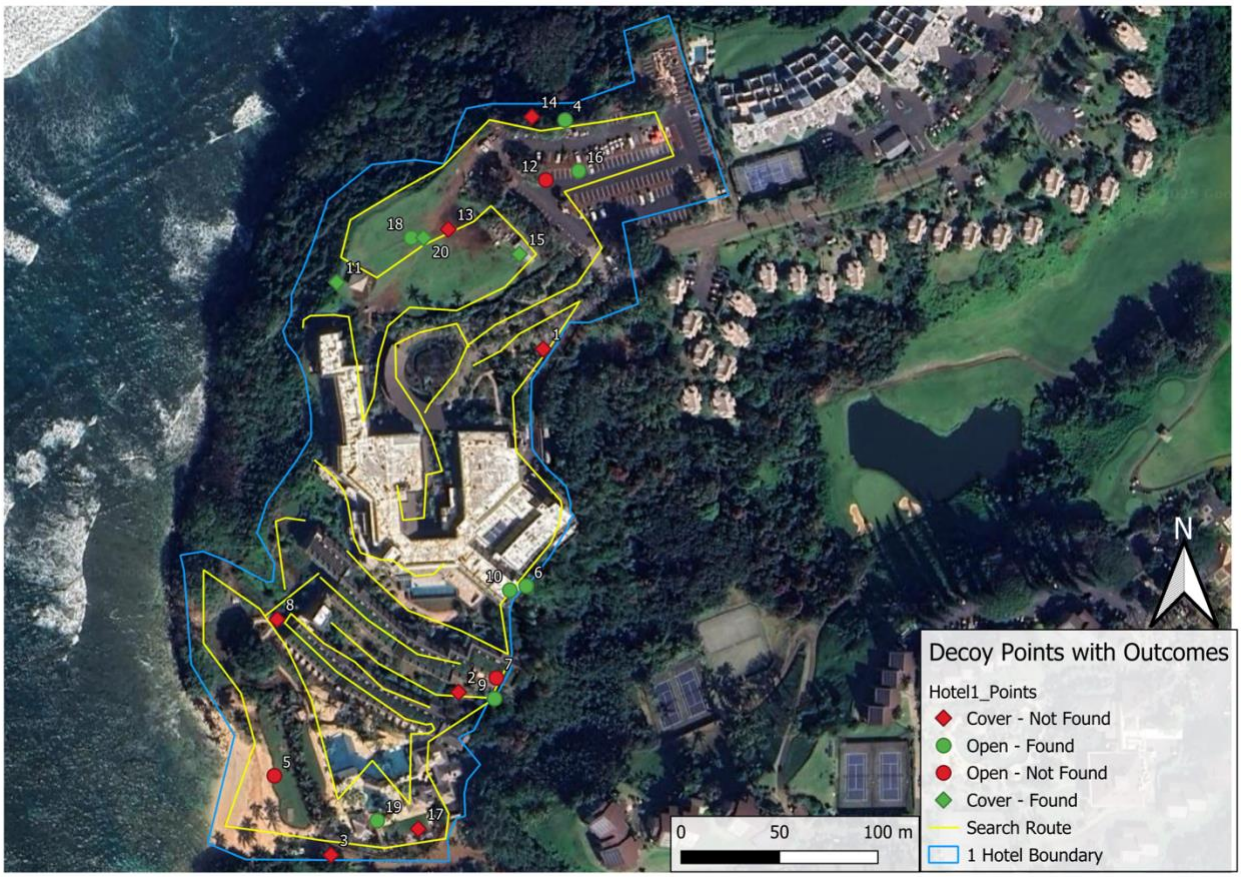

Figure 1 Locations and cover type for all decoys deployed in 1 Hotel Hanalei Bay premises in 2024.

Table 2 Searcher efficacy of 1 Hotel Hanalei Bay in 2024

Cover Type	# Deployed	# Found	Discovery Rate
Open	10	7	70%
Partial Cover	5	2	40%
Full Cover	5	1	20%
TOTAL	**20**	**10**	**50%**

The 50% searcher efficacy shows an improvement after 35% in 2023. While 1 Hotel Hanalei teams performed very similar in reporting decoys placed in open (when compared to 6 out of 10 decoys reported in 2023), the performance was slightly better than 2023 in reporting decoys placed in cover (1 out of 10 decoys in cover was reported in 2023).

Time until Reported

The average time to discovery (i.e., the time when the decoy was first reported) for all decoys reported by the 1 Hotel Hanalei team was 232 minutes (Figure 2), 140 minutes longer than the average of 92 minutes performed in 2023. For decoys deployed in open areas, the average time to discovery was

234.7 minutes (n=7, range 112-550 minutes). The time to discovery for decoys found in cover was 124.3 minutes (n=3, range 102-167 minutes).

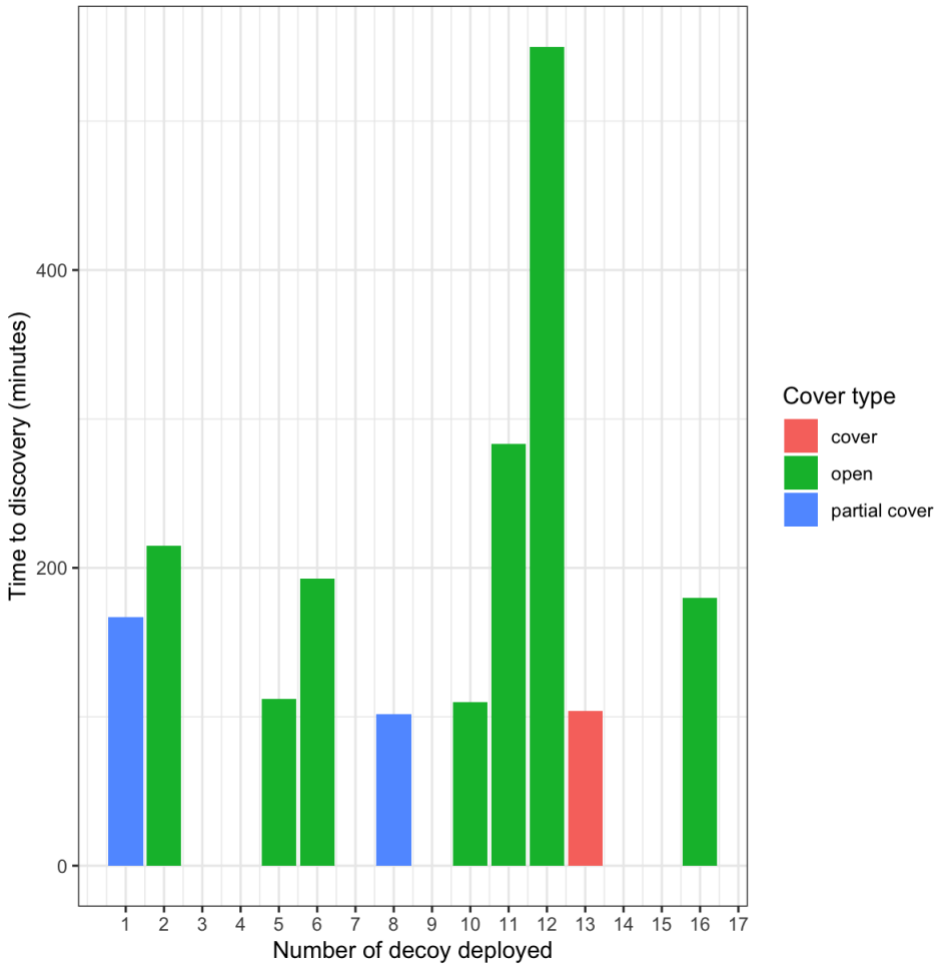

Figure 2 Time to discovery for the reported decoys by the 1 Hotel Hanalei team. Note, the last four decoys were not reported and therefore not shown in the plot.

Encounter with Seabird Predator Species

No cats were seen and reported to the 1 Hotel Hanalei team this season during the decoy deployment and retrievals.

Suggestions for Improvement

Although the results of the 2024 trial show a 15% improvement from the same trial conducted in 2023, the conclusion remains the same; the results of this trial show a significantly lower rate of searcher efficacy than the claim of 90% searcher efficiency in the 1 Hotel Hanalei's Downed Seabird Implementation Plan. Especially given a dedicated seabird search team and regular searches every night, it is anticipated that all of the decoys placed in open areas would be found. The reporting rate for decoys placed in open was 70% (7 out of 10), which is a 10% improvement from decoys reported in the

same category in 2023. However, it should be noted that for decoys placed in open, 1 Hotel Hanalei team reported these on average 2 hours later when compared to 2023. Although not being monitored in KSHCP, time to discovery is a good metric to monitor the performance changes in seabird searches.

1 Hotel Hanalei team showed an improvement in reporting the decoys placed in cover in 2024, however, the majority of these decoys were missed despite the currently improved capacity in seabird searches and past recommendations from agencies. Reporting decoys placed in cover is assumed to be an important indicator of a search teams' efficacy is in finding live birds as a live, downed bird is expected to seek cover. All decoys placed in cover were within one meter of either a paved path or an accessible field, a metric intended to reflect the likely area where a downed bird might initially seek cover after landing in the open, yet visible enough for searchers to locate. Moving forward, there should be a focus on searching along vegetation lines, within ornamental vegetation, and under cars and other obstructions. Areas with obstacles like cars, beach cabanas, or vegetation warrant more meticulous and time-consuming searches. Searching between and under objects and viewing areas from multiple angles becomes essential in such areas to ensure comprehensive coverage.

90% (9 of 10) of the reported decoys were reported by the dedicated seabird search team of 1 Hotel Hanalei. Only one decoy, which was deployed beside a cat trap, was reported by 1 Hotel Hanalei Security personnel. On a few occasions, we received more than one report from the dedicated 1 Hotel Hanalei on the same night, suggesting that the search team deployed several seabird searchers on these nights.

Despite having a dedicated seabird search team and presumably multiple searches at night, 1 Hotel Hanalei still falls short of their claimed 90% searcher efficiency and did not show an improvement on the discovery rate of covered decoys or time to discovery when compared to 2023.

Kauai Coffee Company

Discovery Rate

Out of the 20 decoys placed at Kauai Coffee Company during the 2024 fallout season, the seabird searchers and hotel staff reported a total of 11 decoys, resulting in a 55% searcher efficacy rate with confidence intervals of 35 and 75% (Table 3). Kauai Coffee Company reported 80% (8 of 10) of the decoys placed in open areas and 30% (3 of 10) of the decoys deployed in covered or obscured areas. Two additional decoys were found after the reporting window closed and are thus excluded from this research study.

Table 3 Searcher efficacy of Kauai Coffee in 2024

Cover Type	# Deployed	# Found	Discovery Rate
Open	10	7	70%
Partial Cover	2	2	100%
Full Cover	8	2	25%

TOTAL	**20**	**11**	**55%**

Time until Reported

Average time to discovery for all decoys was 369 minutes (range 35 - 690 minutes) (Figure 2). For decoys placed in open, decoys were found on average in 417 minutes (range 50 to 690 minutes, n=7), and for decoys placed in partial or full cover, decoys were found on average in 285 minutes (range 35 to 602 minutes, n=4).

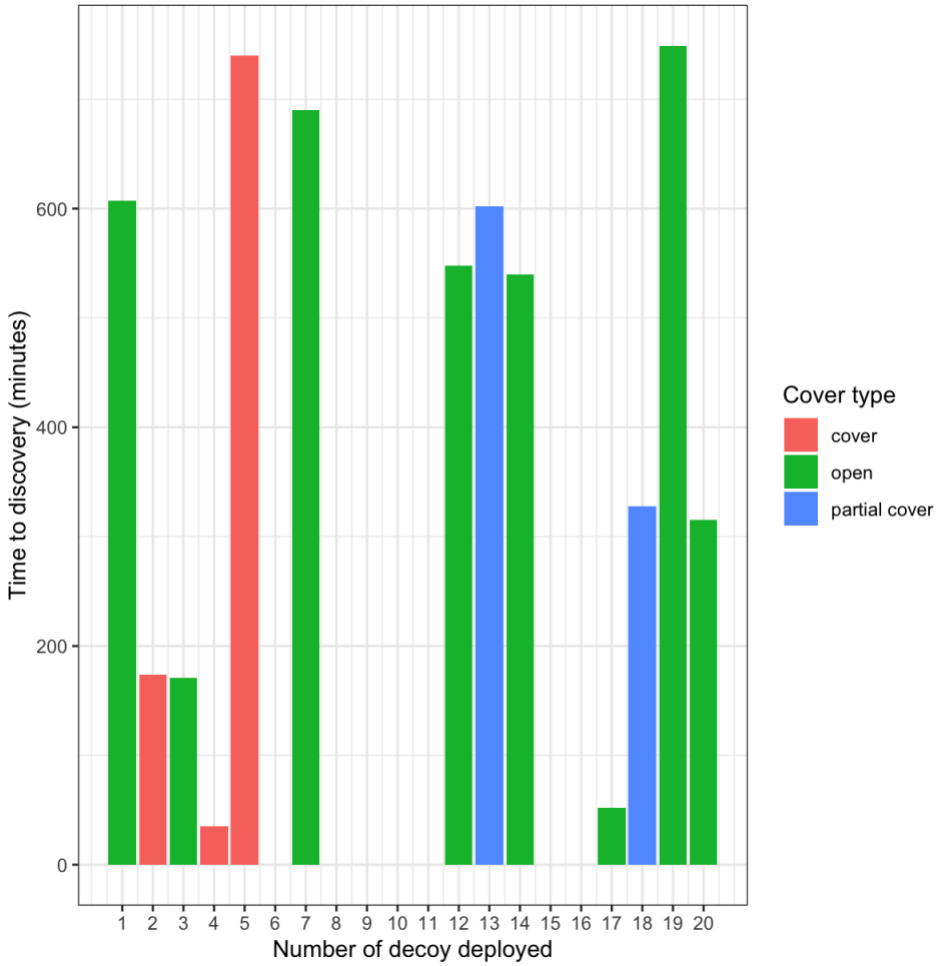

Figure 3 Time to discovery for the decoys reported by Kauai Coffee team in 2024.

Encounter with Seabird Predator Species

Throughout the study, a total of six cat sightings were reported to the Kauai Coffee team. It should be noted that these sightings are opportunistic observations when the researchers were in the area for decoy deployments. Assuming regular predator control effort is in place, it is clear that cats are not being captured efficiently either due to trapping methodologies or the flow of cats to the area. We

recommend that Kauai Coffee revise its predator control methodologies and take measures to reduce the flow of cats to their premises.

Suggestions for Improvement

Kauai Coffee showed a significant improvement in their seabird search efficacy when compared to 2021 and increased it from 10% to 55% in 2024. The performance of the 2024 season also meets 50% claimed searcher efficacy rate in their PIP. However, given the size of the area searched and number of people working in the area at night, we believe Kauai Coffee can achieve a higher rate and we recommend Kauai Coffee team to regularly remind their staff about fallout throughout the season.

Kauai Coffee team on average found the decoys placed in cover faster than those placed in open, however they still took more than four hours to find the decoys in cover. A live, downed bird is expected to seek cover in such a time frame and given the continuous presence of cats in their premises, we recommend Kauai Coffee to improve this metric, for birds in cover and birds in open.

Despite a better performance in seabird searches, Kauai Coffee's predator control was not adequate to keep the cats out of their premises. The researchers reported several cases of cat sightings throughout the fallout season. This is important as with the continuous cat presence, and with more than a few hours of finding bird 50% claimed search efficacy will be lower than assumed.

Royal Sonesta Kauai

Discovery Rate

Out of the 20 decoys placed at Royal Sonesta Kauai during the 2024 fallout season, the seabird searchers and hotel staff reported a total of 6 decoys, resulting in a 30% searcher efficacy rate with confidence intervals of 10 and 50% (Figure 4 and Table 4). The searcher efficiency of Royal Sonesta was 40% in 2022 and 17% in 2021. Royal Sonesta Kauai reported 50% (5 of 10) of the decoys placed in open areas and 10% (1 of 10) of the decoys deployed in covered or obscured areas in 2024.

Figure 4 Location and cover type for all decoys deployed in Royal Sonesta premises in 2024.

Table 4 Searcher efficacy of Royal Sonesta Kauai in 2024

Cover Type	# Deployed	# Found	Discovery Rate
Open	10	5	50%
Partial Cover	1	0	0%
Full Cover	9	1	11%
TOTAL	**20**	**6**	**30%**

The searcher efficiency study was suspended between October 21 and 31 by the Royal Sonesta due to an unforeseen problem. This resulted in shifting the deployment of seven decoys to the second time block. Instead of increasing the number of visits, these decoys had to be deployed in the planned blank visits, potentially biasing the study as it leads to more decoys deployed in a shorter time period than planned. However, based on the reporting received, we have not noticed a significant increase in searcher efficiency in the second block as expected due to increased chance of finding a decoy. Therefore, we think the impact of this suspension on the overall results is insignificant.

Time until Reported

The average time until reported for all decoys found was 182 minutes (n=6, range 23 - 429 minutes). For decoys placed in open it was 131 (n=5, range 23-270 minutes) and in cover 439 minutes (n=1). Royal Sonesta team showed a significant improvement in time to discovery when compared to their performance in 2022. Overall discovery time improved from 382 minutes to 182 minutes.

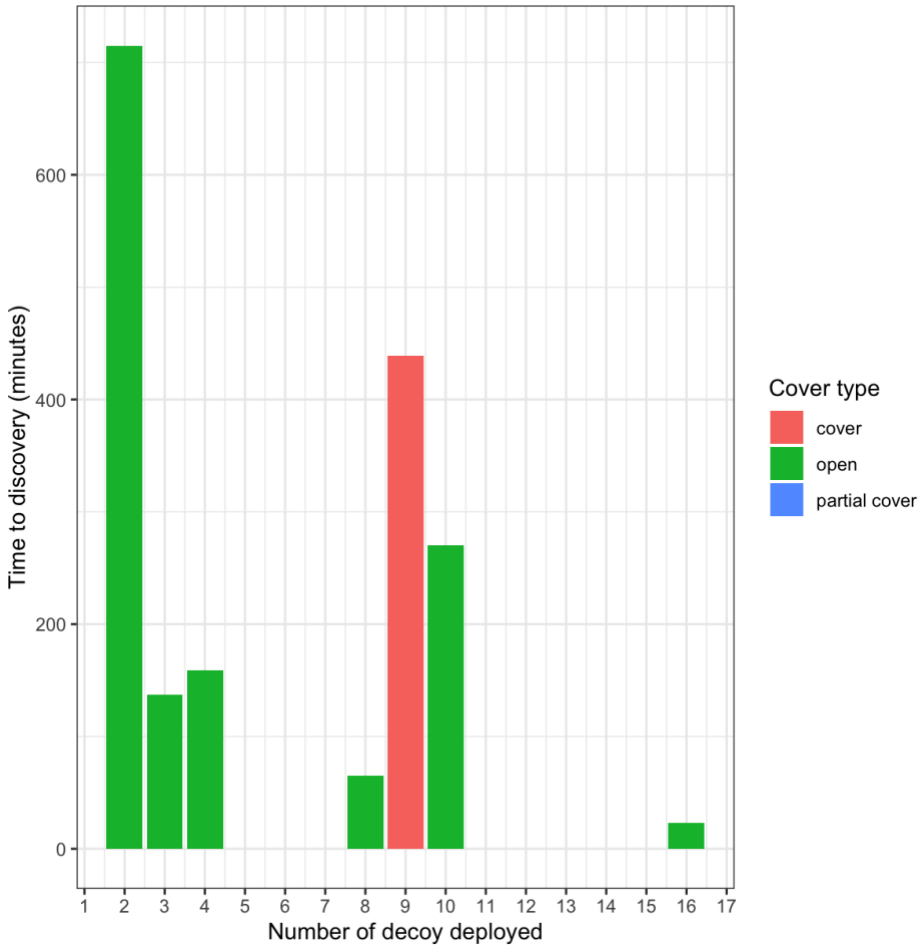

Figure 5 Time until discovered for the decoys reported by Royal Sonesta in 2024. Note, the last four decoys were not reported and therefore not shown in the plot.

Encounter with Seabird Predator Species

On one occasion, the researchers encountered a cat at the Royal Sonesta premises and reported it to the hotel team.

Suggestions for Improvement

Royal Sonesta team showed a poorer performance when compared to 40% efficacy in finding the decoys in 2022 and stayed below their claimed 50% searcher efficacy. The fact that 50% of the decoys placed in

open are not reported indicates inadequate search effort in 2024. Search effort for seabirds in open areas as well as vegetated areas should be increased.

Despite poorer searcher efficiency, discovery time of the decoys were on average shorter than their performance in 2022. However, it should be noted that average three hours to find a decoy in an open area is still a long time when behavior of live birds are considered.

Acknowledgments

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