MICHAEL P. VICTORINO
Mayor

HELENE KAU
Director

SHAYNE R. AGAWA, P.E.
Deputy Director

BOARD OF WATER SUPPLY
COUNTY OF MAUI
200 SOUTH HIGH STREET
WAILUKU, MAUI, HAWAI'I 96793
www.mauicounty.gov/water

June 27, 2022

Honorable Alice L. Lee, Chair
and Members of the Maui County Council
200 South High Street
Wailuku, Hawaii 96793

Dear Chair Lee and Members:

SUBJECT: RESOLUTION 22-119, PROPOSING AN AMENDMENT TO THE REVISED CHARTER OF THE COUNTY OF MAUI (1983), AS AMENDED, TO ESTABLISH THE EAST MAUI COMMUNITY WATER AUTHORITY

On June 16, 2022, the Board of Water Supply unanimously voted to approve this letter in support of Resolution 22-119, and to have this charter amendment placed on the ballot to let the people of Maui County decide on the establishment of the East Maui Community Water Authority.

Thank you for your consideration.

Sincerely,

Buddy James Nobriga, Chair
Maui County Board of Water Supply

cc: Michael P. Victorino, Mayor
Sandy Baz, Managing Director
Helene Kau, Director
Shayne Agawa, Deputy Director

BJN:sco

"By Water All Things Find Life"

County Clerk

From: Hanna Mounce <mounce@mauiforestbirds.org>
Sent: Tuesday, June 28, 2022 2:25 PM
To: County Clerk
Subject: Support the passing of Bill 21 CD1 Outdoor Lighting Ordinance for Seabird Protection

Aloha Maui County Councilmembers and Chair,

My name is Dr. Hanna Mounce. I am the coordinator of Maui Forest Bird Recovery Project, the founder of Na Koa Manu Conservation, a mother, a longtime resident of Pukalani, and a local small business owner.

I strongly support Bill 21 CD1, seeking to regulate the impact of outdoor lighting on wildlife and dark skies by requiring outdoor lighting to be fully shielded, down directed, mounted as low to the ground as possible, and limited to 2% blue light content.

Safer lighting is readily available for businesses and this is a small change to make in our human activities that will make a big change for our native wildlife. I would like to ensure that Hawaiian seabirds are still here for my children and my grandchildren. Without them, we will not have the nutrients we need for our forests to flourish and provide the water that humans also so greatly rely upon.

Mahalo,

Dr. Hanna L. Mounce
Coordinator - Maui Forest Bird Recovery Project
2465 Olinda Road, Makawao, HI 96768-7138 USA
www.mauiforestbirds.org

808-573-0280 MFBRP Office
808-421-7483 Cell

County Clerk

From: Eric Miyasato <eric@hawaiianlights.com>
Sent: Tuesday, June 28, 2022 5:23 PM
To: County Clerk
Subject: Full Council meeting - File # CC 22-154 Climate Action, Resilience and Environment Bill 21, CD1 (2022)
Attachments: chapter14 - lighting.pdf; Urmston_et_al._2022_PONE.pdf

Dear County Clerk,

I would like to submit the attached for Friday's meeting July 1st, in regards to CC 22-154

Document 1 (Umston_et_al_2022_PONE.pdf)

- Hawaii Pacific University & US Fish and Wildlife Study
  - 8 year study with 4 years of High pressure sodium lamp and 4 years of full cutoff LED in 3000K and 4000K along the coast from Waimanalo to Hawaii Kai.
  - Page 14, Highlighted – "There is no evidence suggesting that the shielded LED streetlights impacted the number of birds affected by fallout overall."

Document 2 – Chapter 14 of the Big Island lighting ordinance.

- Section 14-52 General Requirements (a)(b)(c)(d)(e)(f) refer to Table 14-A
- Table 14-A covers Class 1, class 2 and Class 3 classifications.
- Section 14.53 (d) Private Residential incandescent light fixtures which are fully shielded or have lumen output of less than eight thousand one hundred lumens for each acre of property that is intended to be illuminated shall be exempt from the requirements of this article.
- Section 14.53 (e) Outdoor Advertising signs, if constructed of translucent material, and illuminated totally from withing and colored with an opaque background using translucent letters or symbols, shall be exempt from the requirement of this article, except that the hours of operation shall be the same as those for the Class 1 outdoor lighting.
- Section 14.51 Definitions (2) Class 1 lighting means all outdoor lighting used for, but not limited to, outdoor sales and eating areas, assembly or repair areas, advertisting or business signs, recreational facilities, and other similar applications in which color rendition is important.
  - Table 14-A – class 1
    - Fully shielded (others above 4,050 lumens / others below 4,050 lumens) OFF from 11:00pm to sunrise.
      - Note: "This is standard LED because color rendition is important."

- Section 14-53 Exemptions
  - (a) EXISTING LIGHT FIXTURES. ALL OUTDOOR LIGHT FIXTURES PLANNED AND APPROVED BY THE COUNTY OR EXISTING AND LEGALLY INSTALLED PRIOR TO SEPTEMBER 1, 1988, ARE EXEMPT FROM THE INSTALLATION AND SHIELDING REQUIREMENTS OF THIS ARTICLE, EXCEPT THAT WHEN EXISTING OUTDOOR LIGHT FIXTURES BECOME INOPERABLE, THE OUTDOOR LIGHT FIXTURES WHICH REPLACE THEM SHALL COMPLY WITH THE REQUIREMENT OF THIS ARTICLE.

The current Maui Bill 21 CD1 does not allow exemptions as the Big Island lighting ordinance does. Also, the Big Island ordinance allows the existing fixtures to remain and only changed when it becomes inoperable, whereas the Maui BILL 21 CD1 will require all outdoor lights to be changed 3 years after passage. The Maui Bill will cause financial hardship to businesses and residences of Maui County to comply.

Eric Miyasato
808-226-5973

(A) All materials which enter into or are produced as part of the nuclear fuel cycle, including milled uranium ore, fissile material, and all fission by-products.
(B) Any quantity of radioactive material specified as a "large quantity" by the Nuclear Regulatory Commission in 10 CFR, part 71.
(C) Any quantity of radioactive waste, including nonradioactive material contaminated with radioactive material, which has been produced as part of the nuclear fuel cycle.

(6) For the purposes of this article, the term "radioactive material or substance" shall not include:
(A) Radiation sources or materials employed in therapeutic radiology, in biomedical research, or in educational endeavors, or medical devices designed for individual application (as for example cardiac pacemakers) or commercial devices, processes, or facilities, as approved by the appropriate regulatory and licensing agencies.

(1981, Ord. No. 665, sec. 1.)

Section 14-46. Transportation of radioactive material, unlawful.

It shall be unlawful for any person to transport radioactive material within or through the County.
(1981, Ord. No. 665, sec. 1.)

Section 14-47. Storage of radioactive material, unlawful.

It shall be unlawful for any person to store radioactive material within the County.
(1981, Ord. No. 665, sec. 1.)

Section 14-48. Nuclear energy facilities, prohibited.

It shall be unlawful for any person to locate or build a nuclear energy facility which utilizes nuclear material for the production of energy within the County.
(1981, Ord. No. 665, sec. 1.)

Section 14-49. Penalty.

Any person violating any provision of this article shall be guilty of a misdemeanor and shall be fined not more than $1,000 or imprisoned for not more than one year, or both, for each violation.
(1981, Ord. No. 665, sec. 1.)

Article 9. Outdoor Lighting.

Section 14-50. Applicability and scope of article.

(a) This article shall apply to the installation of all outdoor lighting fixtures within the County.
(b) The provisions of this article, including provisions for the imposition upon any person of the penalties by fine for any violation of this article, shall not be construed to exclude the operation of applicable State statutes or other County ordinances. In the case of conflict with other County ordinances, the stricter ordinance shall apply.

(1988, Ord. No. 88-122, sec. 3.)

Section 14-51. Definitions.

(a) As used in this article, unless the context clearly indicates otherwise:
(1) "Outdoor lighting fixture" means any outdoor artificial lighting device, fixture, lamp, or other similar device, permanently installed or portable, which is intended to provide illumination for either visibility or decorative effects. Such device shall include, but not be limited to, search, spot, and flood lighting used for:
(A) Buildings and structures;
(B) Recreational facilities;

(C) Parking lots;
(D) Landscape lighting;
(E) Business and advertising signs;
(F) Roadways;
(G) Walkways.

(2) "Class I lighting" means all outdoor lighting used for, but not limited to, outdoor sales and eating areas, assembly or repair areas, advertising or business signs, recreational facilities, and other similar applications in which color rendition is important.
(3) "Class II lighting" means all outdoor lighting used for, but not limited to, illumination for walkways, roadways, equipment yards, parking lots, outdoor security, and other similar applications in which general illumination of the grounds is the primary concern.
(4) "Class III lighting" means any outdoor lighting used for decorative effects. It includes, but is not limited to, waterfall and pond lighting and architectural highlighting for buildings and landscapes.
(5) "Building official" means the director of public works or the director's designated representative.
(6) "Individual" means any private individual, governmental entity, tenant, lessee, owner, or any commercial entity including, but not limited to, companies, partnerships, joint ventures, or corporations.
(7) "Fully shielded" means the outdoor lighting fixture is constructed so that all of the light emitted by the fixture is projected below the horizontal plane of the lowest point of the fixture.
(8) "Partially shielded" means that the outdoor lighting fixture is constructed so that at least ninety percent of the light emitted by the fixture is projected below the horizontal plane of the lowest point of the fixture.
(9) "Blue light content" means the ratio of the amount of energy emitted by the outdoor light fixture between 400 and 500 nm divided by the amount of energy between 400 and 700 nm.
(10) "Traffic color compliant" means the 1931 CIE x y color coordinates of the outdoor light fixture is outside of any of the traffic signal color boxes as defined by ITE ST-052 500/AGS-PM/1105.

(1988, Ord. No. 88-122, sec. 3; Am. 2001, Ord. No. 01-108, sec. 1; Am. 2011, Ord. No. 11-18, sec. 1.)

Section 14-52. General requirements.

(a) Standard fixture. All class types of outdoor light fixtures shall follow the requirements set forth in Table 14-A.
(b) Shielding. All outdoor lights shall be shielded pursuant to the requirements set forth in Table 14-A.
(c) Hours of operation. All outdoor light fixtures shall be subject to the hours of operation as required by Table 14-A.
(d) Mercury vapor lights prohibited. Mercury vapor lamps shall not be used for any new outdoor lighting installations or for the replacement of any existing installation. All existing mercury vapor outdoor lighting fixtures shall be removed by August 17, 1998.
(e) Blue light content. The blue light content of the outdoor light fixture shall be pursuant to the requirements set forth in Table 14-A.
(f) Traffic color compliant. The color of the outdoor light fixture shall be pursuant to the requirements set forth in Table 14-A.

(1988, Ord. No. 88-122, sec. 3; Am. 2011, Ord. No. 11-18, sec. 2.)

Section 14-53. Exemptions.

(a) Existing light fixtures. All outdoor light fixtures planned and approved by the County or existing and legally installed prior to September 1, 1988, are exempt from the installation and shielding requirements of this article, except that when existing outdoor light fixtures become inoperable, the outdoor light fixtures which replace them shall comply with the requirements of this article.
(b) Fossil fuel light. All outdoor light fixtures producing light directly by the combustion of fossil fuels, such as kerosene and gasoline, shall be exempt from the requirements of this article.
(c) Holiday decorative lighting. Low wattage fixtures used for holiday decorations shall be exempt from the requirements of this article.

(d) Residential incandescent illumination. Private residential incandescent light fixtures which are fully shielded or have a lumen output of less than eight thousand one hundred lumens for each acre of property that is intended to be illuminated shall be exempt from the requirements of this article.
(e) Business signs. Outdoor advertising signs, if constructed of translucent material, and illuminated totally from within and colored with an opaque background using translucent letters or symbols, shall be exempt from the requirements of this article, except that the hours of operation shall be the same as those for Class I outdoor lighting.
(f) Searchlights. Searchlights used for advertising purposes shall be exempt from the requirements of this article, except that the operation of such lights is limited to the hours of 6:00 p.m. to 10:00 p.m.
(g) Emergency lighting. Emergency lighting required for public safety is exempt from the requirements of this article.

(1988, Ord. No. 88-122, sec. 3.)

Section 14-54. Submission of plans.

(a) All outdoor lighting fixtures shall be installed in conformance with the provisions of this article and those of the electrical code of the County as applicable and subject to the appropriate permit and inspection requirements thereof. The applicant for any permit required by the County for work involving nonexempt outdoor light fixtures shall submit to the building official proof that the proposed work will comply with the article requirements. The submission shall contain, but not be limited to, the following:
    (1) The location of the site where the outdoor light fixtures will be installed;
    (2) Plans indicating the type(s) of outdoor light fixtures to be used and their location on the premises;
    (3) A description of the outdoor light fixtures including, but not limited to, manufacturer's catalog cuts and drawings.
(b) The plans and descriptions required by subsection (a) sufficiently complete to enable the building official to readily determine whether compliance with the requirements of this article will be secured. If such plans and descriptions cannot enable this ready determination, by reason of the nature or configuration of the devices or fixtures proposed, the applicant shall be required to submit further proof of compliance. Furthermore, any design, material, or method of installation not specifically forbidden by this article may be used, provided any such alternate has first been approved by the building official. The building official may approve any such proposed alternate provided:
    (1) It is at least approximately equivalent to the applicable specific requirements of this article; and
    (2) It is otherwise satisfactory and complies with the intent of this article.

(1988, Ord. No. 88-122, sec. 3.)

Section 14-55. Tables.

TABLE 14-A

Lamp Type	Shielding Requirement	Operation Restrictions
Class I		
Low pressure sodium	Fully shielded	None
Low pressure sodium	Partially shielded	Existing fixtures only. New installations as of October 2010 prohibited
Others above 4,050 lumens	Fully shielded	Off from 11:00 p.m. to sunrise*
Others below 4,050 lumens	Fully shielded	Off from 11:00 p.m. to sunrise*
LED fixtures with less than 2% blue light content	Fully shielded	Off at 11:00 p.m. to sunrise*

Class II		
Low pressure sodium		
90 watts or less	None	Existing fixtures only. New installations as of October 2010 prohibited
greater than 90 watts	Partially shielded	Existing fixtures only. New installations as of October 2010 prohibited
Low pressure sodium	Fully shielded	None
LED fixtures with less than 2% blue light content and traffic color compliant	Fully shielded	None
Others above 4,050 lumens		Prohibited
Others below 4,050 lumens		Prohibited
Class III		
Low pressure sodium	Fully shielded	None
Others above 4,050 lumens		Prohibited
Others below 4,050 lumens	Fully shielded	Off from 11:00 p.m. to sunrise*
Neon	None	Off from 11:00 p.m. to sunrise*

*These lights may remain on after 11:00 p.m. if bona fide business or recreational activities are taking place.
(1988, Ord. No. 88-122, sec. 3; Am. 2011, Ord. No. 11-18, sec. 3; Am. 2013, Ord. No. 13-60, sec. 2.)

Section 14-55.1. Penalty.

Any person violating any provision of this article shall, upon conviction, be punished by a fine not to exceed $500. Such person shall be deemed guilty of a separate offense for each and every day any violation of this article is committed. Furthermore, payment of such a fine shall not relieve the individual from the responsibility of correcting the violative condition, nor shall it preclude the County from instituting any action for its removal.
(1988, Ord. No. 88-122, sec. 3.)

Article 10. Exceptional Trees.

Section 14-56. Intent.

In accordance with section 58-2, Hawai'i Revised Statutes, to safeguard exceptional trees from destruction due to land development, the County desires to enact protective regulations to preserve exceptional trees within the County.
(1984, Ord. No. 84-22, sec. 1.)

Section 14-57. Definitions.

For purposes of this article, "exceptional trees" means a tree or grove of trees with historic or cultural value, or which by reason of its age, rarity, location, size, aesthetic quality, or endemic status has been designated by the council as worthy of preservation. The term exceptional trees does not apply to trees planted for commercial forestry operations. Exceptional trees may be designated generally by biotaxy or individually by location or class.
(1984, Ord. No. 84-22, sec. 1.)

Section 14-58. Arborist advisory committee.

There shall be an arborist advisory committee consisting of six members who shall be appointed by the mayor. The committee shall include the following: the planning director, or the director's designee; one

PLOS ONE

RESEARCH ARTICLE

Quantifying wedge-tailed shearwater (*Ardenna pacifica*) fallout after changes in highway lighting on Southeast O'ahu, Hawai'i

Jennifer Urmston[1,2¤]*, **K. David Hyrenbach**[1,2], **Keith Swindle**[3]

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OPEN ACCESS

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Data Availability Statement: All relevant data are within the manuscript and its Supporting Information files.

Abstract

Attraction to artificial light at night (ALAN) poses a threat to many fledgling seabirds leaving their nests for the first time. In Hawai'i, fledgling wedge-tailed shearwaters disoriented by lights may become grounded due to exhaustion or collision, exposing them to additional threats from road traffic and predation. While the timing and magnitude of shearwater fallout varies from year to year, little is known about how changing lighting and environmental conditions influence the risk of grounding for this species. We analyzed 8 years (2012–2019) of observations of road-killed shearwaters along the Kalaniana'ole Highway on O'ahu to quantify the timing and magnitude of fallout during the fledging season (November–December). Our goal was to compare fallout before (2012–15) and after (2016–19) a transition in highway lighting from unshielded high-pressure sodium (HPS) to full-cutoff light-emitting diode (LED) streetlights. To detect the shearwater response to the lighting regime, we also accounted for three potential environmental drivers of interannual variability in fallout: moon illumination, wind speed, and wind direction. The effects of these environmental drivers varied across years, with moon illumination, wind speed and wind direction significantly affecting fallout in at least one year. Altogether, the interaction between moon illumination and wind speed was the most important predictor, suggesting that fallout increases during nights with low moon and strong winds. The lack of an increase in fallout after the change from HPS to shielded 3000K - 4000K LED streetlights suggests the new streetlights did not worsen the light pollution impacts on wedge-tailed shearwaters on Southeast O'ahu. However, due to potential species-specific disparities in the behavior and light attraction of petrels, similar studies are needed before energy saving LED lights are implemented throughout the Hawaiian archipelago.

Introduction

Light pollution is a concern for burrow-nesting seabirds globally, with documented impacts on over 50 species of shearwaters, petrels, and puffins [1]. While coastal light pollution can

Funding: This work was supported by Experiment.com (Blinded by the light: reducing shearwater deaths along a coastal highway in O 'ahu, Hawai'i) and The Eppley Foundation for Research (Blinded by the Light: Shearwater Deaths Along a Coastal Highway in O'ahu). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing interests: The authors have declared that no competing interests exist.

disrupt adult seabirds provisioning their chicks on colonies [2–4], fledglings consistently account for the majority (68% - 99%) of the grounded specimens [1]. Fledgling seabird "fallout" occurs when chicks leaving their nests are disoriented by onshore lighting and become stranded on land instead of flying out to sea [1]. The magnitude of fallout is likely influenced by the number of chicks fledging, the prevailing environmental and celestial conditions [4, 5], and the features of anthropogenic lights, which vary as a function of light fixture design and bulb type [6, 7]. To gauge the effectiveness of light pollution mitigation measures, wildlife managers need to understand the influence of these biological and environmental drivers on the timing and magnitude of fallout.

A conceptual model to explain fallout involves fledging seabirds being drawn toward well-lit coastal areas, especially in the absence of moonlight [4, 5, 8–11] and when strong winds are directed toward shore [10, 11]. Birds are affected by bright light sources from vessels at sea and urbanized areas on shore, including streetlights and sports fields [1, 6, 12–13]. Moreover, collisions with powerlines and other structure can lead to injury and grounding [14, 15]. While our understanding of the environmental drivers of fallout is growing, the influence of specific design features of anthropogenic light sources remains understudied. In particular, lamp color and directionality are two key streetlight features that can affect fallout [7, 16]. Spurred by efforts to improve energetic efficiency, many cities are replacing yellow high-pressure sodium (HPS) lightbulbs commonly used in streetlights with white light-emitting diode (LED) bulbs [17–19]. Although LED bulbs decrease electricity consumption and maintenance costs, these benefits could be costly to wildlife, as shearwaters may be more sensitive to LED lights [7]. A study on the visual perception of Wedge-tailed Shearwaters (*Ardenna pacifica*–previously *Puffinus pacificus)* showed that they experience maximum light absorption of the wavelengths emitted by white LED lights (406–566 nm) and have lower absorption of the wavelengths emitted by HPS lights (560–620 nm) [20]. Moreover, a field-based experiment in Australia showed that Short-tailed Shearwaters (*Ardenna tenuirostris*) show increased attraction to LED lights over HPS lights, although the difference was not statistically significant [7].

Mitigation measures often target light directionality, whereby streetlights are shielded through the use of a "full-cutoff" design, which inhibits light emission above the horizontal plane of the fixture. This approach, when applied to HPS lights, reduced Newell's Shearwater (*Puffinus newelli*) fallout on Kauai (Hawai'i) [16]. Although mitigation is being addressed through shielding, the common use of optimized LEDs with broad spectra and Correlated Color Temperature (CCT) greater than the maximum recommended value for wildlife (2200 K) may be a cause for concern [17]. While modern LED lights possess the flexibility to give off a range of low to high CTT, short-wavelength light with high CCT is a common choice because of its efficiency [19]. The effectiveness of light shielding coupled with the use of broad spectrum, high CCT LEDs is unknown.

On the island of O'ahu (Hawai'i), Wedge-tailed Shearwaters (hereafter referred to as WTSH) experience fallout during the annual fledging season (November-December) [21, 22]. A three-year study in the early 1990s, revealed that hundreds of chicks become grounded every autumn, with the number varying widely from year to year [22]. Starting in 2002, U.S. Fish and Wildlife Service initiated a program of opportunistic road surveys of the southeast section of O'ahu during the fledging season, which documented a fallout hotspot in the town of Waimānalo, within 5 km from two WTSH colonies on offshore islets [21].

While there is evidence of interannual variability in WTSH fallout, little is known about the influence of environmental (weather and oceanographic conditions) and biological (breeding population size and reproductive success) drivers. To date, only one study has investigated the environmental drivers of WTSH fallout, by comparing a "wreck" year of unusually high fallout (1994), when WTSH groundings increased ten-fold from the two "normal" years prior [22].

This study suggested that anomalous southerly winds likely carried fledglings inland rather than out to sea and scattered them throughout the windward coast of O'ahu. While the southerly winds help explain why many birds were found inland, it is unclear to what extent low ocean productivity during the breeding season and unusual weather conditions during the fledging period caused the high fallout observed that year.

Over a decade later, Friswold et al. (2020) documented an increasing trend in annual fallout numbers between 2003 and 2010, and a two-year cycle of alternating years of high and low fallout. Subsequently, an unusually large fallout event in 2011 was documented during a La Niña year with high ocean productivity [23]. These results are suggestive of the potential influence of breeding population size and reproductive success on fallout.

In 2012, we began conducting systematic road surveys along a 17.3-km section of the Kalaniana'ole Highway to document WTSH fallout. In 2016, the Hawai'i Department of Transportation changed the streetlights on O'ahu's major roads from unshielded 2200 K HPS lights to shielded 3000–4000 K LED lights, where Kelvin (K) is a unit of measurement for CCT. Lower CCT indicates a warm yellow-orange appearance whereas higher CCT indicates cool blue light [18]. The shift in lights halfway through our study provided a unique opportunity to compare WTSH fallout under different street lighting conditions. To this end, we continued conducting standardized surveys following the established protocol through 2019 and analyzed an 8-year time series with four years before (2012–15) and four years after (2016–19) the change in lighting. This is the first study to compare changes in seabird groundings in response to HPS versus LED streetlights, by repeatedly surveying a fallout hotspot during the fledging season.

The goal of this study is to quantify the magnitude of WTSH fallout under two contrasting lighting regimes, to inform future coastal development and management of light pollution. Although shielding of the LED streetlights may reduce initial WTSH attraction, we predicted that disorientation caused by high intensity/shorter wavelength lights would outweigh the benefits of shielding. Thus, we expected an increase in fallout after the installation of LED streetlights (2016–2019). To detect the fallout response to the lighting regime, we also accounted for three potential environmental drivers: moon illumination, wind speed, and wind direction. Because WTSH rely on wind to take flight and may become disoriented in the absence of moonlight, we predicted higher fallout during windy nights of low moon illumination. In particular, due to the location of our study area, southwest from two breeding colonies, we anticipated that strong northeasterly winds would drive the fledging birds towards shore.

Methods

Study area

This study focuses on the southeast section of O'ahu, where a two-lane coastal highway runs through a rural and developed landscape (Fig 1). The survey route was illuminated with HPS streetlights until 2016, when the Hawai'i Department of Transportation transitioned to LED streetlights. The CCT of the LED streetlights is 3000 K on sections of the highway directly adjacent to the ocean, whereas inland lights are 4000 K.

The WTSH breeding colonies of Mānana Island and Kāohikaipu Island, where approximately 25,000 and 800 chicks were counted in 2019, are located 1.3 and 0.7 km offshore of our study area, respectively [25]. Three additional WTSH colonies on offshore islets (Mokulua Nui, Mokulua Iki, and Popoi'a) lie approximately 6 km north of the study area (Fig 1), with 2019 chick count estimates of 3,500, 5,000, and 900, respectively [25].

Weather patterns on windward O'ahu are dominated by the northeast trade winds, which typically persist for 1 to 2 weeks, interspersed with no-wind periods or southerly storms. Peak wind speeds occur in the afternoon, with lower wind speeds at night [26].

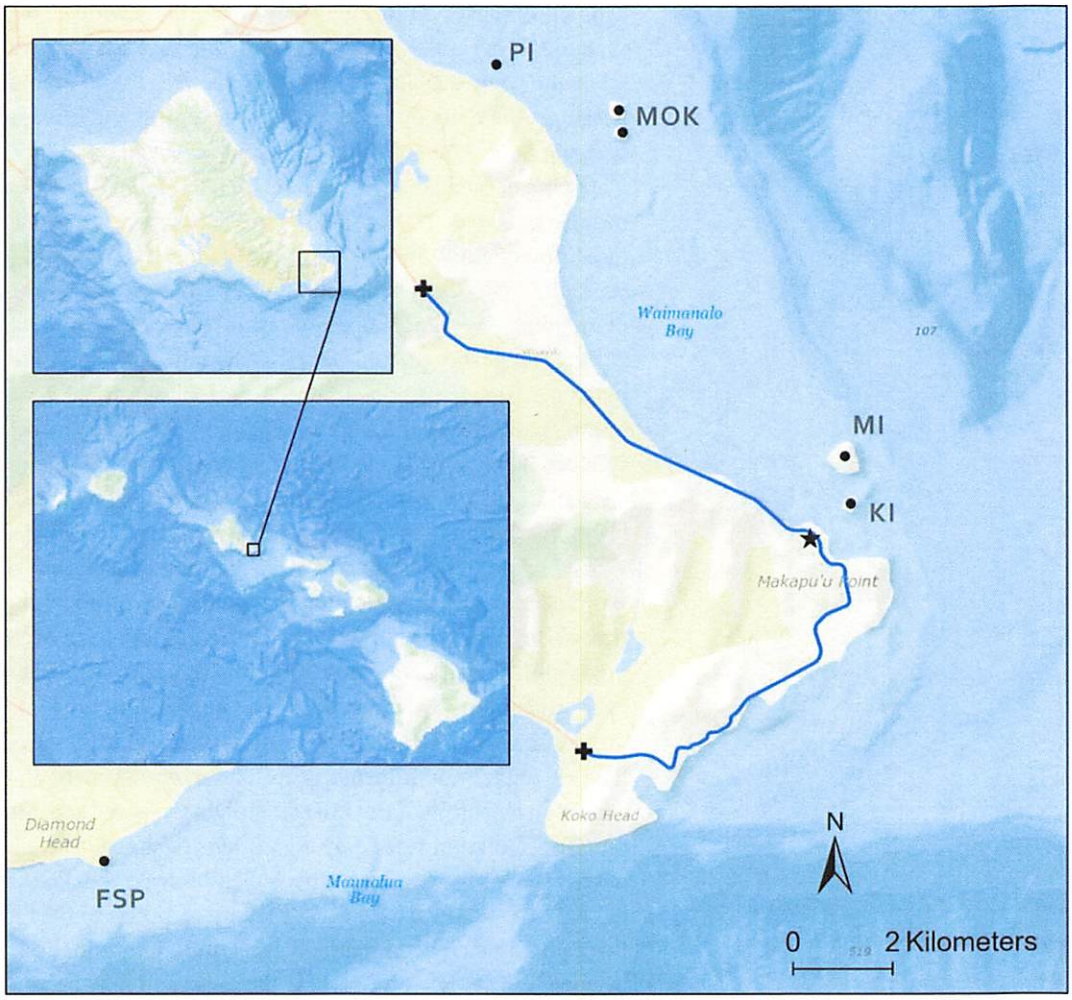

Fig 1. Map of the study area in southeast O'ahu. Blue line shows the survey route, and crosses indicate the start and end points. Black dots indicate WTSH breeding colonies. (PI = Popoi'a Island, MOK = Mokulua Islands, MI = Mānana Island, KI = Kāohikaipu Island, FSP = Freeman Seabird Preserve). Star marks the location of the Sea Life Park seabird rehabilitation center. Inset maps show the island of O'ahu, and the main Hawaiian Islands. Map features are overlaid on an ArcGIS Pro Software Version 2.5 base layer [24].

https://doi.org/10.1371/journal.pone.0265832.g001

Intake records

Members of the public deliver grounded WTSH to Sea Life Park (SLP), a marine life center located along our survey route in Waimānalo, for rescue and rehabilitation. SLP intake records, involving the daily number of rescued WTSH chicks, have been used to document the island-wide temporal variability in WTSH fallout during the fledging season and from year to year [21, 22]. To provide a broader context for our localized surveys of a known WTSH fallout hotspot, we compared the timing and the magnitude of annual fallout documented in the SLP intake records and our surveys.

Road surveys

We used a time series of standardized road surveys along a 17.3-km stretch of the Kalanianaʻole Highway, starting at the Olomana Golf Club, running through Waimānalo, and ending at the Koko Marina Center (Fig 1). While this survey route is a subset of the area surveyed by

USFWS from 2002–2010, it encompasses the main WTSH fallout hotspot in Waimānalo [21]. We conducted morning surveys by car, every 3 days, throughout the WTSH fledging season (November 6 –December 21). We began surveys at sunrise (6:15–7:15 AM) and drove the route once in each direction, at speeds between 25–35 mph, while visually searching for dead birds in each lane and along the shoulder. Since these surveys were conducted in the morning, likely a full 12 hours after fledging time, almost all the birds we observed were deceased. In 8 years of surveys, we observed 2 live birds, which were brought to SLP for rehabilitation and not counted in our analysis. All dead birds sighted while driving were included in the surveys, even if they were found on the shoulder, the median, or off the road.

Upon encountering a carcass, we recorded its position on the road, location (latitude and longitude coordinates from a hand-held Garmin e-trex GPS unit), nearest street address, and nearest utility pole using their unique id tags. We also took photos of each WTSH we encountered, showing diagnostic identification features (head and feet).

Environmental variables

We related WTSH fallout to two publicly-available environmental datasets: (i) wind speed (knots) and wind direction (degrees) recorded on Moku Lo'e (Kaneohe Bay) and provided by PacIOOS [27], and (ii) the lunar cycle, quantified using the percent of the lunar disk that was illuminated each night, from the U.S. Naval Observatory [28].

Because WTSH fledge during the night, we averaged the hourly wind data every night (18:00–6:00 local time). To match our surveys to the preceding environmental conditions, we related the number of grounded WTSH documented during a given road survey to the average wind speed (knots), wind direction (degrees), and lunar disk illumination (%) from the three nights prior.

Data analysis

We analyzed fallout across and within years using generalized linear models (GLM) built with R version 3.5.1 and the stats and MASS packages [29]. We developed and fitted nine separate models: a full model (involving all study years) quantified interannual variability, and eight yearly models visualized the interannual differences documented by the full model.

We ran all models using both Poisson and negative binomial distributions. Because the Poisson assumes that the variance equals the mean, the negative binomial is more appropriate whenever there is overdispersion [30]. We used the Akaike Information Criterion corrected for small sample size (AICc) to select the best-fitting distribution for each model [31].

Multi-year model of WTSH fallout. We related the number of WTSH observed during 128 surveys of the entire study area (16 per year times 8 years) to the light regime (unshielded HPS / shielded LED), year (2012–2019), and four environmental variables: moon illumination (% lunar disk illuminated), average wind speed (knots), average wind direction (degrees), and Julian date (the number of days since the beginning of the year).

We used multi-model inference to test all possible combinations of these six explanatory variables. Whenever two of three potentially interacting variables were included in a model, we also considered their interaction ('moon*date', 'moon*wind speed', and 'wind speed*date'). We used the AICmodavg package [29] to assess the model fit using AICc, which prevents over-fitting by penalizing models for each additional variable [31]. AICc assigns a value to each model using the formula, $AICc = -2log(L)+2K+(2K(K+1)/(n-K-1))$, where K is the number of parameters, n is the sample size, and L is the maximum likelihood of obtaining the given results with K parameters. We used Akaike weights (w_i) to calculate the likelihood of each

model as follows:

$$\omega_i = \frac{exp\left(\frac{-\Delta_i}{2}\right)}{\Sigma_{r=1}^{R} exp\left(\frac{-\Delta_r}{2}\right)}$$

where the numerator is the model likelihood with Δ_i showing the change from the lowest AICc model to the given model, and the denominator is the sum of all relative weights, as determined by Δ_r, the change in each contending model from the lowest AICc model. The lowest AICc value indicates the model that best describes the patterns in the observed data without over-fitting [31, 32].

To test the influence of the streetlights, in the context of interannual variability, we built two complementary sets of full models that either included "light regime" (comparing two groups of years: 2012–15 vs 2016–19) or included individual "years", regardless of their "light regime". This resulted in a total of 106 models: 36 included "light regimes", 36 included "years", and 34 included neither. Individual models ranged from having one to eight predictors (five variables and three interactions) (S1 Table). Following Michael et al. (2014), we assessed the importance of each variable in terms of their scaled average weight, calculated using the models where those variables were included.

Yearly models of WTSH fallout. We related the number of WTSH observed during 16 surveys of the entire study area (every three days during a single year) to the four aforementioned environmental variables: moon illumination, average wind speed, average wind direction, and Julian date (S1 File). We did not consider variable interactions, and calculated pseudo R-squared values based on the standard errors using the 'rsq' package [29].

Results

Fallout records

To interpret our road surveys in a broader context, we compared the number of grounded WTSH we documented along the SE corner of O'ahu with the SLP intake records, which provided an island-wide measure of fallout timing and magnitude. The SLP intake records of fledging chicks spanned from November 2 to January 5, and our observations of grounded shearwaters along the Kalaniana'ole Highway spanned from November 6 to December 21. Overall, only 2.3% of the SLP intake records fell outside of our road survey period (November 6 –December 21), with yearly proportions ranging from 1.3% to 6.3% (S1 Table).

The total number of rescued WTSH brought into SLP yearly across the 8-year study varied by nearly an order of magnitude, ranging from 74 to 525 birds per year, with an average of 226.1 +/- 170.6 S.D. (median = 159.5) (S1 Table). The number of WTSH carcasses observed on the survey route per year also varied widely, ranging from 7 to 60 birds, with an average of 24.1 +/- 18.7 S.D. (median = 17.5) (S1 Table). There was a positive correlation between the yearly number of road-killed birds (our surveys) and rescued birds (SLP records), with 2012 and 2016 standing out as high-fallout years ($r^2 = 0.85$, df = 6, $p < 0.01$) (Fig 2). There were 469 rescued birds in 2012 and 525 in 2016, with both years exceeding the median by over 300 birds. Likewise, there were 60 road-killed birds in 2012 and 45 in 2016, compared to the median of 17.5 birds. The lowest numbers of rescued and road-killed birds occurred in 2018, with 74 and 7 birds respectively.

Fallout modeling

Over the 8-year study, the number of grounded WTSH observed per survey ranged from 0 to 10, with an overall average of 1.5 +/- 2.2 S.D. (median = 1) (Fig 3). Moreover, to account for

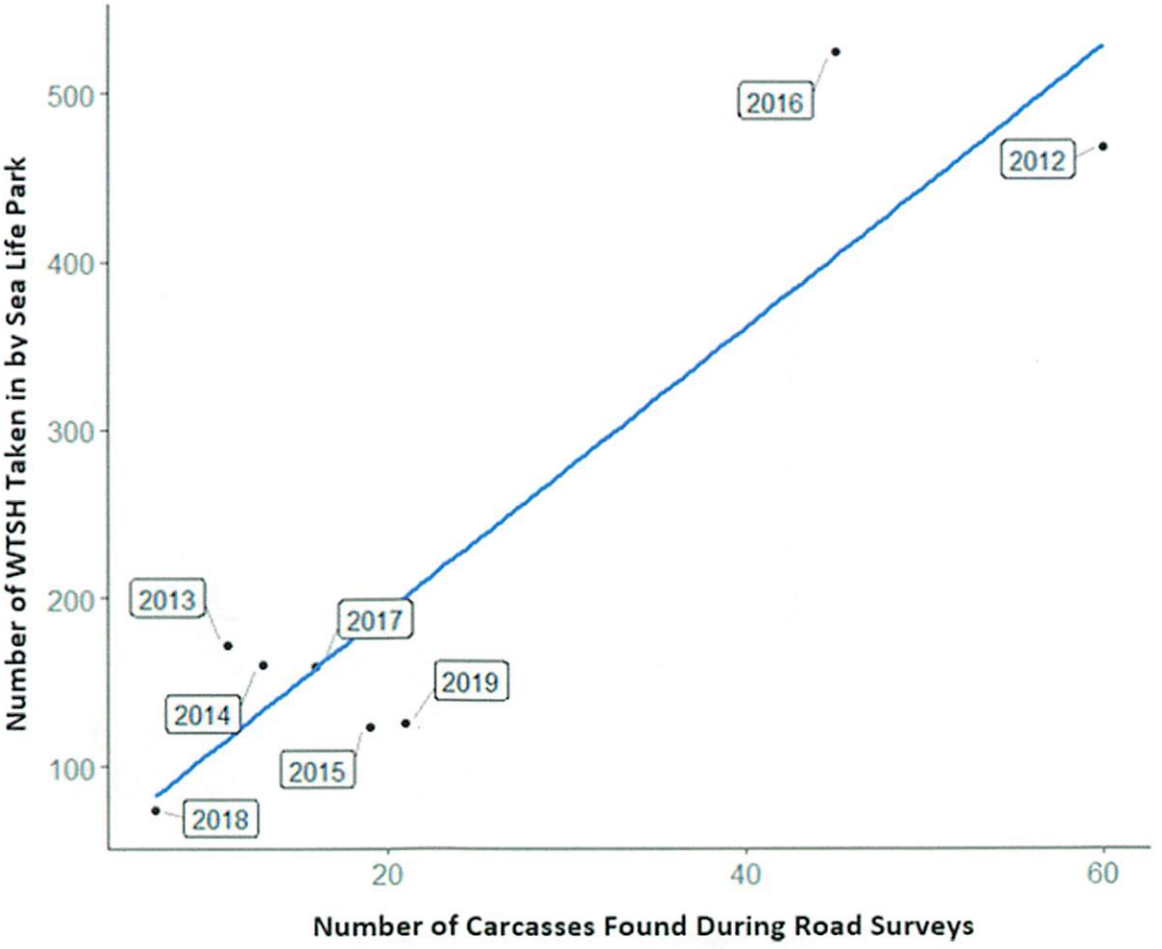

Fig 2. Fallout comparison between Sea Life Park intake records and road surveys. Scatterplot showing the total rescued WTSH per year from Sea Life Park intake records versus the total WTSH carcasses documented per year during road surveys ($r^2 = 0.85$).

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the large proportion (46%) of absences (0 WTSH detected during a road survey), we fitted the fallout count data to Poisson (1< VMR < 2) and negative binomial (VMR > 2) distributions. We developed and fitted a full model and eight single-year models.

Multi-year model of WTSH fallout. Because 9 different model formulations were required to achieve an AICc weight of 0.90, this model set was used to ascertain the importance of the driver variables. Of the 9 variables tested, only the interaction between moon illumination and wind speed (moon*wind speed) achieved a scaled average weight >1 and was thus deemed an "important" variable (S2 Table). Moon, wind speed, and year all had weights of 1, because they contributed an average amount to each model's weight. Date, wind direction, (moon*date), and (wind speed*date) had weights < 1, and contributed less than the average variable to each model's weight. Light regime had a weight of 0, and did not appear in any of the models required to achieve the AICc weight of 0.90.

The overall best-fitting model had a weight of 0.37 and included four explanatory variables: moon, wind speed, year, and the interaction of moon and wind speed (moon*wind speed) (Table 1). All variables in this model were significant, except wind speed and year 2016 (not significantly different from 2012). The negative coefficient for the moon variable in this model (-2.9) indicates that, across the 8-year period, fewer birds were grounded when a greater percentage of the lunar disk was illuminated. All years except for 2016 were significantly different

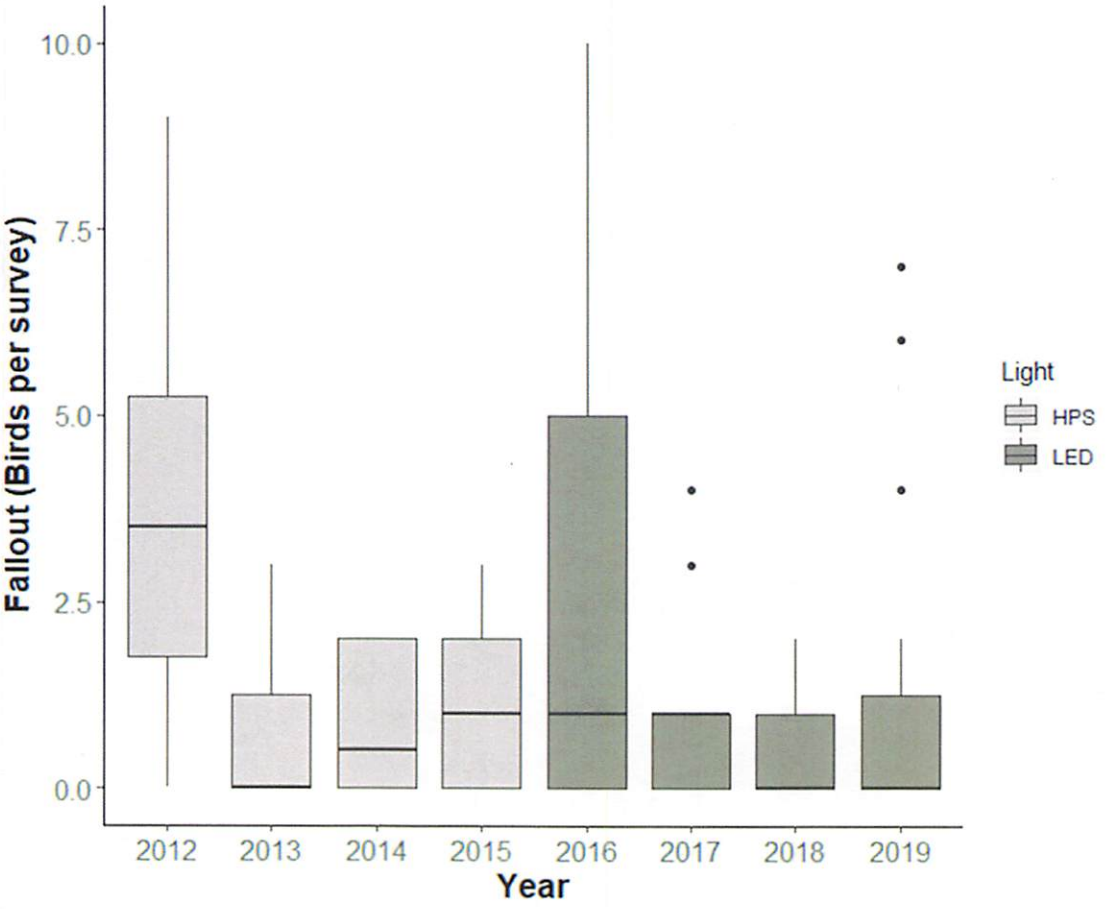

Fig 3. Boxplots of WTSH carcasses observed during road surveys. Distribution (5, 25, 50, 75, 95 percentiles) of the number of grounded WTSH observed each study year (n = 16 yearly surveys). Dots indicate outliers.

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Table 1. Full model output.

Explanatory variable	Estimate	S.E.	Z-value	p-value
Intercept [a]	2.136	0.580	3.709	**<0.001**
Wind Speed	-0.027	0.046	-0.576	0.565
Moon	-2.884	0.827	-3.485	**<0.001**
Year2013	-1.711	0.447	-3.825	**<0.001**
Year2014	-1.685	0.406	-4.148	**<0.001**
Year2015	-1.490	0.365	-4.082	**<0.001**
Year2016	-0.373	0.324	-1.148	0.251
Year2017	-1.661	0.391	-4.247	**<0.001**
Year2018	-2.492	0.483	-5.153	**<0.001**
Year2019	-1.034	0.366	-2.824	**0.005**
Wind Speed*Moon	0.225	0.083	2.710	**0.007**

GLM results from best-fit full model, following a negative binomial distribution. Bold font denotes significance at alpha < 0.05.

[a] Reference year (intercept) is 2012.

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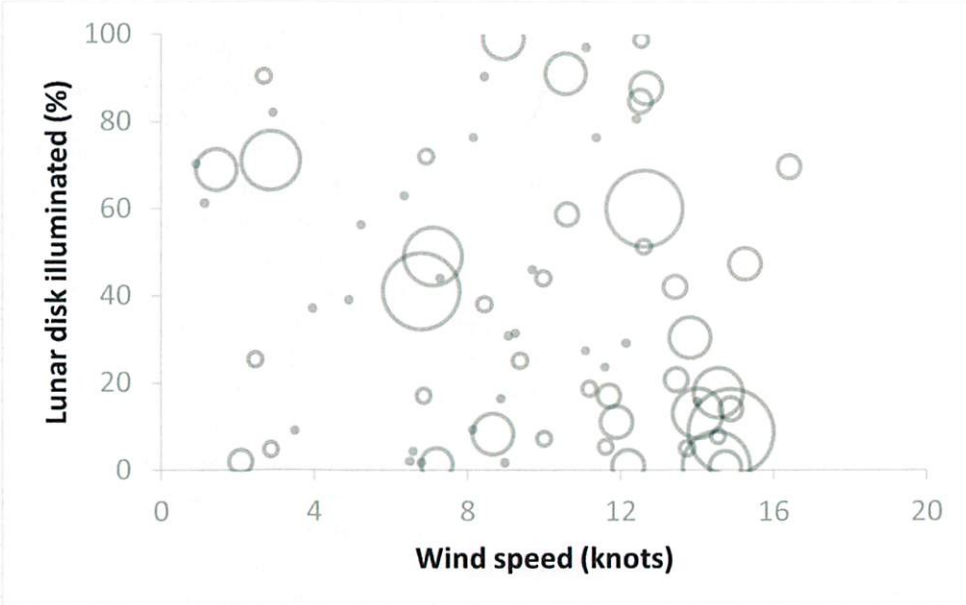

Fig 4. Fallout as a function of moon illumination and wind speed. Scatterplot of the number of grounded WTSH observed per survey, in relation to wind speed, and moon illumination. Open circles indicate the presence of fallout, with the increasing radius ranging from 1 to 10. Small solid dots indicate the absence of fallout (0 birds).

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from the reference year (2012). The interaction between wind speed and moon had a positive coefficient (+0.23) suggesting that fallout was higher during periods of lower lunar illumination and higher wind speed (Fig 4).

Yearly models of WTSH fallout. In addition to the interannual variability in the number of WTSH observed during road surveys (Fig 3), the temporal aggregation of fallout across surveys was also highly variable, as evidenced by the varying dispersion (variance to mean ratio, VMR) observed yearly (1.02–4.03) (Table 2)). Moreover, due to the large proportion (46%) of absences (0 WTSH detected during a road survey), fallout counts followed a Poisson distribution ($1 < VMR < 2$) in every year, except for 2019 (VMR = 4.03), when the negative binomial model yielded a lower AICc value.

Table 2. Yearly model output.

Year	Dis.	VMR	Pseudo Adj. R^2	Estimate					p-value				
				Int.	WS	WD	Moon	Date	Int.	WS	WD	Moon	Date
2012	P	2.11	0.41	-29.293	-0.744	-0.032	-0.065	0.137	0.096	0.236	0.408	0.071	0.054
2013	P	1.50	0.51	-28.120	0.684	0.029	-4.944	0.065	0.146	**0.028**	**0.016**	**0.006**	0.211
2014	P	1.02	0.64	3.055	0.393	0.003	-1.659	-0.020	0.751	**0.045**	0.782	0.144	0.456
2015	P	1.14	0.33	-3.680	0.03	-0.001	1.993	0.008	0.575	0.818	0.902	**0.006**	0.720
2016	P	3.89	0.50	-0.169	0.268	0.002	0.439	-0.006	0.979	**0.034**	0.816	0.507	0.777
2017	P	1.20	0.18	8.690	0.099	-0.002	-0.854	-0.027	0.291	0.273	0.638	0.291	0.309
2018	P	1.20	0.57	-20.160	-0.190	-0.001	-1.592	0.064	0.183	0.546	0.959	0.261	0.178
2019	NB	4.03	0.26	42.940	-0.100	-0.022	-3.305	-0.115	0.056	0.543	0.196	**0.004**	0.055

GLM output of annual fallout models, based on 16 surveys (Nov. 6 –Dec. 21) and clumped data distributions (P = Poisson, NB = negative binomial), as evidenced by the variance to mean ratio (VMR). In addition to the intercept (Int.), four explanatory variables were considered: wind speed (WS), wind direction (WD), lunar illumination (Moon), and Julian Date (Date).

[a] The bold font denotes significance at alpha < 0.05. and the pseudo adjusted R-squared quantifies the model fit.

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Overall, the yearly models explained a wide range of the variation in fallout throughout the fledging season, with their pseudo R^2 values ranging from 18% (2017) to 64% (2014). Moreover, different variables were significant in different years (Table 2). Surprisingly, the influence of moon illumination was not consistent across our study, with a significant effect in three years: it was negative twice (2013 and 2019), and it was positive once (2015). Wind speed had a significant positive effect in three years (2013, 2014, and 2016), whereby higher wind speeds led to more fallout. Wind direction had a significant positive effect once (2013), whereby wind blowing from the southwest led to more fallout. Julian date was never significant, suggesting that fallout was variable throughout the survey period (November 6 –December 21).

Overall, while fallout was explained well (pseudo $R^2 \geq 0.5$) by wind speed alone in 2014 and 2016, it was explained moderately well (pseudo $R^2 \geq 0.3$) by moon illumination alone in 2015 and 2019. In 2013, about half of the fallout variation was explained by a combination of wind speed, wind direction, and moon illumination. In three years (2012, 2017, and 2018), fallout was not significantly explained by any of the predictors.

Two years (2012 and 2016) showed significantly higher fallout compared to the other study years (Fig 3) and together accounted for 55% of the WTSH found during road surveys. Those same years were also responsible for 55% of all rescued birds brought to SLP, within the timeframe of this study. While none of the predictor variables were statistically significant in 2012, moon and date were marginally significant ($0.10 < p < 0.05$) (Table 2). The highest yearly fallout occurred in 2012, when 60 WTSH were grounded during an early new moon period (Julian days: 317–326, November 12–21), and a later one (Julian days: 344–353, December 11–18) (Fig 5), both of which were accompanied by strong winds (Fig 6). In 2016, a new moon period occurred in the middle of the fledging season, leading to a single peak in fallout (Fig 5), which coincided with a period of high wind speeds (> 12 knots), increasing the number of birds grounding at this time (Fig 6).

Discussion

Timing and magnitude of WTSH fallout

The strong positive correlation between the yearly numbers of grounded WTSH found during our road surveys and rescued WTSH brought to SLP suggests that our small-scale surveys of a fallout hotspot are indicative of island-wide fallout trends on O'ahu. Both the rescue records and the road surveys documented the highest fallout in 2012 and 2016, and the lowest fallout in 2018. Moreover, only 2.3% of the WTSH brought to Sea Life Park during the fledging season between 2012–2019 fell outside of our study period (November 6 –December 21), suggesting that our survey window captures most of the fledging season fallout.

Interpretation of model results

Multi-year model of WTSH fallout. Our hypothesis that the LED streetlights would increase shearwater groundings due to higher sensitivity to shorter wavelengths was not supported, as the light regime was not selected as a significant predictor variable in any of the top models. It is possible that shearwater visual perception of LED lights was in fact greater, but shielding reduced initial attraction, thus balancing out overall fallout. However, even if this were the case, our analysis could not distinguish between these two factors, because the changes in bulb type and shielding were not independent. Nonetheless, this finding has useful implications for resource managers since LED lights are a common replacement for HPS lights in Hawai'i and elsewhere. While we encourage managers to seek lighting adjustments that will mitigate fallout, our study shows that the change in streetlights from unshielded HPS to shielded 3000 K– 4000 K LED did not exacerbate this problem for WTSH on O'ahu.

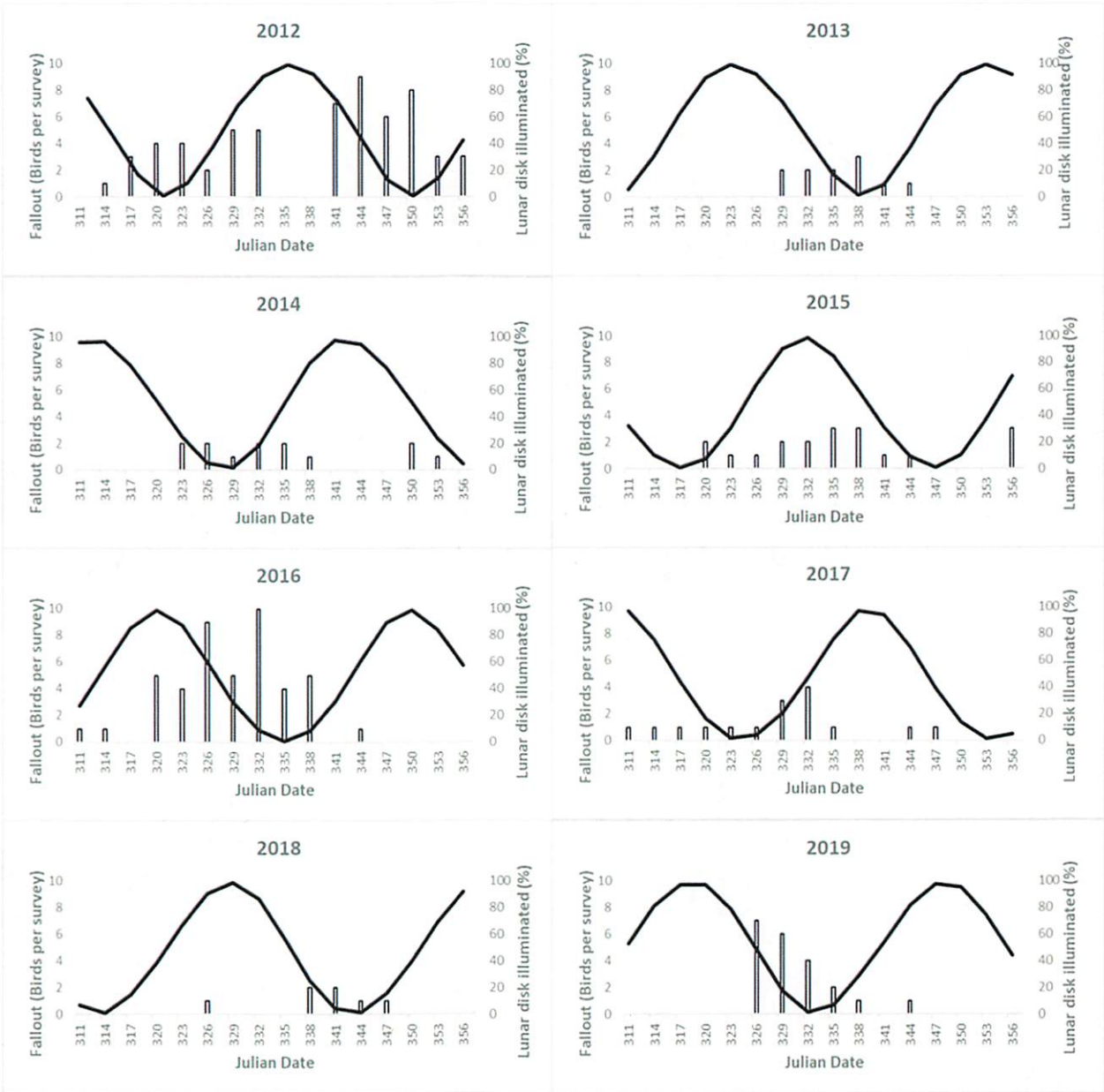

Fig 5. Moon illumination and fallout. Time series of the number of grounded WTSH observed per survey (bars) and nightly lunar illumination (back line). The dates on the x-axis indicate the survey days.

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It is possible that, even if there was an effect of light type on WTSH fallout, its influence was marginal compared to the effect of the other environmental drivers. In particular, the higher than average variable weight of the interaction between moon and wind speed suggests that fallout is a dynamic process, driven by the synergy of low moon illumination and strong winds, more so than by moon or wind alone (Fig 4, S2 Table). While previous studies have identified the importance of moon and wind, this is the first time their interaction has been considered.

This significant interaction underscores a conceptual model, whereby wind speed determines the magnitude of fledging birds departing their colonies, and the moon illumination

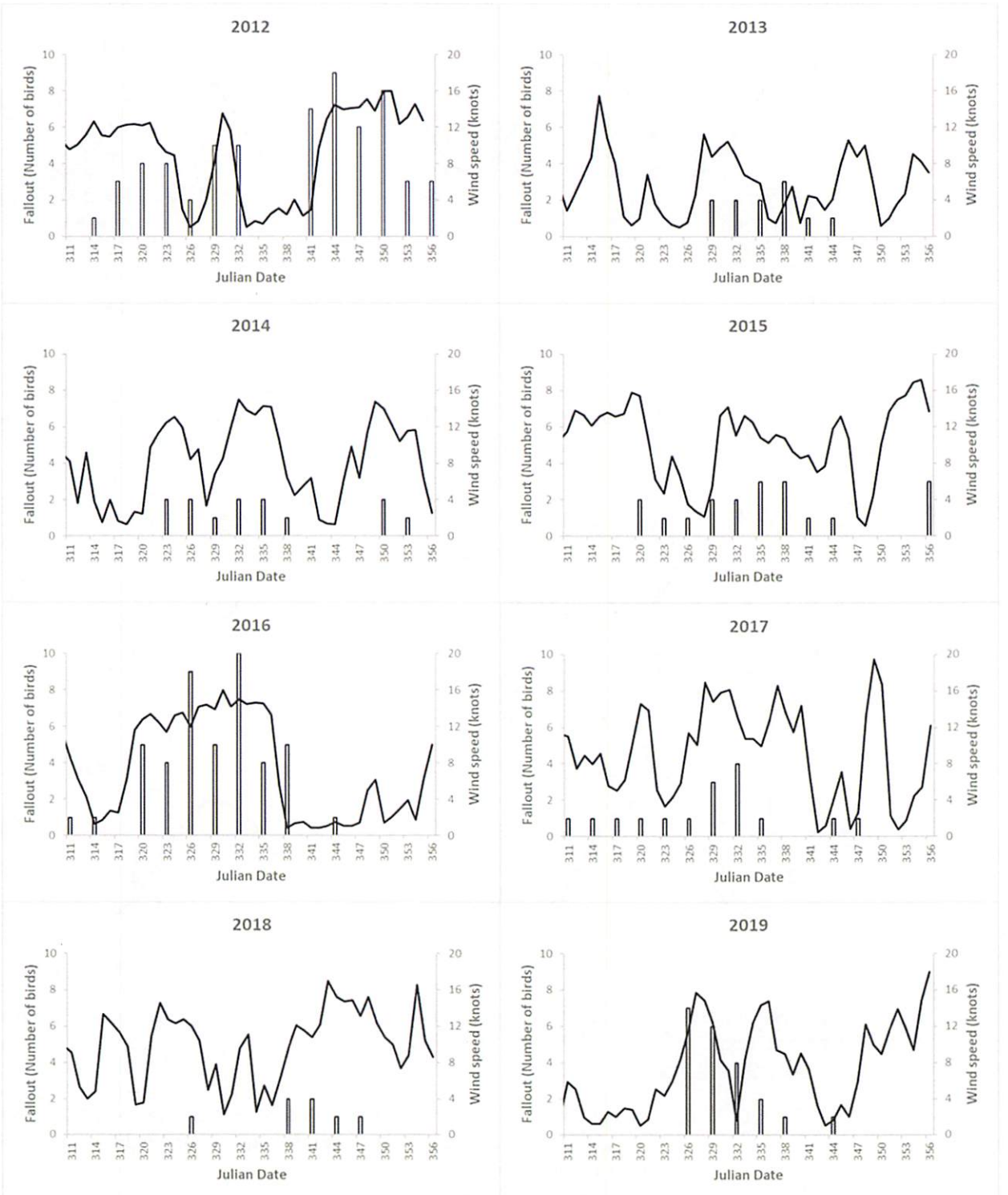

Fig 6. Wind speed and fallout. Time series of the number of grounded WTSH observed per survey (bars) and nightly wind speed (back line). The dates on the x-axis indicate the survey days.

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determines the attraction of those fledglings toward onshore lighting. This conceptual model can explain why years like 2016, when the peak of the fledging season coincided with a new moon and high wind speeds, have greater fallout.

While the interaction of the lunar illumination and the wind speed was critical, the timing of these variables, captured using their interactions with date, were less important. Together, these results suggest that, within the time frame of our study, fallout is most dependent on the temporal overlap of low moon illumination and high winds, rather than on their specific timing.

Yearly models of WTSH fallout. The influence of the four predictor variables (wind speed, wind direction, moon, and Julian date) were not consistent across all 8 study years. While most previous studies have found strong negative relationships between moon illumination and fallout, our yearly models only documented this pattern in 2 years [4, 8, 10, 11, 33]. One possible explanation for this result could be a mismatch between moonrise / moonset times and WTSH fledging. We used an average lunar disk illumination for the three nights prior to each survey, assuming that this would be representative of visible moonlight while WTSH were fledging. However, if most birds fledge shortly after sunset, before the moon rises during waning moon phases, conditions will resemble a new moon [16, 34]. Similarly, if island topography or clouds obscure a rising moon from a given natal colony, the navigational benefits provided by the lunar disk could be compromised until the moon rises over obscuring landscape features. The peak fledging times of WTSH are unknown but could be useful to improve our understanding of the influence of moonrise / moonset times on fallout. Furthermore, the lack of strong lunar trends in the yearly models could be due to small sample sizes, with each year only involving 16 surveys.

Contrary to Rodríguez et al. (2014), who documented a significant increase in fallout as the fledging season progressed, our yearly models did not find a date effect. However, the likelihood of finding an effect of date depends partly on the timing and the duration of the study period. While opportunistic studies using intake records and citizen-science programs sample a wider temporal window, spanning before and after the fledging season, our surveys spanned a narrow temporal window during the WTSH fledging season. Thus, our results suggest that, due to interannual variability in the timing and magnitude of fallout, on average it is distributed evenly throughout our study period (November 6 –December 21). Fledging primarily occurs during this 6-week period, and is likely modulated by a variety of factors, including breeding phenology, chick development, and environmental conditions [10, 33, 35].

The positive relationship between wind speed and fallout is likely related to the fledglings using this environmental cue for fledging and relying on wind to take flight. One possible explanation for why we observed more fallout with higher windspeeds is that intermediate to strong windspeed enable WTSH to take flight, however a lack of flight experience and muscle development may make it difficult for fledgling birds to navigate in strong winds, thus leading to more fallout under higher wind speeds [36, 37].

Although the model results suggest that wind speed is more important than wind direction, an exception to this general pattern was observed in 2013, when peak fallout coincided with a period of moderate to weak southerly winds (S1 Fig). A previous study on O'ahu suggested that winds from the southeast were more common during a year of very high fallout and hypothesized that birds were advected to the northwest and deposited along the entire windward coast of the island [22]. The lack of significance of wind direction in years other than 2013 may be related to the prevailing wind patterns on windward O'ahu, which rarely switch from the northeast direction, thus limiting the comparison of different wind directions. Furthermore, because south-westerly winds during the study are characterized by lower speeds, any potential influence of direction is not independent from the wind speed effect discussed previously (S2 Fig).

Previous studies show an increase in fallout when prevailing winds are directed toward brightly lit coastal areas [10, 11]. Yet, the influence of wind direction is difficult to interpret since headings are circular (0–360 degrees) and should be carefully considered on a case-by-case basis. Because the prevailing winds in our study area are the northeasterly trade winds or southern (Kona) storms, these bi-directional wind headings facilitated the analysis and simplified the interpretation. With the exception of 2013, peak fallout occurred during trade winds (Fig 6).

Although our study did not show a significant effect of Julian date on fallout, previous road surveys from O'ahu spanning ten years (2002 to 2010), revealed that November 25 was the peak fallout date, with 67% of the grounded WTSH found during a one-week period (21–27 November) [21]. We hypothesize that the timing of the moon phase, in relation to this peak fallout period could explain the interannual relationship of moon illumination and fallout. Namely, higher fallout occurs in years when the new moon overlaps the peak fallout week (21–27 November).

In 2015, the full moon occurred on November 28, whereas in 2013 and 2019 the moon phase was closer to a new moon on that date. It appears that when peak fallout coincides with a new moon, a single fallout peak occurs, thus causing a negative correlation with moon illumination. However, if peak fallout coincides with a full moon, the unimodal pattern breaks down, resulting in two smaller fallout peaks. Previous work yielded a quadratic relationship between the timing of the full moon and the number of Newell's shearwater (*Puffinus newelli*) fallout, with fewer total groundings when the full moon occurred during the middle of the month [5]. When we replicated this analysis for WTSH, the quadratic model was not significant ($R^2 = 0.038$, $F_{2,5} = 1.140$, $p = 0.39$), suggesting that annual fallout did not follow the same pattern with the timing of the full moon. Although, other variables such as the timing of moon rise, cloud cover, and topography blocking the moon were not taken into account and may play a role in the moon's influence on fallout. Demographic factors, involving the size of the breeding population and the reproductive success likely influence the yearly supply of fledging chicks [5].

Implications for fallout mitigation

Our results are reassuring because they suggest that the shielded LED streetlights did not increase WTSH mortality due to fallout, as we hypothesized. Given the strong correlation between the dead birds observed in our road surveys and the live birds brought to SLP, there is no evidence suggesting that the shielded LED streetlights impacted the number of birds affected by fallout overall. However, because these new lights did not reduce fallout, wildlife managers may consider modifications such as dimming, wavelength alteration or motion sensors, to mitigate negative impacts to fledging WTSH on O'ahu [6, 19].

A recent survey of lighting experts suggests that while LEDs can be adjusted to reduce light pollution and minimize wildlife impacts, yet municipalities rarely capitalize on those benefits [19]. For instance, although new-technology LED streetlights can filter out lower wavelengths [17], full spectrum white LED lights maximize brightness, and are commonly chosen to replace HPS streetlights. Furthermore, LEDs come in a variety of CCTs with options as low as 2200 K, the maximum temperature experts recommend for wildlife [17]. However, municipalities commonly implement 3000–5000 K LED streetlights because of their efficiency for human use [19]. Future studies should compare different LED lighting options in areas where seabird fallout occurs to determine the characteristics that best mitigate negative impacts to seabirds and other wildlife.

While it may be unfeasible to reduce light pollution wherever fallout occurs, areas near breeding colonies could be targeted for localized management [21]. In addition to diminishing

light pollution during the fledging season, we also encourage community-based rescue efforts for WTSH to target fallout hotspots on O'ahu on nights with low moon illumination and strong winds. Further documentation of fallout hotspots could help guide lighting management and rescue efforts throughout the Hawaiian Islands.

Finally, predictive fallout models are limited by the lack of comprehensive annual population estimates, which might have explained some of the interannual variation in the number of grounded birds. Thus, annual WTSH breeding population sizes and reproductive success would likely improve our understanding of fallout interannual variability and trends in Hawai'i. The findings and conclusions in this article are those of the authors and do not necessarily represent the official views of the U.S. Fish and Wildlife Service.

Supporting information

S1 Table. Annual data from sea life park and road surveys. Comparison of annual WTSH fallout magnitude (total number of grounded birds) and timing (date ranges) from Sea Life Park intake records and road surveys (this study). Summary statistics (mean, median, and range) refer to the number of grounded birds encountered yearly, based on 16 standardized surveys spanning November 6 to December 21.
(TIF)

S2 Table. Variable importance in AICc analysis. Scaled average variable weights. (>1 values indicate greater than average weight when variable was included in model; weights = 1 are average, weights <1 less than average).
(TIF)

S1 Fig. Wind direction and fallout in 2013. Wind direction and fallout during the 2013 fledging season. Black line is wind direction and white bars are number of birds per survey.
(TIF)

S2 Fig. Wind speed and wind direction. Scatterplot of wind speed and wind direction during the fledging seasons 2012–2019 ($R^2 = 0.71$).
(TIF)

S1 File. WTSH fallout data from road surveys. Data from road surveys (total = 128) including variables year, Julian date, moon illumination (%), wind speed (knots), wind direction (degrees), light regime (HPS = high pressure sodium, LED = light emitting diode), and number of grounded WTSH observed.
(XLSX)

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Writing – original draft: Jennifer Urmston.

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MAUI OCEAN CENTER

Our Mission: To foster understanding, wonder and respect for Hawaii's marine life.

06/29/22

TESTIMONY OPPOSING MAUI COUNTY CORPORATION COUNCEL VERSION OF BILL 21 SEABIRD AND BIODIVERSITY PROTECTION (CARE 74)

Dear Honorable Chair and Committee Members,

I strongly support Bill 21, CD 1.

I am a Board member at Ma'alaea Triangle Association (MTA) which represents all the commercial business in the Ma'alaea Triangle commercial area. We have a parking lot that contains 756 parking stalls and 27 light poles most being 30' high. These light poles were installed about 25 years ago when the commercial area was developed and are end of life with outdated lighting technology that is not energy efficient and not very seabird friendly. We are in the final stages of contract negotiations with a lighting manufacturer that is able to deliver to our specifications; < 2% blue light content, < 3,000K, and shielded light fixtures. This technology meeting the above specifications is readily available. They are completely PV + battery operated. Our new lights will be 18' tall. We expect to be able to execute this project by the end of 2022.

I wanted to share this project with Maui County Council considering this issue as here we have a private organization that recognizes the importance of this issue and is making the decision on its own to lead with a solution that is not only seabird and sea turtle friendly but also most energy efficient and it is happening now. And the UH astronomy will also appreciate more clarity in the night skies. I urge the Maui County Council to continue to be forward looking and be the agents for positive change in and for our Community. Thank you for your time and consideration.

Aloha,

Tapani Vuori
c.808.561.2022
tvuori@mauioceancenter.com

County Clerk

From: Pamela Polland <mele@pamelapolland.com>
Sent: Wednesday, June 29, 2022 9:28 AM
To: County Clerk
Subject: In Support of The Maui Community Water Authority

Please support the creation of the Maui Community Water Authority.
I'm unable to come to the live meeting, but please count my "vote"
in favor of this much needed idea.

Mahalo,
Pamela Polland
226 Kulalani Drive, Kula HI 96790

County Clerk

From: steve g <steveg0606@gmail.com>
Sent: Wednesday, June 29, 2022 9:36 AM
To: County Clerk
Subject: East Maui and Upcountry water

You don't often get email from steveg0606@gmail.com. Learn why this is important

Hello,
I would like to add my voice to the many who support establishing a county-wide community water authority. For too long large corporations, such as Mahi Pono, have had too much sway in distribution and use of our water resources. Too much water that could be used by upcountry farmers and residents is being diverted or dumped to suit the needs of a corporate few.
I implore you to help create the Maui County Community Water Authority.
Sincerely,
Steve Grimes

County Clerk

From: Akari Ueoka <akariueoka2@gmail.com>
Sent: Wednesday, June 29, 2022 9:48 AM
To: County Clerk
Subject: Maui County Community Water Authority

You don't often get email from akariueoka2@gmail.com. Learn why this is important

Please support the creation of the Maui Community Water Authority.
Akari Ueoka
Zipcode: 96708

County Clerk

From: Beth Hird <bethpaints@gmail.com>
Sent: Wednesday, June 29, 2022 9:50 AM
To: County Clerk
Subject: Creation of the Maui Water Authority

Please support the creation of the Maui Community Water Authority!

Elizabeth Hird
14 Kupalaiki Loop
Kihei, HI 96753

County Clerk

From: Toni Lawson <tonialawson.esq@gmail.com>
Sent: Wednesday, June 29, 2022 10:03 AM
To: County Clerk
Subject: Maui county water authority

[You don't often get email from tonialawson.esq@gmail.com. Learn why this is important at https://aka.ms/LearnAboutSenderIdentification]

I am a resident of maui county and am kanaka maoli. For whatever reason the water in Maui has been terribly mismanaged and priority has been given to outsiders and not the indigenous people. Additionally and shamefully consideration of sustainable use of the water is not taken into account.

I support having a maui county water authority to help correct the water situation. Water is life. Our water is not unlimited unless you have a way we can drink ocean water that is also being contaminated by greedy ignorant people.

Sent from my iPhone

County Clerk

From: Barry Sultanoff <essential@hawaii.rr.com>
Sent: Wednesday, June 29, 2022 10:49 AM
To: County Clerk
Subject: I support creation of MCWA

Please support the creation of the Maui Community Water Authority

Barry Sultanoff
2401 Umi Place
Haiku HI. 96708

From: Tara Grace <taragrace808@gmail.com>
Sent: Wednesday, June 29, 2022 11:38 AM
To: County Clerk
Subject: Upcountry Water

Please support the creation of the Maui Community Water Authority
Mahalo
Tara Grace
808.870.1006

From: John Naylor <johnnaylor@kula.us>
Sent: Wednesday, June 29, 2022 11:52 AM
To: County Clerk
Subject: Maui County

Aloha,

I am writing in full SUPPORT of a Maui County Water Authority.

Nuff said,

John Naylor Makawao

County Clerk

From: Sarah Hofstadter <skhof@comcast.net>
Sent: Wednesday, June 29, 2022 12:46 PM
To: County Clerk
Subject: Resolution 22-119, 7/1/22 Agenda Items CC22-151 and CR22-56

Aloha. I am writing to express my support for creating a county-wide Community Water Authority, as proposed by Council Member Sinenci, or at a minimum, an East Maui Community Water Authority, as originally proposed by the GREAT Committee.

Fresh water is a critical necessity for human life, for agriculture, and for our islands' ecosystems. It is considered a public trust under Hawai'i law. It should be managed by the community for the benefit of everyone, not by a private entity for profit. Our existing privately held water capture, storage, and distribution systems are vestiges of the colonial plantation era.

It is well past time to establish public ownership and control of this finite, infinitely valuable resource, so that our limited water supply can be shared equitably in the public interest, and our infrastructure can be upgraded to better handle the droughts and floods that are likely to increase in frequency and severity as climate change intensifies.

I urge the Council to allow Maui's voters to establish a county-wide Community Water Authority, or, at a minimum, an East Maui Community Water Authority that can act to prevent the East Maui water system from remaining in private hands for the foreseeable future.

Respectfully,
Sarah K. Hofstadter
Kihei resident

County Clerk

From: Boisvert-Jorgensen <infofordenise@yahoo.com>
Sent: Wednesday, June 29, 2022 1:29 PM
To: County Clerk
Subject: Charter Amendment testimony

I fully SUPPORT the charter amendment because now is the time to finally be on the right side of history when it comes to water management in Maui County.

The establishment of a Maui County Community Water Authority, administered by members of the community, is critical to independence from the self-serving, water-hogging, corporate powers that have essentially controlled the island's water and daily life for almost 200 years.

The time has come for the residents of Maui to make their own decisions that will protect and benefit their island's farmers, the ability to fish, the safety of the environment, and ultimately the community.

Mahalo for your understanding and kind consideration.
Denise Boisvert
Honlulu

County Clerk

From: Mary L Keller <islandharpist@comcast.net>
Sent: Wednesday, June 29, 2022 1:37 PM
To: County Clerk
Subject: Please support the Maui Community Water Authority

I believe it's vitally important to support the creation of the Maui Community Water Authority. I am a resident of Paia and follow the water issues closely.
Thank you!

Mary Keller
41 Meha Place
Paia, HI 96779

County Clerk

From: Waikiki - Hawaii Condo <hawaiicondo@yahoo.com>
Sent: Wednesday, June 29, 2022 1:50 PM
To: County Clerk
Subject: Testimony in Support of a Maui County Community Water Authority

Aloha. As someone who lives on O'ahu where the island's primary sole-source aquifer has been at the mercy and under control by an omnipotent and deceitful entity for decades, I am writing from personal understanding of how important it is for residents to have control of the most valuable resource.

The creation of the Maui County Community Water Authority is the fairest way for decisions to be made about the county's water. **Please approve this charter amendment**.

Kim Jorgensen
Waikiki

County Clerk

From: Alicia Rittenberry <arittenberry888@gmail.com>
Sent: Wednesday, June 29, 2022 2:14 PM
To: County Clerk
Subject: Resolution 22-119, FD1

Aloha and mahalo for allowing me to voice my approval of the resolution to create a Maui County Community Water Authority to manage East Maui stream waters in order to protect and equitably distribute our most precious resource.

--
Alicia Wood
(808) 298-9337

County Clerk

From: Suzette Marlowe <suzettemarlowe@gmail.com>
Sent: Wednesday, June 29, 2022 2:15 PM
To: County Clerk
Subject: Maui Community Water Authority

Please support the creation of the Maui Community Water Authority

Sincerely,
Suzette Marlowe
P.O. Box 593
Kula, HI 96790
suzettemarlowe@gmail.com

DAVID Y. IGE
GOVERNOR
STATE OF HAWAI'I

TYLER T. GOMES
DEPUTY TO THE CHAIRMAN

JOSH GREEN
LT. GOVERNOR
STATE OF HAWAI'I

STATE OF HAWAI'I
DEPARTMENT OF HAWAIIAN HOME LANDS
P. O. BOX 1879
HONOLULU, HAWAI'I 96805

TESTIMONY OF WILLIAM J. AILA, JR, CHAIRMAN
HAWAIIAN HOMES COMMISSION
BEFORE THE MAUI COUNTY COUNCIL
MEETING ON JULY 1, 2022 AT 9:00 AM

RESOLUTION NO. 22-119 (2022)

Aloha Chair Lee, Vice Chair Rawlins-Fernandez, and Members of the County Council:

The Department of Hawaiian Home Lands (DHHL) submits the following comments on this proposed resolution that would place on the next General Election ballot a proposed amendment to the County Charter to establish water authority with regional community boards.

DHHL has been actively following the development of this and related proposals. We recognize both that concerns over the financial and operational implications of this proposal have been raised, and also that the measure currently only proposes for enactment, rather than obligates, County acquisition and operation of non-potable water systems.

We support and are grateful for the inclusion of the language in the proposed measures which specify that:

- "WHEREAS, as a government agency, the Maui County Community Water Authority would have an unambiguous obligation to uphold the public trust doctrine and the legal obligations of the Hawaiian Homes Commission Act and the State of Hawai'i Constitution"; and
- A member of any established boards would include "...one member who is a representative of the Hawaiian Homes Commission, and is nominated by the Department of Hawaiian Home Lands."

The availability of water is one of the key barriers DHHL faces in the development and delivery of homesteads across Hawai`i. This proposal could meaningfully help DHHL and the County implement the Hawaiian Homes Commission Act, a Constitutional mandate and a condition of statehood.

Thank you for your consideration of our testimony.

County Clerk

From: marla mervis <marlamervis@me.com>
Sent: Wednesday, June 29, 2022 2:58 PM
To: County Clerk
Subject: Water

To whom it may concern,

"Please support the creation of the Maui Community Water Authority",

Thank you!
Marla mervis-Hartmann

1007 Calasa Drive
Kula, HI 96790

www.LoveYourBodyLoveYourself.com

From: Ane Takaha <bhaktirocks@earthlink.net>
Sent: Wednesday, June 29, 2022 3:47 PM
To: County Clerk
Subject: Water

Please support the creation of the Maui Community Water Authority Thank you Ane Takaha Maui Meadows

Sent from my iPad

County Clerk

From: Lucrezia Oddie <lucreziacreation@gmail.com>
Sent: Wednesday, June 29, 2022 4:37 PM
To: County Clerk
Subject: Support the Maui County Community Water Authority

Hello. I am in favor of this resolution.
Being a 38 year resident of Maui I have seen years of mismanagement resulting in copious waste of fresh water and diversions operated without consideration of residents' and farmers' uses, as well as wildlife habitat. I would appreciate your attention to this very important matter of ensuring equitable water distribution.

Aloha.
Sincerely,
Lucrezia Oddie
Kuiaha stream riparian resident
700 East Kuiaha Road
Haiku, HI.
96708
808-495-0104 (landline)

Aloha,

My name is Carter Rosenthal, a 17-year-old upcoming senior at Seabury Hall High School. I spent much time living on Maui's north shore before moving upcountry. In those years, I do not recall seeing a single seabird, despite living minutes from the ocean. That was until I recently visited the burrows at Ho'okipa, paying special attention to the birds that lived there. I had heard that millions of seabirds had once thrived where I stood, yet simply seeing two or three was shocking to me. It is clear that seabirds are in danger due to Maui's light pollution, but with their danger comes ours as well. It is for this reason that I write in favor of Bill 21.

When I was a freshman, I learned about the concept of "trophic cascades" in my biology class. I was drawn to the concept and found it remarkable that the extinction of a keystone species could immeasurably impact its surrounding ecosystem. Little did I know that Maui was undergoing a trophic cascade of its own.

As global warming becomes more severe, so do rising sea levels and storms. Without seabirds, our reefs will be unable to receive nutrients, dying and being unable to protect Maui from these threats. Without seabirds, my old north shore yard will erode into the ocean, taking my house with it. Without seabirds, the fish that sustain many people will lose their habitats.

It is our kuleana to repair the damage that has already been done. To think that we could cause irreparable damage to our local communities if we do not take the somewhat simple action of changing light bulbs is painful. We have already taken tremendous steps towards restoring our reefs by banning chemical sunscreens. Now it is time that we take similar steps through passing Bill 21's blue light limitations. Bill 21 is not a bill exclusively supporting seabirds, rather, it is a bill that supports seabirds, reefs, fish, the aina, people, and countless others.

Mahalo,
Carter Rosenthal

County Clerk

From: Alexa Hatton <alexahatton33@gmail.com>
Sent: Wednesday, June 29, 2022 5:11 PM
To: County Clerk
Subject: Support for Maui community water authority

Please support the creation of the Maui Community Water Authority.

Mahalo, Alexa Hatton
1670 Olinda Rd
Makawao, HI

Sent from my iPhone

County Clerk

From: mmmmahalo2000@aol.com
Sent: Wednesday, June 29, 2022 7:08 PM
To: County Clerk
Subject: KCA testimony for 7/1/22 on Item 22-57 for Reso 22-144 CD1
Attachments: pslu.committee Tesimony 1-8-2020 (PSLU-34)(PSLU-44)(RSLU-43) (4).pdf

Aloha Chair Lee and Council.

Mike Moran for the Kihei Community Assoc (KCA) in support of 22-57

As we have testified previously we have long supported a planning commission for our district, so we are seeking support to get this charter on the 2022 ballot. In prior meetings, there was some discussions about district advisory committees to the MPC. We offer this attached doc which was testimony to the PSLU committee over two years ago on such proposed advisory committees which addresses district planning commissions as preferable. John Blummer- Buell explains while he supported the committees being proposed at that time, he addresses the short comings of them & the preference for district planning commissions. He opinion is based on his experiences as a three term Hana Advisory Committee as you see in this doc.
At this same time John contacted me explaining his position & suggested our org pursue the commission in place of the committee. I replied that while we agreed with him, we were going for the committee as a step toward a future commission.

Now 2 1/2 years later we finally have been advised the first meeting of the SMAC is being scheduled for this month, while we have this matter for a area planning commission potentially on this years ballot. So our expectation this is the process we hoped to achieve. We can have this advisory committee in place in S Maui now as we prepare to have our own planning commission soon.
While it is not the same we have experienced our community organization's input to MPC on matters in our district rejected by the MPC not based on laws nor regulations, but because of lack of understanding of proposed matters and their location in South Maui by this commission.

In conclusion we ask your support to get his matter on the ballot so the voters can decide

Mahalo

Mike Moran

JOHN BLUMER-BUELL
Post Office Box 787, Hana, Hawai'i 96713
Email blubu@hawaii. rr.com

January 7, 2020 (Testimony for January 8)

Maui County Council Planning and Sustainable Land Use Committee,
Tamara Paltin, Chair
Sent Via Email to pslu.committee@mauicounty.us with Request for Confirmation of Receipt

Public Testimony for January 8, 2020, Meeting Regarding Agenda Items PSLU-34, PSLU-44, and PSLU-43.

Aloha Chair Paltin and Committee Members,

I support the creation of the proposed Advisory Committees to the Maui Planning Commission. **However, INSTEAD, I suggest creating a Planning Commission for each community.** This will save time, taxpayer funds and be more accessible to the communities. Legal options and due process for participants will remain the same.

The Lanai and Molokai Planning Commissions demonstrate the practical application. **In contrast, the Hana Advisory Committee to the Maui Planning Commission demonstrates a wasteful duplication of time and expense. And, demonstrates how a good, legal decision in Hana can be totally corrupted by the Maui Planning Department and Planning Commission. The recent example of the proposed Nahiku Community Center demonstrates how the Hana Advisory Committee to the Planning Commission made a community supported legal decision only to be TOTALLY IGNORED by the Maui Planning Commission.** Several

commission members had never been to Nahiku and clearly did not comprehend the applications or situation.

IT IS WAY PAST TIME FOR A HANA PLANNING COMMISSION.

I make these recommendations having served three terms on the Hana Advisory Committee to the Maui Planning Commission. I was asked by Mayor Hannibal Tavares to serve on the initial committee.

The Hana Advisory Committee was initiated by Council Member Velma Santos during a very controversial land use case. Mahalo Velma!

Read the context in the July 30, 1987, Maui News story "Hana Apartment Plan Debated", page 2, last two paragraphs. Attached as Exhibit.

Mahalo for your careful consideration.

John (Blumer-Buell)

June 29, 2022

The Honorable Tamara Paltin
Chair, and Members, Maui County Planning & Sustainable Land Use Committee
RE: PSLU-3; PSLU-2; and PSLU-53 Relating to the South Maui Community Plan Update

Aloha Chair Paltin and Councilmembers,

Mahalo for the opportunity to review the Implementing Actions contained in the Countywide Policy Plan, Maui Island Plan and, specifically, the South Maui Community Plan. Ma`alaea Village Association (MVA) eagerly awaits the South Maui Community Plan update process and appreciates the chair's initiative.

MVA applauds this Council for realizing the importance of protecting and restoring Ma`alaea Bay – not only for Ma`alaea residents and visitors but for all of Maui. Your support for purchasing Ma`alaea Mauka with County Open Space funds, funding for Ma`alaea regional wastewater solutions in the SRF request, and funding coastal erosion research in Ma`alaea Bay begun last year all address important Implementation Actions in the Countywide Policy Plan, Maui Island Plan, and South Maui (K-M) Community Plan.

Maui Island Plan:
Heritage Resources/Scenic Resources is a major item in the MIP but most tasks have yet to begin. This is a major weakness. Maui's quality of life and future sustainability, including the 'right' kind of visitor who will respect and support Maui Nui, depend on protecting and preserving what makes Maui 'no ka oi'.

MIP priorities include the 'development of a master plan for the preservation and enhancement of the Ma`alaea Beach recreation area and Kealia Pond National Wildlife Refuge to include the possible mauka realignment of North Kihei Road.'

Ma`alaea was identified as one of the locations for a Transit Corridor due to its location at the crossroads to Lahaina and frequent road closures due to traffic accidents. Future solutions to highway traffic congestion must be found, including locating rental car facilities in resort areas rather than all at Kahului Airport.

Another priority under Agricultural lands deals with water reuse and recycled stormwater runoff. Ma`alaea wwtr solutions address this ongoing need to preserve Maui's precious water supply. Mahi Pono has pledged 10 acres for the Ma`alaea regional system. The water can be reused for numerous purposes.

South Maui Community Plan Update:
The 'planning and design of the Ma`alaea -Kealia bypass highway' is a major priority for connecting South Maui with West and Central Maui through Ma`alaea and alleviating some of the area's traffic issues. This item should be pursued by the Metropolitan Planning Organization. Mahi Pono may be a willing partner.

Sadly, major items in the 2012 Countywide Policy Plan relating to promoting "Sustainable Use and Growth Management" have not been implemented and Maui is suffering for it. I hope this and future Councils will strongly encourage the Planning Department to tackle this challenging but important task.

It's not too late. I hope that the South Maui Community Plan update process will pay attention to these key plans and find ways to manage Maui's future growth for the benefit of Maui citizens and visitors.

Mahalo for your time and leadership.

Lynn Britton

Lynn Britton
Immediate Past President and Government Affairs Chair, Ma`alaea Village Association

Ma'alaea Village Association
P. O. Box 2122, Wailuku, HI 96793
maalaeavillageassociation@gmail.com

County Clerk

From: aerie waters <aeriewaters@gmail.com>
Sent: Wednesday, June 29, 2022 9:18 PM
To: County Clerk
Subject: Maui County Community Water Authority

Water is a gift from the heavens, and as such, its fair distribution should be the decision of a broad based voice. Please approve this more pono way to protect water rights for all.
With aloha,
Aerie Waters

County Clerk

From: Ralph Hendrickson <write-maui@hawaii.rr.com>
Sent: Wednesday, June 29, 2022 10:46 PM
To: County Clerk
Subject: Maui Community Water Authority...

Please support the creation of the Maui Community Water Authority!

Ralph Hendrickson
P.O. Box 331
Kihei, HI 96753

Sent from my iPad

County Clerk

From: Tria Cabral <vibrantliving11@gmail.com>
Sent: Wednesday, June 29, 2022 11:18 PM
To: County Clerk
Subject: Water Authority

Aloha!

I am in Full Support of the Maui Community water Authority.

Maui county must do better to ensure the sustainability of our resources.

Private and or Corporate control should never be given
over our waters or any of our natural resources.

We NEED this Community water Authority Now!

Sincerely,

Tria Cabral
Haiku, 96708

County Clerk

From: Mauimanakai <dave@mauimanakai.com>
Sent: Thursday, June 30, 2022 6:47 AM
To: County Clerk
Subject: Right of Entry Keawakapu No 22-58

I own unit #215 at the Mana Kai and have for over 20 years. It is at the end and on the second floor.

I think I am the closest residential owner near the proposed parking lot.

Since the beach there is one of the best in the world, no matter how much additional parking is provided, it will never be enough.

Right now the Mana Kai Homeowners Association pays for the portable toilets at the entrance and for their cleaning. Sometimes the security from the Mana Kai deals with the lots. The new lot is even further away and will be more difficult to patrol.

Additionally, the Mana Kai pays for and maintains lawn care, tree care, shower, and trash containers including recycling and sweeps, and picks up litter even though this is state property.

However, if this is done, these are some additional issues that should be considered:

Water Erosion

Right now water runoff to the beach from upcountry flows through the existing gravel lots to the lawn area and out to the ocean along the path people take from the parking lots to the beach. When it rains a small lake forms. A water management program should be put into place to mitigate this.

Noise

The two lots for parking (Along the Mana Kai access road and the Ocean Front Inn lot) are currently gravel which creates a lot of noise to interrupt sleeping especially late a night or very early in the morning. I have been woken many times from car traffic and parties in those lots.

There should be noise mitigation measures undertaken, perhaps paving, perhaps time limits on using, perhaps increased Police patrols.

Foot Access

Right now the footpath from the lots to the beach is overstressed. The grass has been worn through due to traffic and at the exact beach access is but a sandy drop-off which is dangerous. This path and access should be improved prior to increased parking like other access points to this beach from public lots south of this location.

Rats

A few years ago when some of the same areas were cleared, the resident rats took up homes in the basement of the Mana Kai including my storage locker. Before any clearing occurs some kind of rat control should be implemented.

Immediate Need

Both restaurants at the Mana Kai and the Ocean Inn I understand are closed so parking pressure from it is currently missing.

Consideration

Since the addition of 50 more parking spaces say turning over three times a day and with an average of four people per vehicle will increase traffic by 600 round trips perhaps the County should consider compensating the Mana Kai Homeowners Association for its increased costs of lawn maintenance, beach access maintenance, tree care, shower maintenance, trash collection and disposal, and security patrols if the County does not provide?

I estimate the new lot will increase the use pressure by about 40% of the current situation.

Mahalo for your consideration.

David Fradin, Owner High Tech Condo Rental on Maui!
Email: dave@mauimanakai.com
Web Site: http://www.mauimanakai.com
Cell: 408-892-5025

To find activities to do when you go to Maui, go to: http://www.mauiactivitiestodo.com/

EARTHJUSTICE

TESTIMONY IN SUPPORT OF BILL 21, CD 1
A BILL FOR AN ORDINANCE AMENDING CHAPTER 20.35, MAUI COUNTY CODE,
RELATING TO PROTECTING SEABIRDS FROM OUTDOOR LIGHTING
(CARE Committee Report No. 22-47 (First Reading))

Maui County Council
July 1, 2022
9:00 a.m.

Good morning, Chair Lee, Vice-Chair Rawlins-Fernandez, and members of the Council:

My name is David Lane Henkin, and I am an attorney with Earthjustice.[1] Earthjustice submits this testimony on behalf of the Center for Biological Diversity and Conservation Council for Hawai'i ***in strong support of Bill 21, CD 1***, which would amend Maui County's lighting ordinance to increase protections for Hawai'i's threatened and endangered seabirds. Bill 21 is consistent with the best available science on how to minimize harm to imperiled seabirds from artificial lights. Bill 21 also provides clear guidance on how to implement these new lighting requirements with minimal burden on the community. For these reasons, the Council should adopt this measure as a win-win for the community and Hawai'i's native seabirds.

Artificial lights in Maui County regularly attract and disorient Hawaiian petrels, band-rumped storm petrels, and Newell's shearwaters as they navigate between the ocean and nesting colonies, resulting in fallout, injury, and death. State and federal wildlife agencies charged with helping to prevent these species from going extinct recognize that artificial light attraction poses an ongoing threat to the species' survival and recovery. Best practices to minimize light attraction, and help prevent extinction, include reducing short wavelength "blue light" in outdoor lighting fixtures, preventing outdoor lighting from shining upward or over the ocean, and eliminating reflective surfaces that bounce light into the sky. Bill 21 would require compliance with these best practices to give our native seabirds the best chance of survival.

To address concerns about increased regulatory burdens for businesses and residents, Bill 21, CD 1 provides a reasonable phase-in period for the replacement of existing outdoor lighting. *See* Proposed Section 20.35.070.B (exempting existing lighting for three years). Bill 21, CD 1 also facilitates compliance with the new lighting requirements by adopting the definition of "blue light content" found in Hawai'i County's lighting ordinance.[2] Using the same definition of "blue light content" provides consistency for businesses operating in both locations, and also

[1] I am registered as a lobbyist.

[2] *Compare* Proposed Section 20.35.060.D *with* Hawai'i County Code § 14-51(a)(9); *see also* Hawai'i County Code § 14-55, Table 14-A (specifying that LED fixtures must have "less than 2% blue light content").

MID-PACIFIC 850 RICHARDS STREET, SUITE 400 HONOLULU, HI 96813
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provides a template for implementation given that Hawai'i County's blue-light content requirement has been on the books for more than a decade. Finally, the bill provides that the director of public works will maintain a list of light fixtures that comply with lighting requirements. *See* Proposed Section 20.35.060.F. These provisions will ensure a smooth transition to seabird friendly lighting in Maui County and reduce any regulatory burdens on the community.[3]

Bill 21, CD 1 is a crucial step forward for seabird conservation in Maui County and provides a clear path forward for businesses and residences to install seabird friendly lighting. For these reasons, we respectfully urge the County Council to pass this bill.

Thank you for the opportunity to provide this testimony in strong support of Bill 21, CD 1. I will be available at the Council meeting to answer any questions you may have. I can also be reached via email at dhenkin@earthjustice.org or via telephone at 808-599-2436.

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[3] The Corporation Counsel's proposal to define permissible outdoor lighting in terms of the Correlated Color Temperature (CCT), measured in degrees Kelvin—rather than the specific percentage of short wavelength light—fails to incorporate the latest science on how best to minimize harm to imperiled seabirds from artificial lighting. The CCT tells you only how yellow or blue the overall color of light emitted from a light bulb appears; it tells you absolutely nothing about what percentage of that light is made up of the short wavelength light that is harmful to imperiled seabirds. Lighting manufacturers can reduce the CCT of their lighting simply by adding more long wavelength light, without reducing any of the short wavelength light that attracts native seabirds, leading to fallout and associated injury and death. Limitations on harmful lighting need to be defined in terms of the percentage of short wavelength light (as the Hawai'i County lighting ordinance currently does and as Bill 21, CD 1 proposes), not in terms of degrees Kelvin.

County Clerk

From: Jill Richards <youdodo_maui@yahoo.com>
Sent: Thursday, June 30, 2022 8:08 AM
To: County Clerk
Subject: Establishing a Maui County Community Water Authority

I am in support of the Maui County Council voting in favor of establishing a Maui County Community Water Authority.

Jill Richards, Haiku resident.

808 264 1663
PO Box 81471
700 Honopou rd
Haiku, Hi, 96708

County Clerk

From: kathydeelewis@gmail.com
Sent: Thursday, June 30, 2022 8:10 AM
To: County Clerk
Subject: Support the Maui County Community Water Authority

Aloha-
I have farmed my land in Peahi/Haiku for 37 years.

I support this historic charter amendment that creates a **Maui County Community Water Authority** to manage East Maui stream waters – and eventually other old plantation systems – for the benefit of our local farmers, kuleana users, residents, and watersheds!!!

It's about time!!
Kathy Lewis

Sent from my iPhone

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It's about time!!
Kathy Lewis

Sent from my iPhone

County Clerk

From: Matt McDonald <mattmcdon@gmail.com>
Sent: Thursday, June 30, 2022 8:47 AM
To: County Clerk
Subject: Testimony in Support of Maui County Water Authority

Dear Council Members,

I write to strongly urge you to support the creation of the Maui County Community Water Authority. As the years have gone by, I have become increasingly concerned about our uncertain climate, private control, and lack of accountability surrounding our watersheds. The County is not currently in a position to understand our water supply, keep it maintained, invest in its future, nor control it to benefit Maui's citizens who are in dire need of this most precious resource – wai. Water is life.

Additionally, our current system of private water control violates the Public Trust Doctrine, putting commercial users ahead of conservation, kuleana users, and domestic water supply. Not only do you have a moral imperative to implement a water supply system that benefits our local communities and wildlife first, you have a legal imperative to do so. Not creating a Maui County Community Water Authority would further disregard the Hawaii Constitution and local laws. We are counting on you, as a concerned electorate, to do the obviously right thing, and take this first step to control our water for the benefit of our local communities, not private users (the largest of which is a foreign pension fund).

A Maui County Community Water Authority would allow us to invest in watershed restoration and repairs and maintenance to old wasteful infrastructure, develop transparent, efficient, and culturally and environmentally responsible systems of management, provide local jobs in resource management, and ensure water security for all of Maui's current and future residents. Regional community boards incorporate the indispensable knowledge from local communities who have an intimate understanding of their watersheds and water systems. It's a win for everyone.

I am incredibly concerned about the alternative – private, corporate control over Public
Trust resources with no guarantee of good stewardship or equitable distribution of water or water rates. And we see this example on large display in East Maui – our largest source of public water. Mahi Pono and PSP are already wasting over half of their daily allocation of 25mgd (stated in public records) and yet they want 88mgd guaranteed for 30 years. The consequences of this are unthinkable, especially as our community already faces a stage 1 water shortage. Our County should absolutely be in the position to reduce the water supply to a non-essential foreign corporation when water supplies are low, rather than taking from our own community of residents.

The decision is obvious. We cannot afford to perpetuate the status quo. Maui County must do better to ensure the sustainability of our resources, our ʻāina, and our communities. Please vote to support the Maui County Water Authority.

Thank you and Aloha,
Matt McDonald

--
808.500.8054

County Clerk

From: Jennifer Valentine <faboo1028@yahoo.com>
Sent: Thursday, June 30, 2022 11:54 AM
To: County Clerk
Subject: Support the Maui County Community Water Authority

please support an historic charter amendment that creates a **Maui County Community Water Authority** to manage East Maui stream waters – and eventually other old plantation systems – for the benefit of our local farmers, kuleana users, residents, and watersheds.

The Maui County Water Authority would have the ability to create regional community boards – for each area affected – to guide the watershed planning of that area.

Help our community have a voice in our water future!

This is an important and necessary step for Maui County!

mahalo, jennifer valentine

HAWAI'I HOTEL
ALLIANCE

June 30, 2022

Gerard C. Gibson
President

The Honorable Alice L. Lee, Chair
The Honorable Keani Rawlins-Fernandez, Vice-Chair
Maui County Council
Kalana O Maui Building
200 South High Street, 8th Floor
Wailuku, Hawaii 96793

RE: Hawaii Hotel Alliance Opposition to Bill 21, CD1 (2022)

Aloha Chair Lee, Vice-Chair Rawlins-Fernandez and Members of the County Council,

Mahalo for this opportunity to provide testimony in advance of the County Council's June 21, 2022 meeting. Maui's lodging industry is deeply committed to its stewardship role for the local environment—including the protection of Hawaii's native seabird species—but if enacted Bill 21, CD1's outdoor lighting fixture requirements would impose impractical, ambiguous and unsafe requirements on businesses (and residents) throughout the County which run counter to the guidance of state and federal agency experts in this space.

For the reasons our testimony will expand upon below, the Hawaii Hotel Alliance must regretfully oppose Bill 21, CD1.

Bill 21, CD1 Conflicts with Prevailing Expert Opinion:
State and federal agencies with expertise on what constitutes appropriate measures to protect endangered seabirds have developed corresponding light minimization guidelines. Importantly, these guidelines were included in Appendix E to the Kauai Seabird Habitat Conservation Plan (KSHCP, or Plan)[1]—a Plan prepared in 2020 by the U.S. Fish and Wildlife Service (USFWS) and the Hawaii Department of Land and Natural Resources (DLNR). This Appendix includes requirements relating to the placement, angling and shielding of lights, as well as other key lighting mitigation measures. At the time the KSHCP was prepared, several groups asked the agencies to also impose light spectrum requirements similar to those found in Bill 21, CD1. It is important to underscore the experts at these agencies declined to do so.

Bill 21, CD1 Ignores Established Safety Parameters:
The wellbeing of our lodging guests and employees alike is of the utmost importance, and something that should not be unduly compromised in anything adopted by the County via Bill 21, CD1. There are human safety benefits of lights with shorter wavelengths, including that they create greater contrast and enhance

[1] *See* Attachment, *"KSHCP Appendix E."*

peripheral vision—yet Bill 21, CD1 does not properly account for this critical dynamic. Conversely, recognition of human safety needs is present within state and federal agency light minimization guidelines for protecting endangered seabirds, and the KSHCP itself requires appropriate lighting level stipulations for particular light functions—recognizing the standards prepared by the Illuminating Engineering Society of North America (IESNA). More specifically, the IESNA standards provide light level recommendations for several applications, including parking lots, walkways and roads—again, something for which Bill 21, CD1 does not properly account. The County should not be requiring light levels be less than these recognized and patterned illumination standards for human safety, which Bill 21, CD1 would concerningly do.

Exacerbating these concerns is the fact that Bill 21, CD1 would newly apply its provisions to *"[t]emporary hotel and condominium beach security lighting"* and *"[s]afety and security lighting for water features,"* which were previously exempt in broad scope. This could increase safety hazards for hotel guests and make it impossible for security staff to implement safety or security lighting at their hotels and resorts, even temporarily to resolve pressing safety matters.

Bill 21, CD1 Contains Unworkable, Unsubstantiated Provisions:
A critical requirement within Bill 21, CD1 would be that all outdoor lighting fixtures must *"limit short wavelength content to no more than two percent of blue light content"* (with *"blue light content"* defined as *"the ratio of the amount of energy emitted by the outdoor light fixture between 400 and 500 nm divided by the amount of energy between 400 and 700 nm"*). Such a standard would be impossible for most—if not all—residents and businesses to adhere to.

The short wavelength content measurement specified in Bill 21, CD1 is not something that is typically provided by light bulb and fixture manufacturers, nor is it included on the labels for their products, so one would be unable to determine if new lights they purchase effectively comply with the law. Most businesses and residents lack the equipment and expertise that would be necessary to perform the calculations necessary to determine compliance, all while state and federal agencies have yet to determine if there is scientific support to suggest this requirement is beneficial for seabirds. State and federal agencies knowledgeable about endangered seabird protection have not recommended adopting this for all outdoor lighting, which means Bill 21, CD1 is again a troubling outlier.

Moreover, requiring all (except neon) outdoor lights to be filtered light emitting diode bulbs (LEDs) is concerning on added grounds, as LED filters are not commonly used and are not widely available. Per the County's Deputy Corporation Counsel,[2] there is only one vendor who arguably sells such filters, yet every outdoor light in the County would require one—presenting cost trepidations, supply anxieties, and even worries over such a product voiding light manufacturer warranties given this alteration of intended use. All for a practice outside of what experts would constitute as necessary.

Further, Bill 21, CD1 would take effect immediately for all new or newly replaced lighting fixtures, and provide only a three-year grace period for existing fixtures. Given the numerous compliance challenges present, this would create immediate difficulties for businesses such as hotels and resorts with large

[2] *See* Memorandum, *"Ordinance on Protecting Seabirds from Outdoor Lighting Bill No. 21 CD1 (2022)"* (May 24, 2022).

numbers of outdoor lighting fixtures. And even a three-year period may not be enough time to comply, particularly with stipulations like those for blue light content and filtering that are stymied by present manufacturer specifications and availabilities.

Concluding Remarks:
In sum, the lodging industry on Maui is steadfastly committed to protecting Hawaii's native seabird species, including by minimizing lighting. When one minimizes lighting though, it is also important that human safety—namely the safety of our guests and employees—is not compromised, especially with impractical and burdensome requirements that do not hold demonstrated, expert-validated benefits.

Bill 21, CD1 is simply not a sensible approach to the important protection of Hawaii's native seabirds, especially given that alternative options are available. One logical option would be for Maui to adopt requirements similar to those included in the KSHCP's Appendix E, which reflects mindful policies established by subject-matter experts from USFWS and DLNR. Another option would be to impose a correlated color temperature requirement, as the State imposes on its own agencies (this measurement is typically included on LED light bulb labels).[3] Any new requirements should also preserve existing exemptions and allow enough lead time for compliance.

For the many reasons articulated in our testimony, the Hawaii Hotel Alliance urges the County Council to reject Bill 21, CD1 and instead pursue an alternative conservation pathway. Without such action, the risks and harms brought about by Bill 21, CD1's requirements—to residents, businesses, guests and more—will greatly exceed any benefit that may possibly be attained.

Mahalo Nui Loa,

Gerard C. Gibson
President
Hawai`i Hotel Alliance

[3] *See* Hawaii Revised Statutes Section 201-8.5.

APPENDIX E: Guidelines for Adjusting Lighting at Facilities

1. Guidelines for Adjusting Lighting at Facilities

This appendix provides detailed guidelines to inform minimization measures that can be customized to address an array of possible lighting issues at Participant facilities. A lighting minimization plan to achieve the maximum extent practicable will be included in each Participant PIP.

These guidelines represent best available science at the time of KSHCP permit issuance. Over the life the plan, likely new information and new technologies will be available, and this appendix may be updated accordingly.

Not all lighting guidelines are appropriate for all types of facilities. Some represent long term, infrastructure solutions, and others may be implemented on a seasonal basis.

1.1. Deactivate Non-Essential Lights

Prioritization of seabird and honu light attraction minimization measures involves evaluating light needs to determine if non-essential lights can be deactivated during the seabird fallout season (September 15 to December 15) and turtle nesting season (May 15-December 15). Deactivating the lights avoids the potential for light attraction that those lights could otherwise cause. Turning off a subset of lights, both unshielded and shielded, during the fallout season (September 15 to December 15) can assist with minimizing the risk of seabird light attraction, if those lights are not necessary. In their PIPs, Applicants must provide rationale for any facility lights that cannot be deactivated during seabird fallout season, and detail what other minimization practices will be implemented on lights that will remain illuminated. The regulatory agencies will review the evaluation and justification as provided in applicant PIPs.

Similarly, turning out lights that shine directly on beaches during the turtle nesting season (May 15-December 15) can prevent hatchling disorientation. Avoid use of the following lamp styles on beachside or shore perpendicular to sides of a structure: private balcony lights, up lights; decorative lighting, not necessary for human safety or security; pond lights; and beach lighting. Timers or other similar devices should be used to ensure the selected lights remain off during the turtle nesting season. This measure may require the installation of independent light switches. Conversely, to prevent accidental activation, light fixtures can be removed for lights that will no longer be needed at a facility.

1.2. Install Full Cut-off Light Fixtures

A full cut-off fixture refers to a light fixture which that does not shine light above a 90 degree horizontal plane. For lights necessary to be activated, full cut-off fixtures provide an effective measure to achieve light minimization because they prevent light from shining directly upward.

These types of lights house the light bulb up within the fixture so that no bulb protrudes below (**Figure 1**). Such fixtures must be mounted at appropriate angle so they point directly down to the ground. Many light manufacturers provide light fixture information along with the light specifications to indicate if a fixture is a full cut-off design. The International Dark Sky Association (www.darksky.org) is a good source for information on full cut-off lights and provides additional references to light engineering resources and light manufactures.

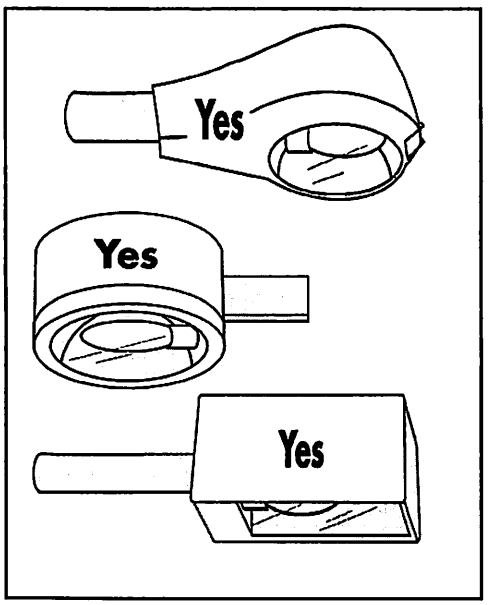

Figure 1: Examples of full cut-off light fixtures. Source: www.darksky.org.

Along shorelines, exterior fixtures on the seaward (makai) and the shore perpendicular sides of the building (and on the landward side of the building if they are visible from the beach) should be down-lit fixtures, fully shielded and full cut-off, louvered, or recessed fixtures that do not have reflective inner surfaces. These fixtures should use low wattage bulbs (e.g.,< 50w). All exterior fixtures on the landward (mauka) side of the building should be directed downward only (Witherington & Martin 2003).

1.3. Shielding Light Fixtures

This minimization measure aims to achieve the functional equivalent of a full cut-off light fixture by installing a shield, visor, hood or similar on an existing light fixture to prevent light from shining upward and reducing trespass. In addition to the shielding, to achieve the functional equivalent of a full cut-off fixture, a light fixture should be adjusted so that it points directly down perpendicular to the ground to create a level, horizontal plane between the fixture and the ground, and have the bulb housed within the light fixture (**Figures 2 & 3**). Reed

et al. (1985) suggest that in areas where other light sources are rare, the shielding of principal lights would likely have a larger effect in decreasing seabird light attraction.

Figure 2: Installation of an appropriately sized floodlight shield. Source: www.darksky.org.

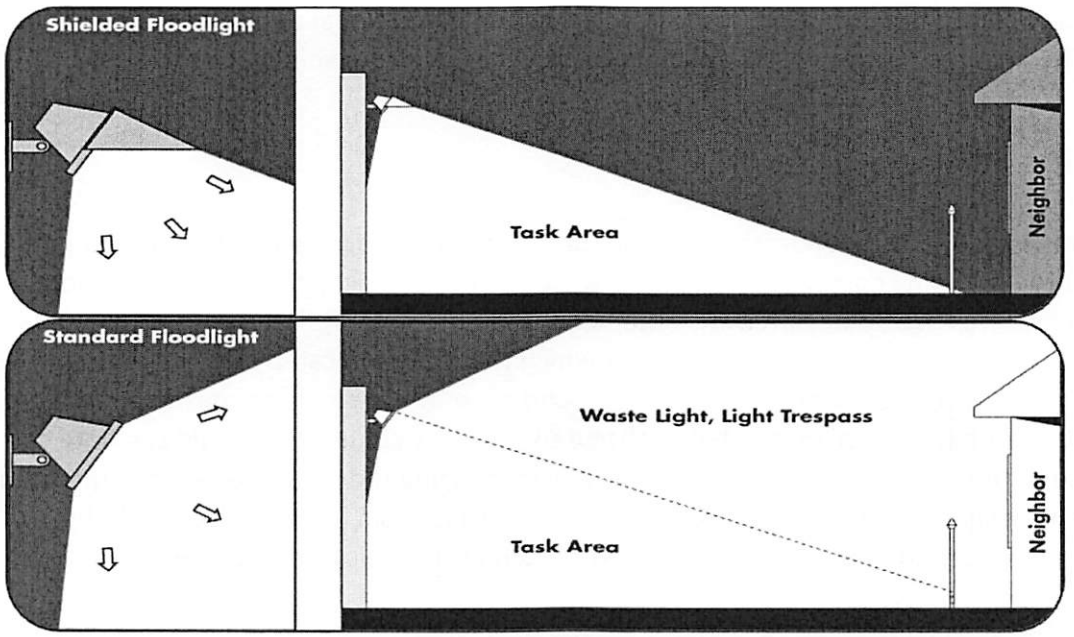

Figure 3: Before and after effects of shielding and light management designed to minimize light attraction risk to seabirds and to decrease light pollution. Source: www.darksky.org.

1.4. Angle Lights Downward

Angling and repositioning lights presents a potential alternative to shielding or replacing light fixtures and may be sufficient to make lights fully cut-off and eliminate light shining horizontally and vertically (**Figure 4**). To achieve the functional equivalent of a full cut-off fixture, a light fixture should be adjusted so that it points directly down perpendicular to the ground to create

a level, horizontal plane between the fixture and the ground, and have the bulb housed within the light fixture. Tree strap downlights may be used to minimize seabird light attraction unless turtles may be present on the adjacent beach.

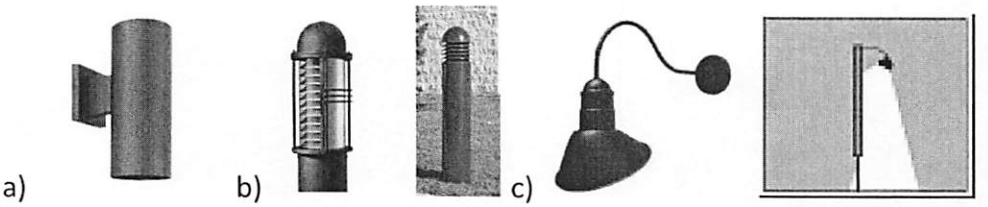

Figure 1-: (a) Wall mount cylinder down-light, (b) bollards with downward-directed louvers, and (c) sign lights angled downward. From http://myfwc.com/media/418417/SeaTurtle_LightingGuidelines.pdf **(FWC 2011).**

1.5. Place Lights Under Eaves

Light fixtures placed under building eaves can achieve the functional equivalent of a full cut-off fixture. The architectural eave acts as shield to prevent light from shining directly upward.

1.6. Shift Lighting According to the Moon Phase

This minimization measure addresses lighting for which the need, or purpose, for the lighting can be shifted in timing each year to coincide with the moon phase. Because a reduction in light attraction has been correlated with the full phase of the moon (Reed et al. 1985; Telfer et al. 1987) lights for essential functions, and for which that function can be shifted in timing, should coincide with the full phase of the moon and avoid the dark phase of the moon. It is important to note that a full moon that is obscured by heavy cloud cover could simulate the dark phase of the moon. By not activating those lights during the dark phase of the moon the effect of those lights is reduced. Examples of activities that could be minimized with this measure include scheduling of night time events, such as festivals or sporting events.

1.7. Install Motion Sensors for Motion-activated Lighting

Motion sensors switch lights on only when triggered, thereby limiting the time that the light stays on and reducing its potential for seabird light attraction. If a sensor light is required for security purposes, the light equipped with the sensor should be at low light levels. For example, Light Emitting Diode (LED) streetlights and parking lot lights can be activated when needed and dim when no activity is detected nearby. However for those fixtures, full cut-off designs or the functional equivalents are recommended because of the possibility of light attraction occurring when the motion-sensor light is activated or in the event that the motion sensor equipment malfunctions and the light remains on.

Where motion sensors are impractical (eg at sporting events), stadium lights should be turned off as soon as the public leaves the stadium.

1.8. Decrease Lighting Levels

This measure addresses lowering light intensity levels (e.g., measured in lumens) while still meeting the need to safely complete tasks and serve the purpose of the light. Guidance on standards for the appropriate lighting level for a particular light function should be followed as provided by the appropriate agency or professional and technical organization. For example the Illuminating Engineering Society of North America (IESNA) provides recommendations for light levels for several applications including parking lots, walkways, and roads. In addition individual entities may have standards and best practices for lighting needs.

For many applications where lighting is needed, brighter lighting may not always provide the best lighting for the needed function. It is often the case where reduced lighting levels can provide for the needed function of the lighting. For example, for security purposes overly bright lights tend to create blind spots, or very dark shadows, outside the lit area that preclude effective visibility. Well placed, but reduced lighting can provide for more effective security. Therefore, when Participants seek to enhance onsite visibility for security, while reducing risk to seabirds, the appropriate reduction of light levels (along with shielding and re-angling lights) forms a starting point to accomplish both purposes.

1.9. Decrease Visibility of Interior Lights

Facilities with large and/or numerous windows, tall building profiles, or large glass facades may also pose a risk of light attraction to Covered Seabirds on Kaua'i. The following measures are based, in part, on efforts in cities in Canada and the mainland USA to decrease harmful effects of buildings on birds and apply to seabirds in that they can decrease the amount of light escaping from within buildings (City of Toronto 2007; Evans Ogden 2002):

- Install screens or shades over large windows that are lowered nightly during the fallout season;
- Modify buildings and decrease or eliminate light glow from within a facility;
- Create glass opacity to prevent the escape of internal light. Tinted glass or film with a visible light transmittance value of 45 percent or less should be applied to all windows and doors within line of sight of the beach;
- Install physical screens outside a building;
- Install landscaping in front of large windows;
- Close all window blinds after daylight hours until sunrise;
- Stagger the operation of lights in the evening or morning hours so that not all lights are turned on at once; and
- Maximize the number of offices or indoor rooms that turn off all lights after sunset;

- Place reminder notices on switches to turn out lights or draw curtains/blinds in oceanfront rooms. This should include coastal areas that are on the perpendicular sides of the structure;

    a. Turn off room and lanai lighting that are not needed;

    b. Relocate moveable lamps away from windows that are visible from the beach; and

    c. Close opaque curtains or blinds after dark to block inside light from shining outside.

1.10. Use Light-less Technologies

Where conditions and facility needs permit, technologies that do not use light, such as closed-circuit television (CCT) with infrared illuminators, may be effectively employed to "see" at night thus enabling some of the lights to be turned off. For example, any fenced areas or the dark sides of facilities can be monitored with CCT so that lights do not need to be used or installed.

1.11. Plant Vegetation Around Lights to Reduce Light Visibility

Trees and shrubs can be planted so that they over-arch lights or shield side visibility of lights along the coast or along a ridge, for example. Whether the lights are mounted on 20-foot poles, walkways, or within landscaped areas, having adjacent or overarching vegetation would further reduce the risk of seabird light attraction that any residual light scatter may pose. Long-term planning and maintenance of screening vegetation is encouraged, where appropriate to the uses and needs of the affected lights.

1.12. Lower Height of Lights

Light that is low in height has potential to reduce the effect of light attraction because lower lights may be less visible to passing seabirds. Installing ground-level lighting, such as along walkways, and reducing pole height can decrease light waste and trespass.

1.13. Use Longer Light Wavelengths

In coastal areas, use of acceptable lights such as: LPS 18w, 35w, red, orange or amber LEDs (true red, orange or amber diodes, but not filters), true red neon, and other lighting sources that produce light wavelengths of 560 nm or longer (Witherington et al. 2014). Long wavelength lights, e.g., those that produce light that measures greater than 560 nanometers on

a spectroscope, are required for all construction visible from and adjacent to sea turtle nesting beaches. Turtles are most sensitive to short wavelengths of light, probably because they live in a marine environment that filters out long wavelengths. Green turtles are least attracted to longer wavelength light in the yellow-orange to red end of the spectrum (630 to 700 nm) (Witherington and Martin 2000). In the absence of other light sources, however, turtles may still be attracted to long wavelength light.

Filters designed to exclude transmission of short wavelengths (<570nm) can be fitted to high pressure sodium (HPS) vapor lights. Such filters have been found to be effective at avoiding disruption of nesting females (Salmon, 2006) but even filtered HPS light has been found to attract hatchlings, although not as strongly as unfiltered HPS lights (Sella et al, 2006). Filtering alone is thus not sufficient to avoid attraction and disruption of hatchling orientation. Bright white light fixtures, such as metal halide, halogen, fluorescent, mercury vapor and incandescent lamps, are not approved for beachside or shore perpendicular sides of a structure. Limited use of shorter wavelength lights may be approved in areas where direct and indirect light or glow could not possibly be visible from the beach due to installation of opaque "light fencing" (see below).