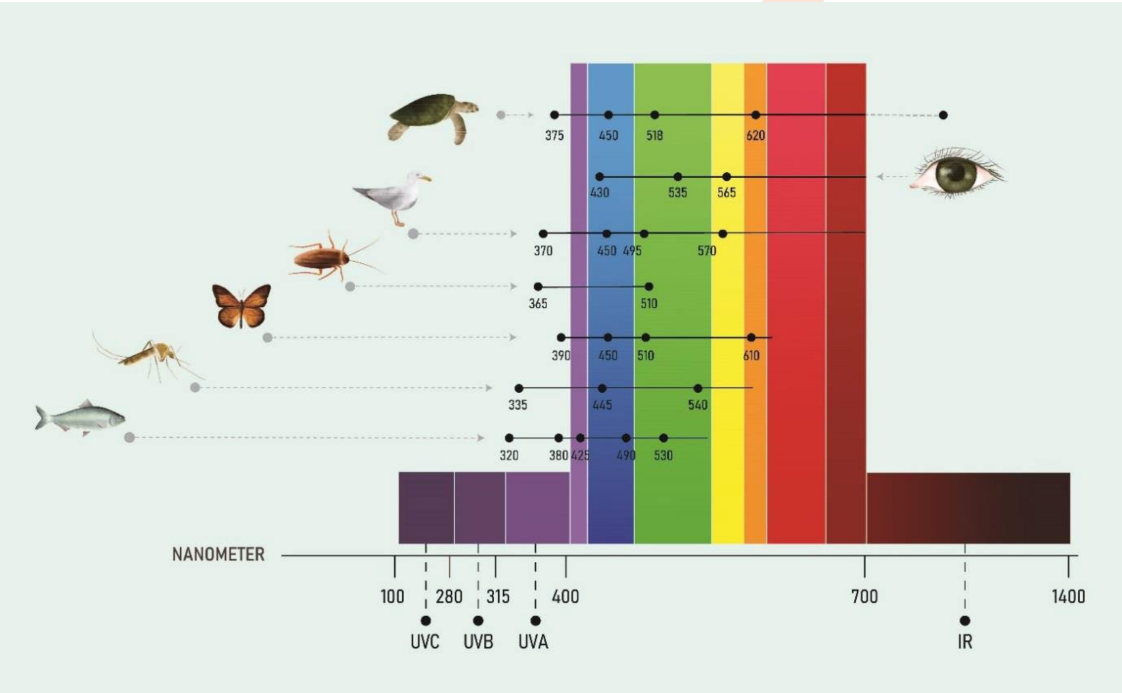
MIT2019-03: Lighting adjustments to mitigate against deck strikes/ vessel impacts

Milestone One – Proposed methodology of land/sea-based testing

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

NORTHERN NZ SEABIRD TRUST

This report has been prepared by: **Dr. Megan Friesen** (St. Martins University/University of Auckland), **Dr. Anne Gaskett** (University of Auckland), **Chris Gaskin** (NNZST).



Cover: Fluttering shearwaters in lights on Taranga Hen Island. *Photo: Edin Whitehead*

Figure 1 (this page). Ability to perceive different wavelengths of light in humans and wildlife. Note the common sensitivity to ultraviolet, violet and blue light across all wildlife. *Image: © Pendoley Environmental, adapted from Campos (2017).*

1 Metanalysis

Objective

Analyse deck strike data from Hauraki Gulf for patterns in fishery types, species impacted. Survey fisheries for operational lighting types and deployment methods.

Using data provided by Ministry of Primary Industries our investigation into New Zealand seabirds' response to artificial light will begin with analysis of deck strikes in the Hauraki Gulf. Specifically, we will analyse seabird species impacted by deck strikes, the fishery type, ecoregion, and light type (if possible). We will carry out this aspect of the project by sending a survey to industry people to obtain data on lights used on vessels, scheduling, and lighting accessories (e.g. filters) that might impact seabirds (Table 1). We will use the data collected during the survey to include in our meta-analysis. To analyse significant trends between species, impacted by artificial lights, light types, fishery type, and regions we will do a multivariate linear regression to find significant correlations that will help us to better understand trends of light impacts on seabirds.

Table 1. Survey sent to industry parties to identify light types used for metanalysis and experimental set-up.

Survey question	Definitions
Fishery type	E.g. trawl surface longline, etc.
Target catch	Fish species targeted
Vessel type	Size and type of vessel
Fisheries zone	Where fisheries are taking place
Light purpose	What is the lighting type used for
Brand of light	Manufacturer's details
Light type	Light details e.g. LED, flood, etc.
Lighting schedule	Time light goes on/off/ intermittent
Light accessories	Any filters, etc. (NA if none used)
Number	How many of this light type are used
Anecdotal observations	What types of lights appear to attract more or less seabirds? What types or species of seabirds?

2 Spectral and behavioural experiments

2.1 Light analysis

Objective:

Measure the spectral reflectance and profiles of different anthropogenic lights. Model the spectral profiles to identify how well seabirds can distinguish light types.

We will measure the spectral reflectance of light types identified during our survey of industry parties (Table 1) and other lights that seabirds might encounter (e.g. vessel navigation lights) as well as natural lights that seabirds use to navigate (e.g. moonlight) to obtain a baseline measure of differences between light types. These differences between spectral reflectance of light are important as the ability to perceive light and colour is different in different species based on their unique physiology. Specifically, we will use a spectrophotometer (Ocean Optics Jaz, Ocean Optics Inc.) to measure spectral reflectance. We will obtain 5 measures of reflectance for each light type in order to calculate a mean reflectance value for each sample. We will analyse if there is a significant difference between light types tested.

Using the 'receptor- noise' model (Vorobyev & Osorio 1998) we will identify detectable differences as perceived by seabirds. Chromatic contrasts will be measured as Just Noticeable Differences (JNDs) and used to identify if seabirds can perceive differences between light types. The physiological spectral sensitivity for short-tailed shearwaters (*Ardenna tenuirostris*), will be used as a proxy for modeling procellariiform visual sensitivity to light types (the only species in this order with data for cellular visual anatomy). We will also take a number of background measurements at night in different moon phases, to indicate what difference these lights show against a natural background.

Table 2. Example of light types that will be measured for spectral reflectance based on light types described in 'National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2019'. Actual light types tested will vary depending on results of survey.

Example of lights to be tested
Moonlight
LED Warm
LED Cool
High pressure sodium
Fluorescent
Metal halide

2.2 Land-based behavioural experiments

Objective

Perform land-based and at-sea behavioural trials to understand how lights impact seabirds, and measures that can be taken to prevent deck strikes and confusion by artificial lights.

During the first year of our study we will focus our behavioural response experiments terrestrially, in order to obtain initial data on how seabirds respond to light types with minimal disturbance. Land-based behavioural experiments will take place on Burgess Island, and Hauturu (Little Barrier Island). These islands have been chosen due to their remote locations, and access to multiple species of Hauraki Gulf seabirds. For behavioural trials we are particularly aiming to assess common diving petrels (*Pelecanoides urinatrix,* NZTCS 'At risk'), white-faced storm petrel (*Pelagodroma marina,* NZTCS 'At risk') and Cook's petrel (*Pterodroma cookii,* NZTCS 'At risk'). We may also encounter other nocturnal seabirds and will also assess their behavioural response to light types when possible (i.e. grey-faced petrel *Pterodroma gouldi,* little shearwater *Puffinus assimilis,* fluttering shearwater *Puffinus gavia,* flesh-footed shearwater *Ardenna carneipes,* fairy prion *Pachyptila turtur*, Buller's shearwater *Ardenna bulleri*, black-winged petrel *Pterodroma nigripennis,* New Zealand storm petrel *Fregetta maoriana,* black petrel *Procellaria parkinsoni).*

Behavioural experiments will begin at sundown (varying for time of year) and will continue for ~ four hours after sunset (with potential for more hours depending on activity or weather conditions make experimentation unsafe). Each behavioural experiment will be set up at 15-minute intervals, where lights are projected for 15 minutes followed by a period of 15 minutes with no lights (including no researcher headlamps). Prior to island trips, a lighting schedule will be cycled, where the light type tested will vary in placement from sunset each night to control for times of greater seabird activity (Table 3). Because nocturnal seabirds are social and attracted to vocalizations, light experiments will be done in complete silence (no acoustic attraction measures and no researcher noise).

During behavioural trials, researchers will follow an ethogram to obtain complete data on how lights impact the behaviour of seabirds (Table 4). In addition to researchers recording behavioural observations on the ground, we will also use a thermal imaging camera to record the activity during each of the trials. Recordings will be filed with the light type, time of night, and island and will provide a reference for behavioural response to light types.

Table 3. Example experimental set-up with minutes from sunset and rotating schedule for light types.

	Night One	**Night Two**
0 mins	LED warm	Metal Halide
15 mins	No light	No light
30 mins	High Pressure Sodium	Fluorescent
45 mins	No light	No light
60 mins	LED Cool	LED Cool
75 mins	No light	No light
90 mins	Fluorescent	High Pressure Sodium
105 mins	No light	No light
120 mins	Metal Halide	LED Warm
135 mins	No light	No light
150 mins	LED Warm	Metal Halide
165 mins	No light	No light
180 mins	High Pressure Sodium	Fluorescent
195 mins	No light	No light
210 mins	LED Cool	LED Cool
225 mins	No light	No light
240 mins	Fluorescent	High Pressure Sodium

2.3 At-sea behavioural experiments

Behavioural experiments at-sea will take place primarily during the second year of our study. We aim to get permissions from vessels using specific lights, and when needed will make use of alternate vessels to test out specific lights. Timing of at-sea experiments will be set-up according to fisheries' activity times (as determined in our survey, Table 1). Behavioural analysis will take place using the same parameters as our land-based trial with a researcher recoding behaviours and using thermal imaging to record additional behaviours for later analysis. The lighting schedule when on fishing vessels will be at the will of the captain. When using an alternate vessel for testing lights, we will use a rotating method to randomize the time of night lights are projected as was done in terrestrial experiments (Table 3).

During at-sea trials, researchers will have bird boxes on deck and any seabirds attracted to the vessel deck will be captured and safely contained in a box to avoid injury until the light can be turned off and the bird released back into the water. Light trials will aim to be done away from boat hazards that could provide harm to seabirds.
Data from land-based and at-sea trials will be analyzed using multivariate methods to identify significance between, species, light type, and behavioural response. We expect these results to indicate which light types have the least impact on altering seabird behaviour and attraction and will provide best-practice guidelines for vessels active at night.

Table 4. Example ethogram that will be used to record behaviours during terrestrial and at-sea behavioural surveys .

Behaviours	**Definition**
Birds present- beginning	Number of birds present at beginning of light trial
Light attraction	Movements toward light source
Call & type	Vocalizations made and type of call
Conspecific agonistic behaviour	Fighting or aggression toward conspecifics
Heterospecific agonistic behaviour	Fighting or aggression toward heterospecifics
Foraging	Attempts to capture prey (during at-sea trial)
Attraction to conspecifics	Preening or attraction to conspecifics
Birds present- end	Number of birds present at end of light trial

3 Applications and Further Questions

We see this project as critical in seabird conservation and understanding the visual acuity of seabirds (an area of little scientific research). Our aim is for this project to be set-up as PhD research at the University of Auckland, with further sensory anatomy and physiological studies furthering our understanding of seabird attraction to stimuli. While our initial analysis of deck strike data focuses on the Hauraki Gulf seabirds, our aim is to expand this to all data that has been collected on light attraction to vessels in New Zealand waters in later years of the study. We will also aim to test behavioural response to more lights on different species in subsequent years as our understanding of light attraction and the physiology of seabird visual systems is strengthened.

4 References

National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2019

Vorobyev, M., Osorio, D., 1998. Receptor noise as a determinant of colour thresholds. Proceedings of the Royal Society of London – Series 265, 351–358.