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

Land-based behavioural experiments

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Photo: Whitehead 2020

Department of Conservation
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NEW ZEALAND

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NORTHERN NZ SEABIRD TRUST

Artificial Light At Night (ALAN)

- Can cause disorientation, exhaustion, injury or mortality from light-induced collisions.
- Petrels and shearwaters are the main seabird group affected by ALAN.
- Mainly fledglings on their first flight.

Image: Whitehead, 2019

Image: Whitehead, 2018

Image: Whitehead, 2020

Aims

- Characterise the wavelengths and intensity of lights used on boats and model how these are perceived by seabirds.
- Carry out land-based behavioural trials to test seabird responses to these lights and alternative options such as different colours/filters.

We predicted the greatest attraction will be to more intense lights, especially if they involve UV wavelengths.

Image: Whitehead, 2020

1. Characterise the wavelengths and intensity of lights used on boats and model how these are perceived by seabirds.

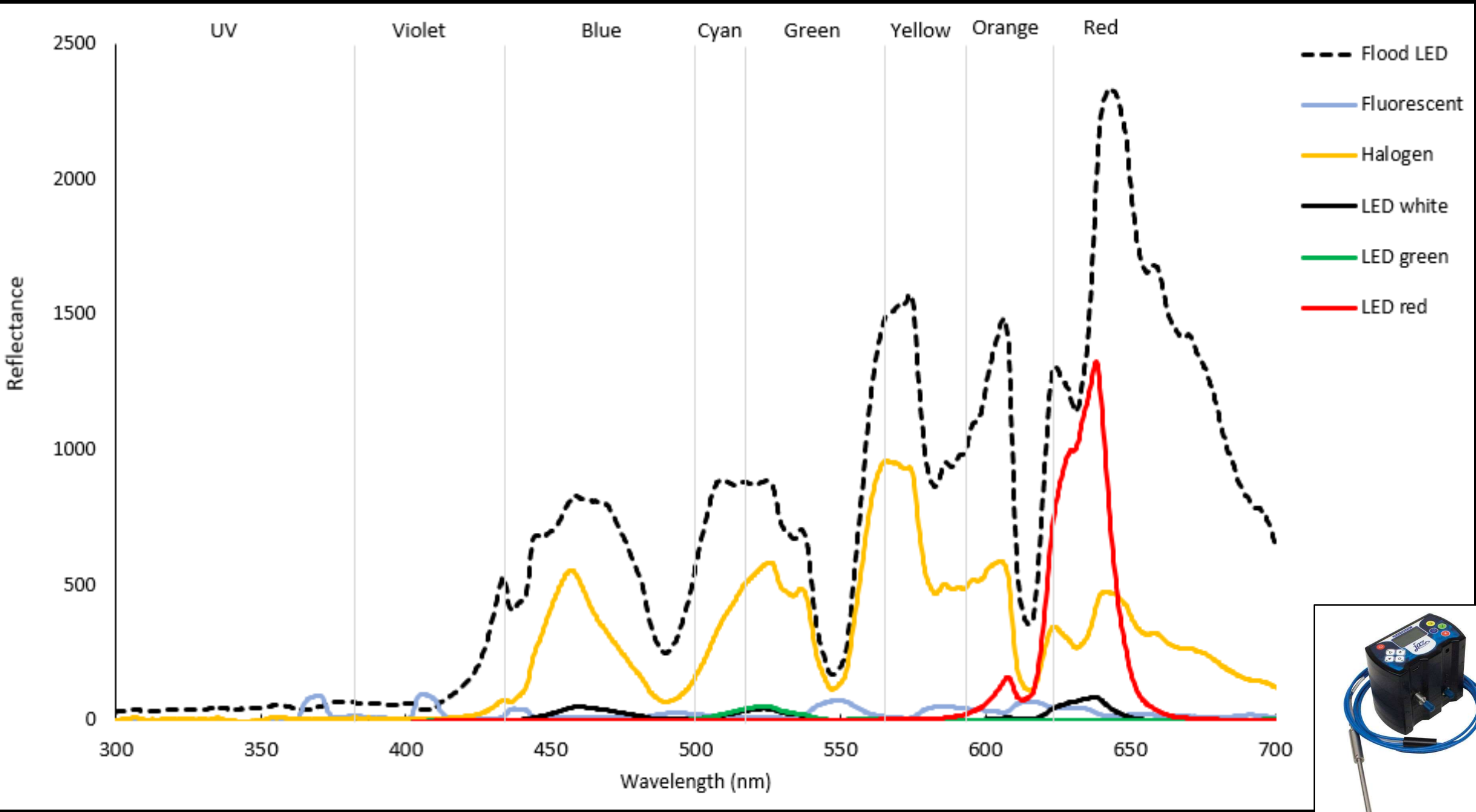
Methods

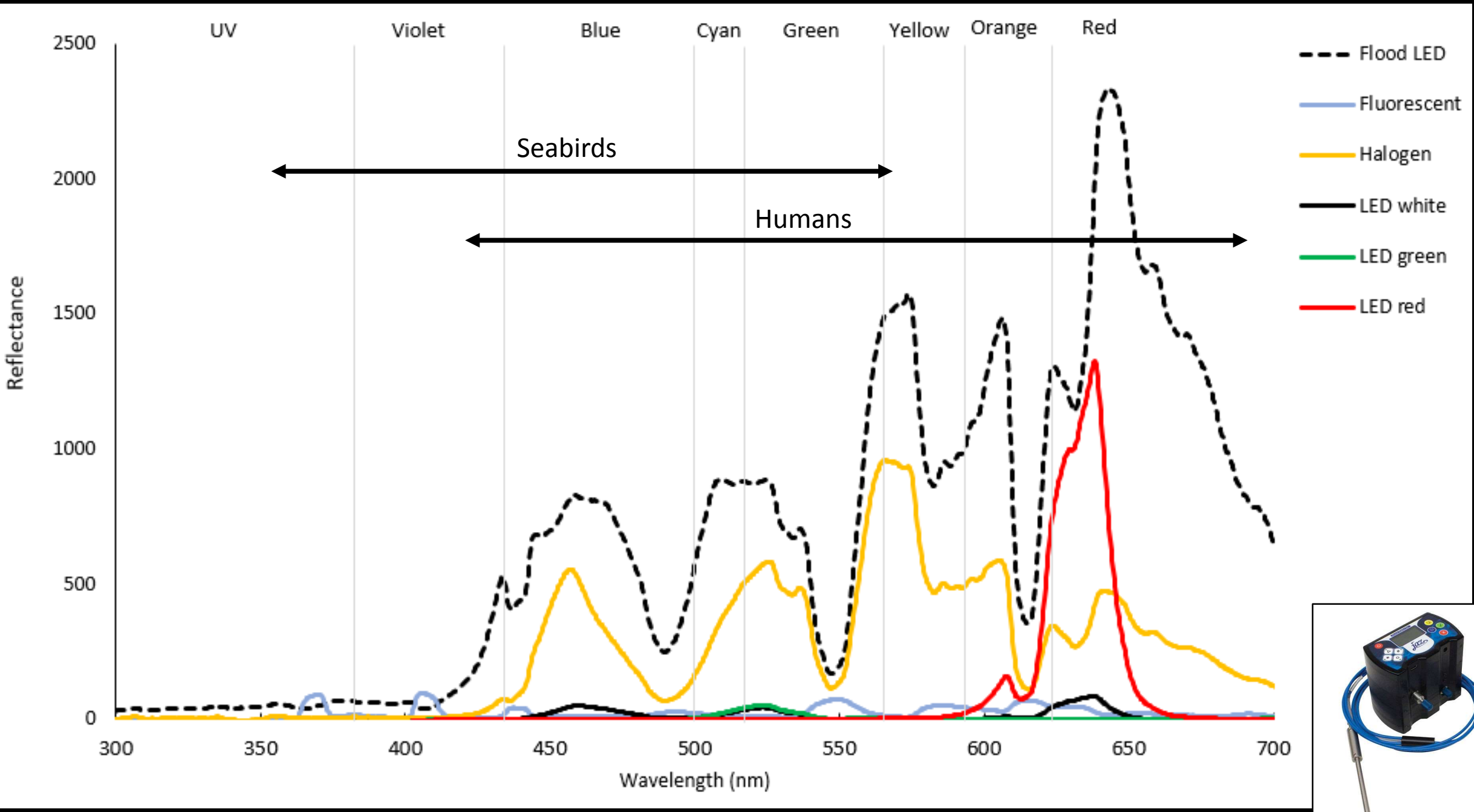
Fishing vessel lighting survey

- Light types used:
  - LED’s (11)
  - Fluorescents (7)
  - Halogen (5)
  - Mercury (1)
  - Sodium lights (1)

- We tested:
  - 144W white LED floodlight
  - Fluorescent
  - Halogen
  - 20W white LED x4
  - 20W red LED x4
  - 20W green LED x4

Image: Whitehead, 2020


UV
Violet
Blue
Cyan
Green
Yellow
Orange
Red
Flood LED
Fluorescent
Halogen
LED white
LED green
LED red
Reflectance
2500
2000
1500
1000
500
0
300
350
400
450
500
550
600
650
700
Wavelength (nm)


UV
Violet
Blue
Cyan
Green
Yellow
Orange
Red
Seabirds
Humans
Flood LED
Fluorescent
Halogen
LED white
LED green
LED red
Reflectance
2500
2000
1500
1000
500
0
300
350
400
450
500
550
600
650
700
Wavelength (nm)

Seabird visual system

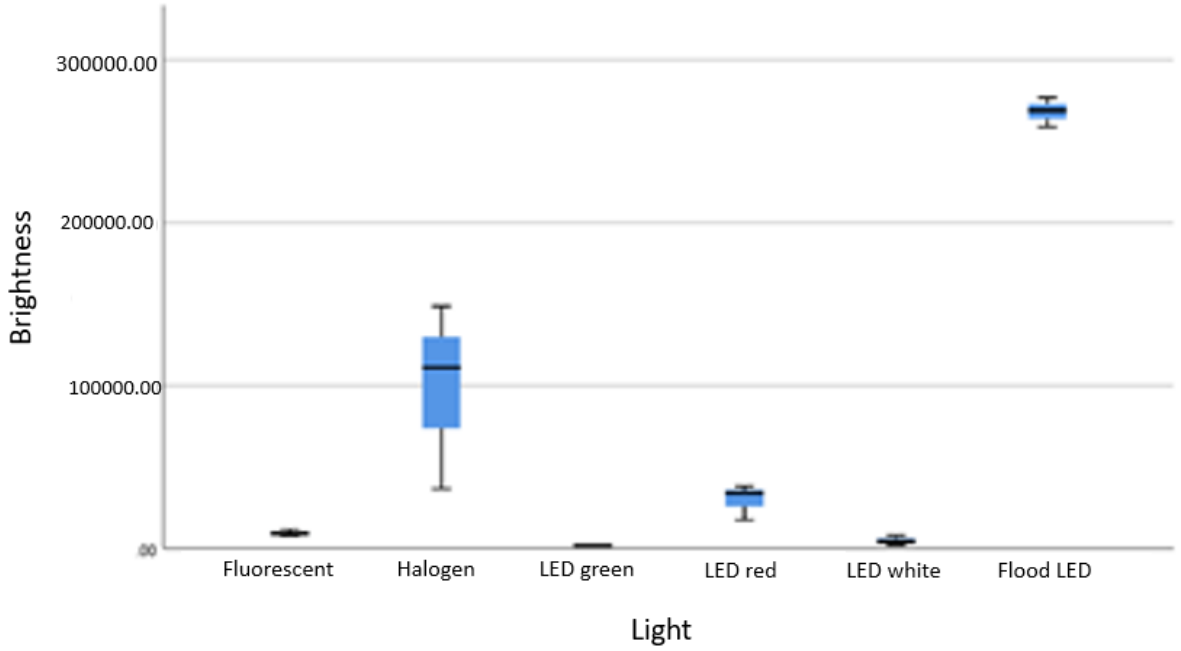


Figure 2. The brightness of each light type used in the behavioural experiments of seabird attraction to artificial light at night .

Table 2. Tukey post-hoc pairwise comparison of colour contrast values of the different lights from a seabird perspective. Values are colour contrast values, in units of JND ('just noticeable differences'). **As JND values approach 1, a seabird likely could not distinguish between the lights**.

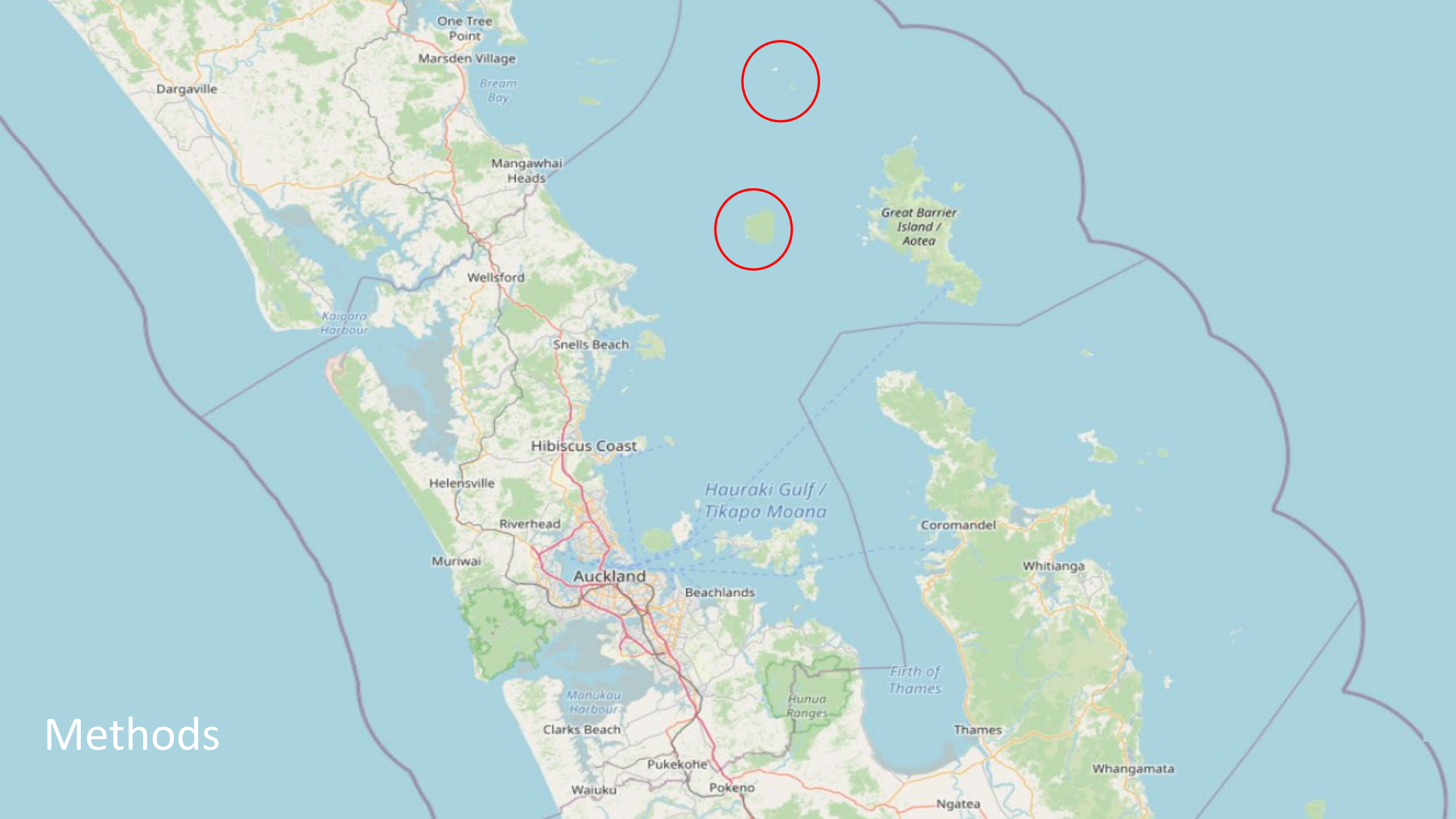
	Fluorescent	Flood LED	LED green	LED red	LED white
Halogen	9.227119254	**2.753929**	22.67938	43.32984	**6.38864**
LED white	9.606844729	**5.67293**	27.52597	43.82132	-
LED red	50.06587149	40.57953	-	-	-
LED green	31.41956181	25.2914	-	-	-
Flood LED	**6.614459589**	-	-	-	-

Brightness

Colour

Image: Whitehead, 2020

2. Carry out land-based behavioural trials to test seabird responses to these lights and alternative options such as different colours/filters.


One Tree Point
Marsden Village
Dargaville
Bream Bay
Mangawhai Heads
Great Barrier Island / Aotea
Wellsford
Kaipara Harbour
Snells Beach
Hibiscus Coast
Helensville
Hauraki Gulf / Tikapa Moana
Riverhead
Coromandel
Muriwai
Auckland
Whitianga
Beachlands
Firth of Thames
Manukau Harbour
Hunua Ranges
Clarks Beach
Thames
Pukekohe
Whangamata
Waiuku
Pokeno
Ngatea

Methods

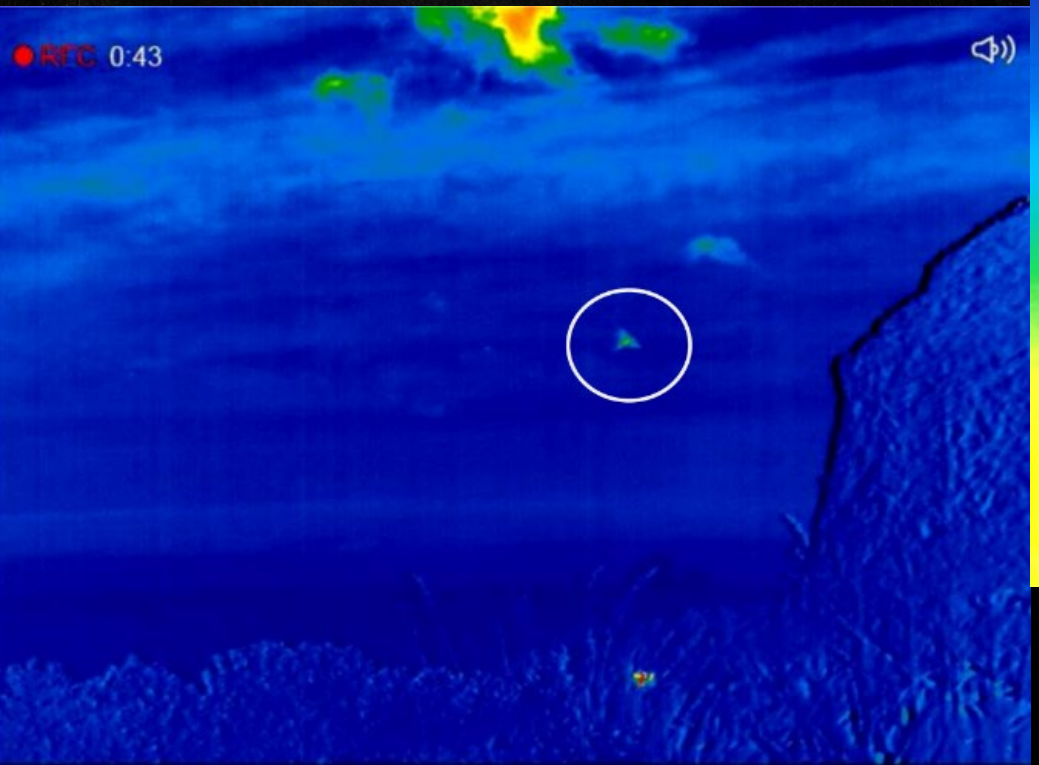
Image: Lukies, 2020

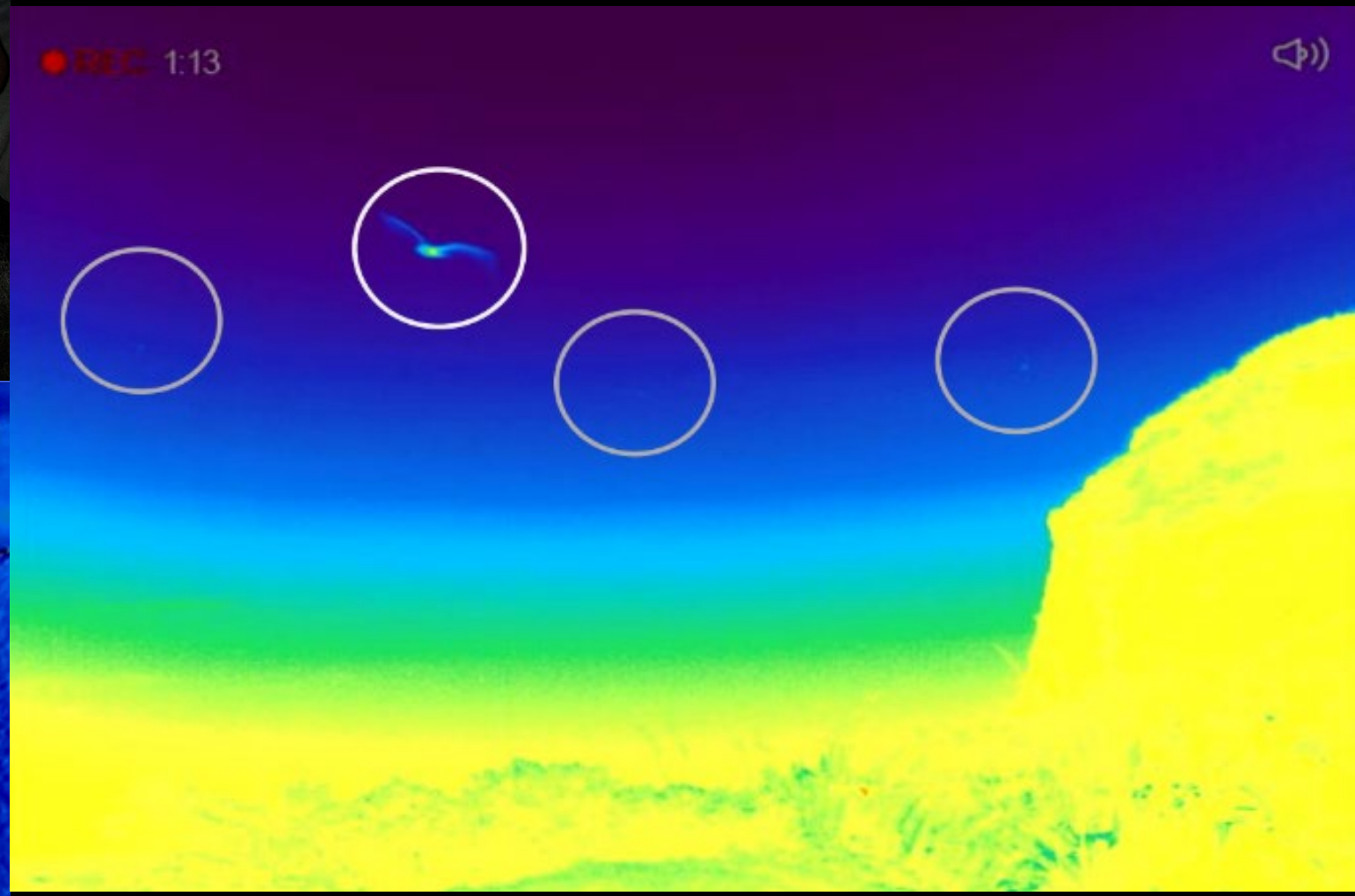
Lighting set up


Images: Whitehead, 2020

Thermal imagery

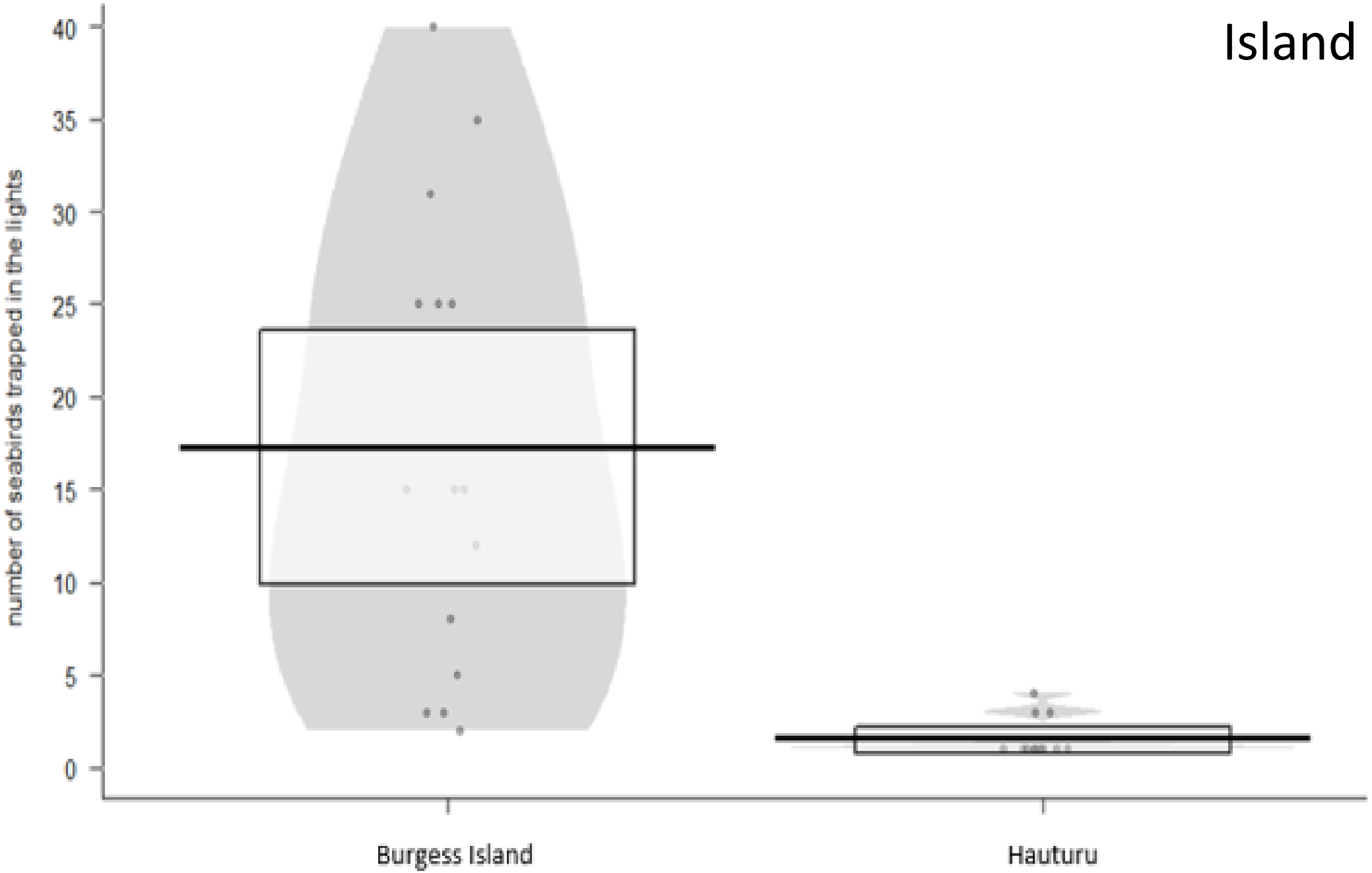

Image: Whitehead, 2020



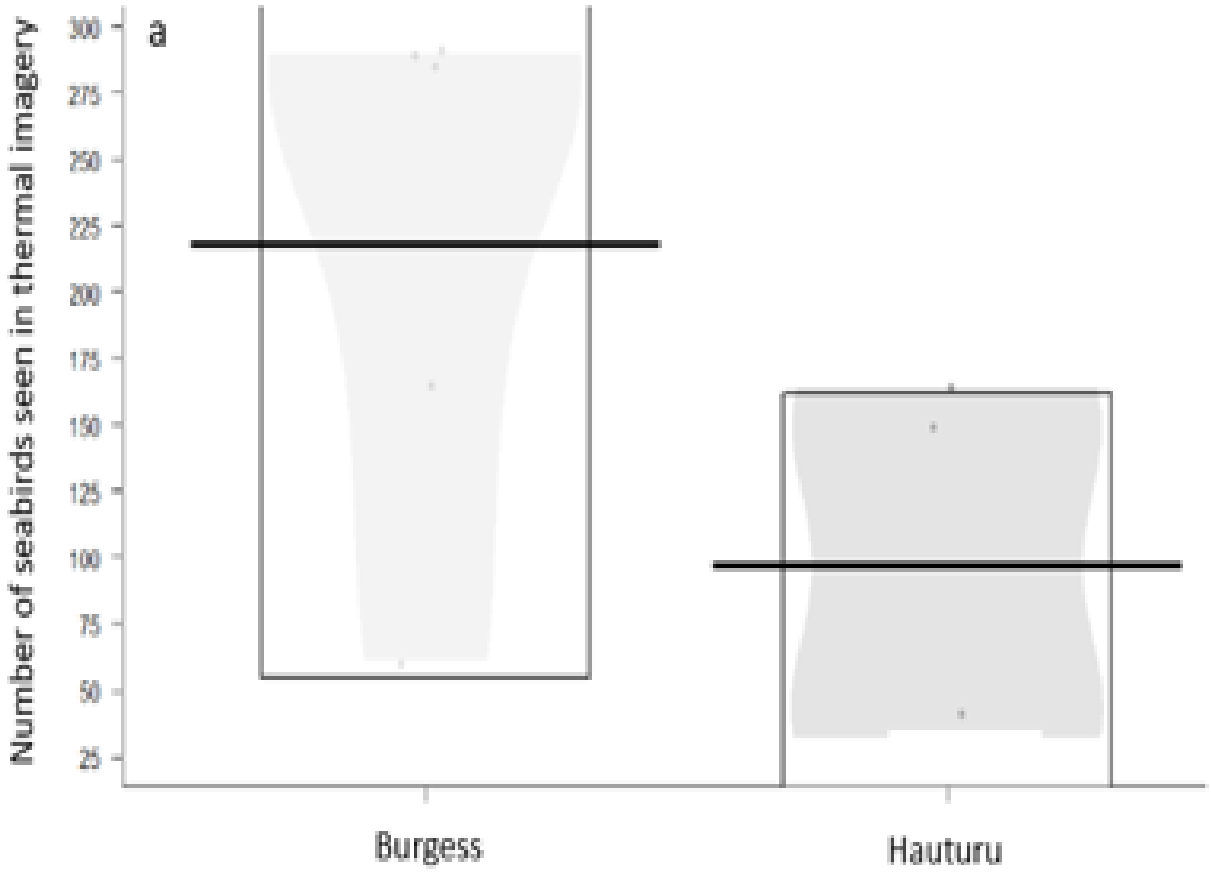


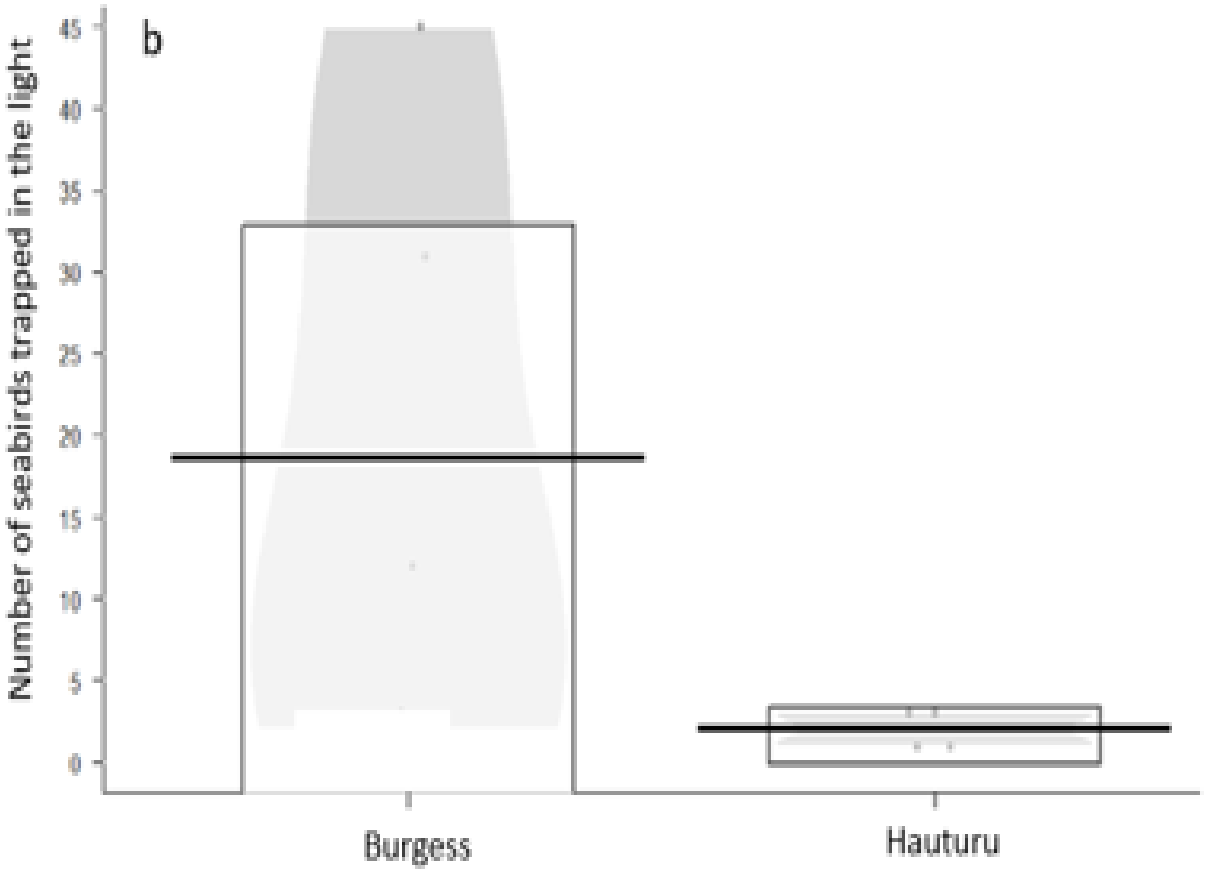
3 categories

- Visually observed passing through the plot
  - Trapped in the light beam
- Observed in scope videos

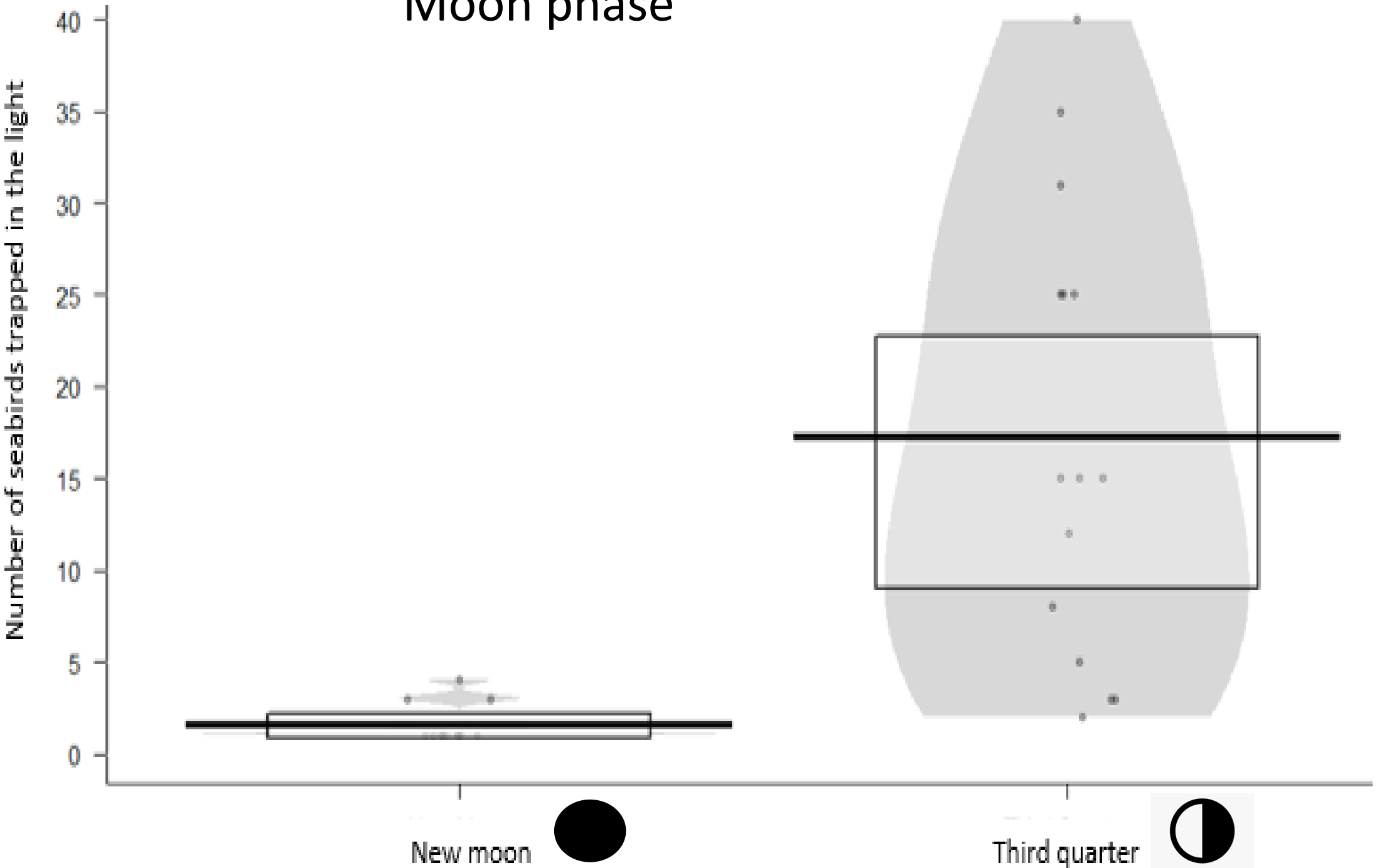

Island
number of seabirds trapped in the lights
40
35
30
25
20
15
10
5
0
Burgess Island
Hauturu

Island

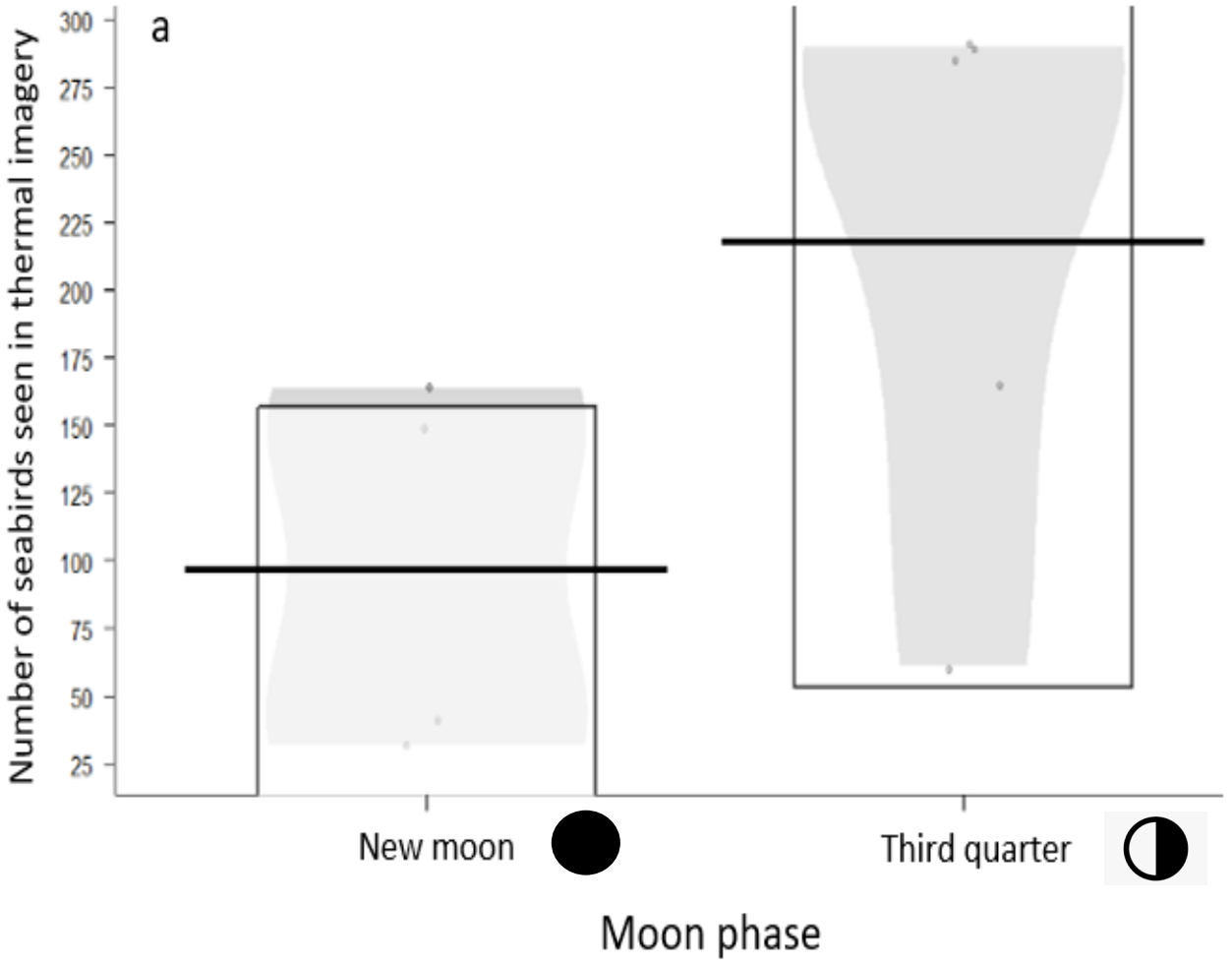

a
Number of seabirds seen in thermal imagery
300
275
250
225
200
175
150
125
100
75
50
25
Burgess
Hauturu


b
Number of seabirds trapped in the light
45
40
35
30
25
20
15
10
5
0
Burgess
Hauturu

Moon phase


Number of seabirds trapped in the light
0
5
10
15
20
25
30
35
40
New moon
Third quarter

Moon phase


a
Number of seabirds seen in thermal imagery
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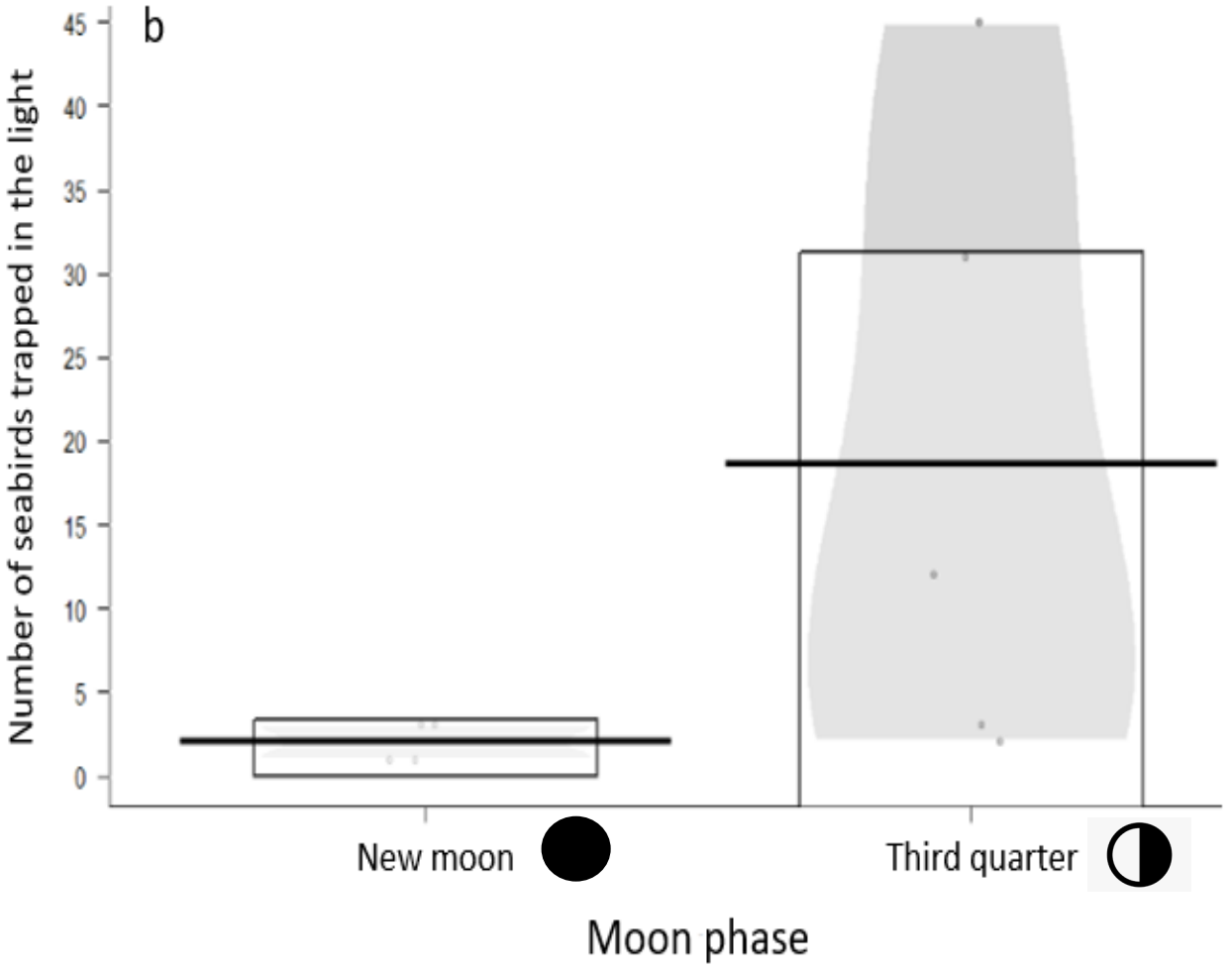
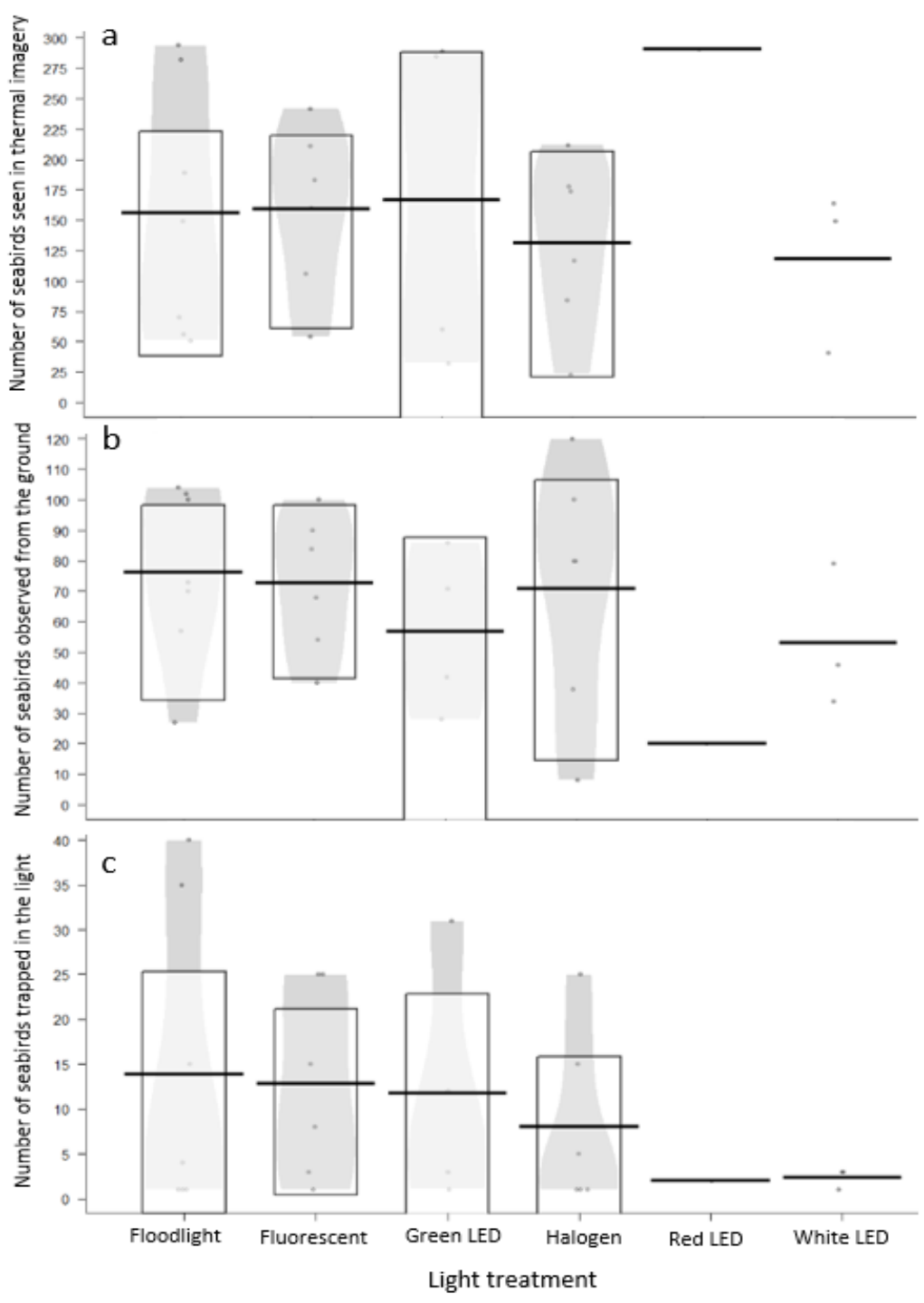
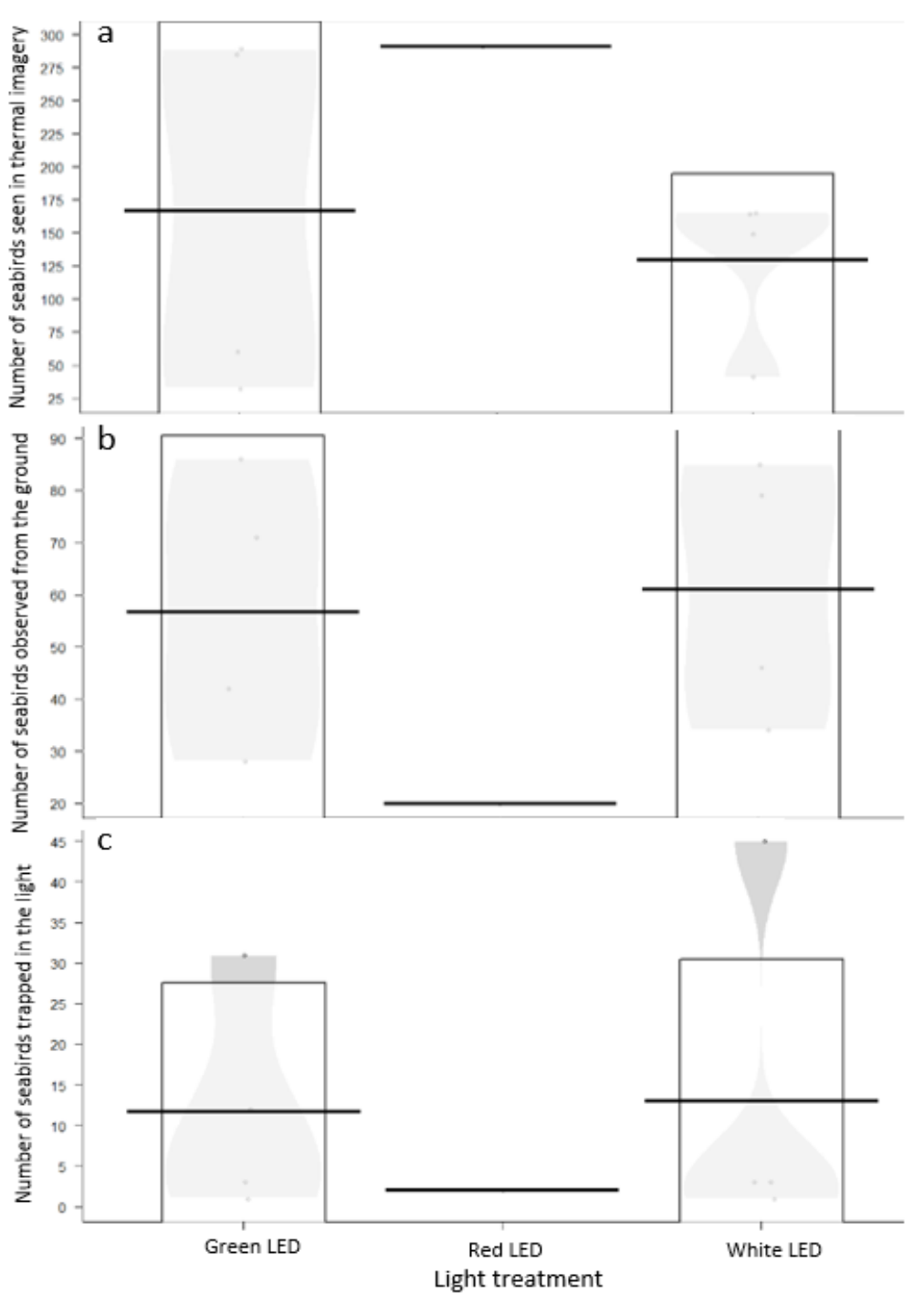
225
200
175
150
125
100
75
50
25
New moon
Third quarter
Moon phase


b
Number of seabirds trapped in the light
45
40
35
30
25
20
15
10
5
0
New moon
Third quarter
Moon phase

Light type


a
Number of seabirds seen in thermal imagery
b
Number of seabirds observed from the ground
c
Number of seabirds trapped in the light
Floodlight
Fluorescent
Green LED
Halogen
Red LED
White LED
Light treatment


a
Number of seabirds seen in thermal imagery
b
Number of seabirds observed from the ground
c
Number of seabirds trapped in the light
Green LED
Red LED
White LED
Light treatment

Grounded birds

Light type	Species	# birds	Island	Moon phase	Grounding event
Flood LED	White-faced storm petrel	4	Burgess Island	Full moon	1
Flood LED	Not determined	2	Burgess Island	Third quarter	5
Flood LED	Cook's petrel	1	Hauturu	New moon	8
Fluorescent	Cook's petrel	1	Hauturu	New moon	7
Halogen	Not determined	2	Burgess Island	Third quarter	3
LED white	White-faced storm petrel	3	Burgess Island	Third quarter	2
LED white	Fluttering shearwater	1	Burgess Island	Third quarter	4
LED white	Grey-faced petrel*	1	Burgess Island	Third quarter	6

Discussion - behavioural experiments

- Difference between islands
  - Different species on each island?
  - 13 birds grounded on Burgess, 2 on Hauturu

- Difference between moon phase
  - More birds attracted during brighter moon
  - Likely due to small sample size

Image: Whitehead, 2020

Discussion – Seabird light perception & behavioural experiments

- Seabirds observed for all light treatments
  - No significant differences in the attractiveness to different lights despite differences in brightness and colour/hue
    - Likely due to small samples sizes
  - Of the 15 grounded birds, flood LED (3), white LED (3), halogen (1), fluorescent (1)

Image: Whitehead, 2020

Discussion – Seabird light perception & behavioural experiments

- Seabirds observed for LED's (white, red, green)
  - No significant differences
    - Likely due to small samples sizes

  - Many other studies and anecdotal evidence have found red light less attractive to nocturnal species

- PhD student to continue land-based lighting experiments

Image: Whitehead, 2020

Image: Whitehead, 2020

Limitations

- Small sample sizes
- Scope memory
- Difference lenses on the two different thermal scopes
- Ground-based observation reflect human visual system
- Bird counts from thermal imagery only done by one person at this stage
  - Re-counts by 2+ poeple

Image: Whitehead, 2020

Conclusion and recommendations for vessel-based behavioural experiments

- Insight into nocturnal seabird visual system
- Larger sample sizes required
- Refined methodology for further land-based and vessel-based behavioural experiments

Image: Whitehead, 2020

Conclusion and recommendations for vessel-based behavioural experiments

- Increase sample size for each light
- Omit the smaller white LED
- Time experiments with:
  - common diving petrel fledging
  - darker nights
- Use less intense LED floodlight
- Different thermal imaging equipment and angle

Acknowledgements

Iwi - Ngāti Rehua-Ngātiwai ki Aotea and Manuhiri Kaitiaki Charitable Trust

Fieldwork: Edin Whitehead, John Rudolph, Ryan de Regnier and Gaia Dell'Ariccia

DOC staff at the Aotea and Warkworth Area Offices

DOC rangers on Hauturu Little Barrier Island

DOC Conservation Services Programme team

Image: Whitehead, 2020

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

Proposed methodology for sea-based testing

Megan Friesen, Kerry Lukies, Ariel-Micaiah Heswall, Anne Gaskett, Chris Gaskin

Photo: Edin Whitehead @edinatw

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Set-up

- Light array will be set up on vessel bow
- Lights to be projected for 15 min increments (including 15 min dark control period)
- 10 mins of dark in between
  - Allows birds to readjust to night sky in between treatments
- Three active researchers
  - Record bird numbers per treatment
  - Record bird behaviors (trapping, etc) and monitor bird safety
  - Operating thermal imaging camera

Light Type
Fluorescent
Halogen
LED green
LED red
LED white flood

Set-up

Chum-

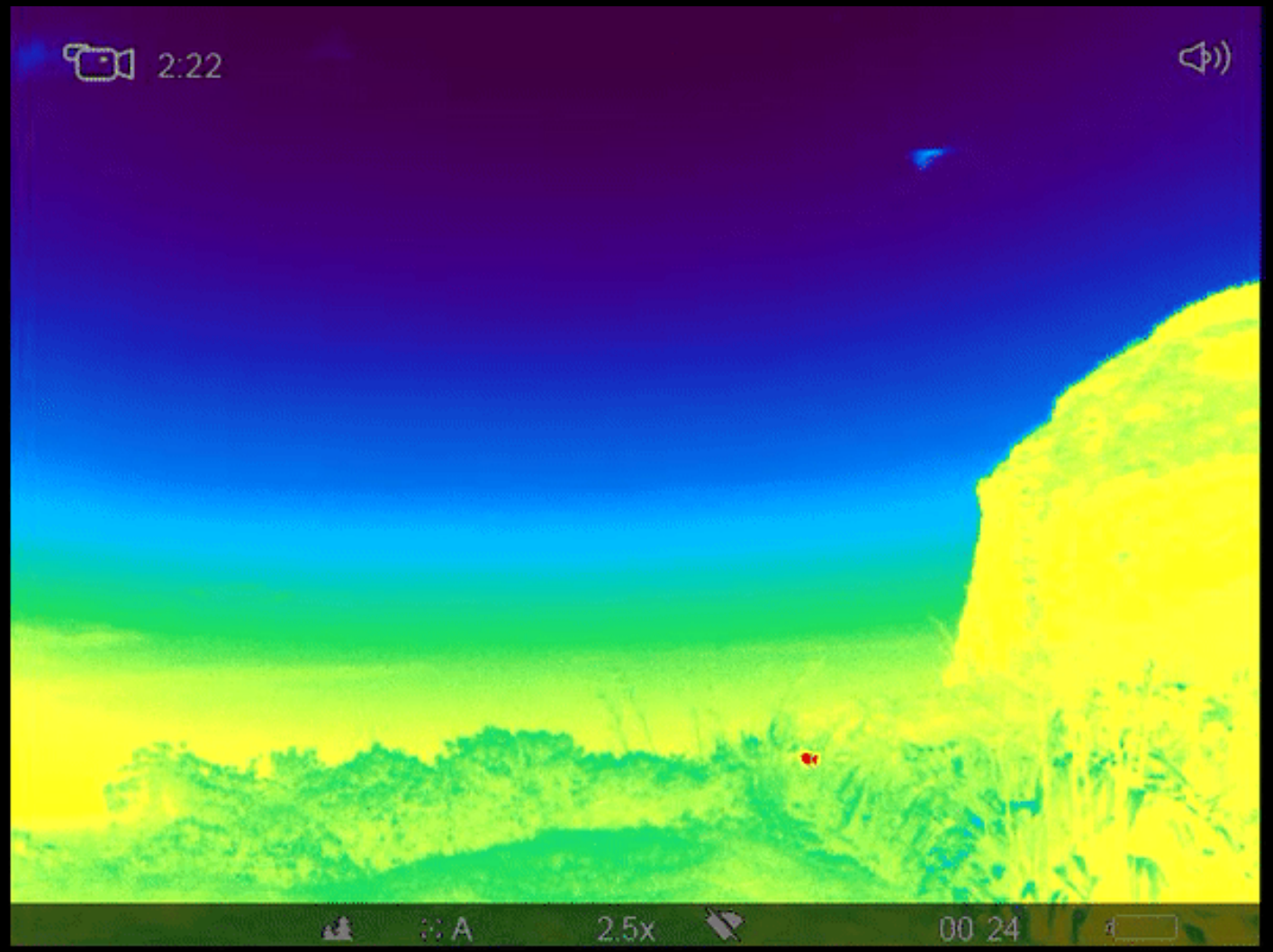
Use chum on deck during all treatments to emulate fishing vessel odour

Light Type
Fluorescent
Halogen
LED green
LED red
LED white flood

Thermal image recording

- Cross-check results of in person researchers
- Allows standardization of survey area in space

Photo: Edin Whitehead @edinatw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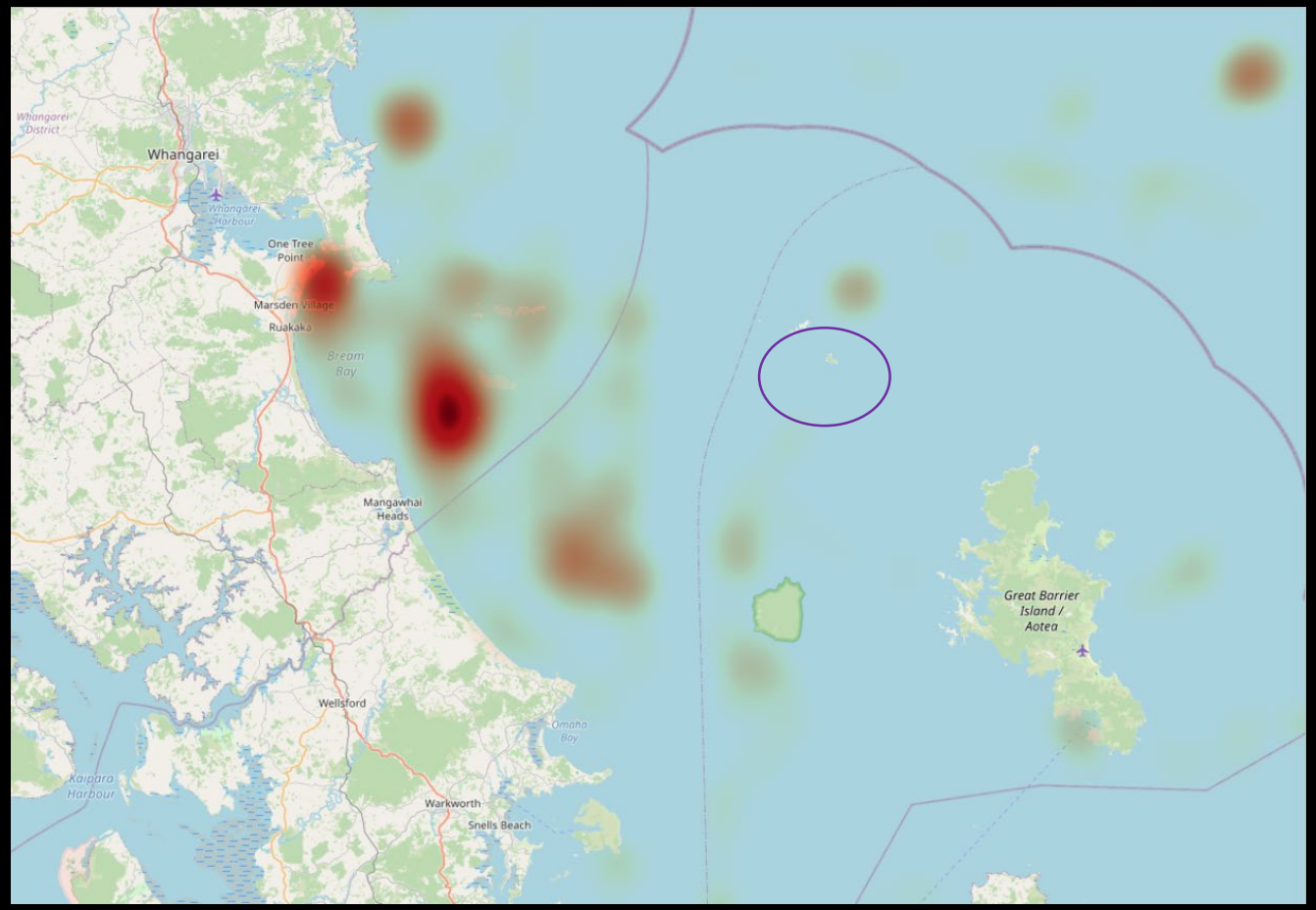
Location

- Vessel will be anchored in hotspots of night fisheries in the Hauraki Gulf
- Near Mokohinau Islands
- Large bird abundance and diversity



Based on 3 years of night-fishing data

Experiment timing

Timing	Target Species
October/November 2020	diving petrels
	white-faced storm petrel
	little shearwaters
	fairy prion
	grey-faced petrel
	Buller's shearwater
	flesh-footed shearwater
	Black petrel
	Cook's petrel
March/April 2021	Cook's petrel
	NZ storm petrel
	Buller's shearwater

- Trips will target the week surrounding new moon during each trip (or as close to this period as possible)

Questions?

Photo: Edin Whitehead @edinatw