Using Electroretinograms to Characterize the Retinal Response of Endangered Hawaiian Seabirds to Different Light Spectra

Hannah Moon | *University of Hawai'i at Mānoa*
hmoon@hawaii.edu

Project Team

Tracy Anderson - *Save Our Shearwaters* - Collaborator
Molly Bache - *Save Our Shearwaters* - Collaborator
Marc Travers - *Archipelago Research and Conservation* - Collaborator
Ellis Loew - *Cornell University* - Consultant
Megan Porter - *University of Hawai'i at Mānoa* - PI

Abstract

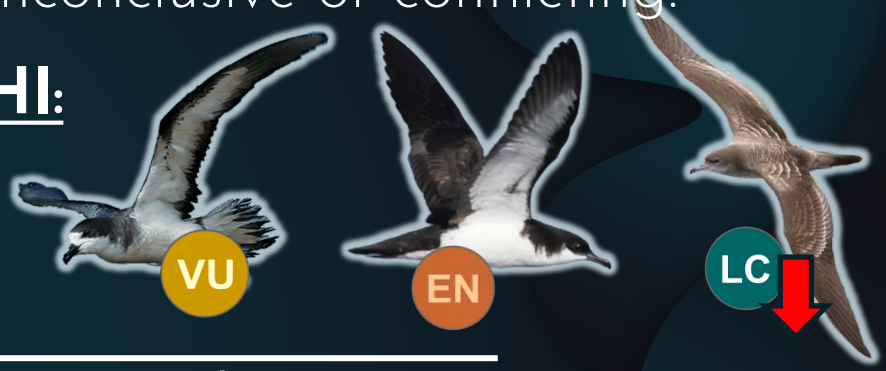
Solid state lighting (SSL) causes high mortality in seabirds due to light attraction.

Behavioral studies of light spectra and attraction are inconclusive or conflicting.

Species of concern on Kaua'i, HI:

Pterodroma sandwichensis, *Puffinus newelli*, *Ardenna pacifica*

Attraction rates vary between species and age groups



With electroretinograms, we measured

(1) flicker fusion frequency (FFF) (2) electrical response to light

in 38 total fledglings and adults

using ≤ 5 intensities of three different spectra: peaks @ 385nm, 450nm, 594nm

! FFF: varied between spectra

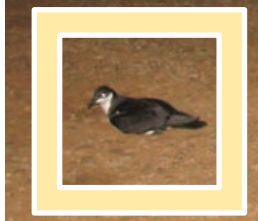
! Electrical response: similar in fledglings/adults, varied between species

These data have implications for management of birds using SSL

Objectives

To better understand physiological drivers of observed variation in seabird light attraction behavior

Every fall, fledgling seabirds around the world head to sea for the first time. Many are attracted to and grounded under streetlights



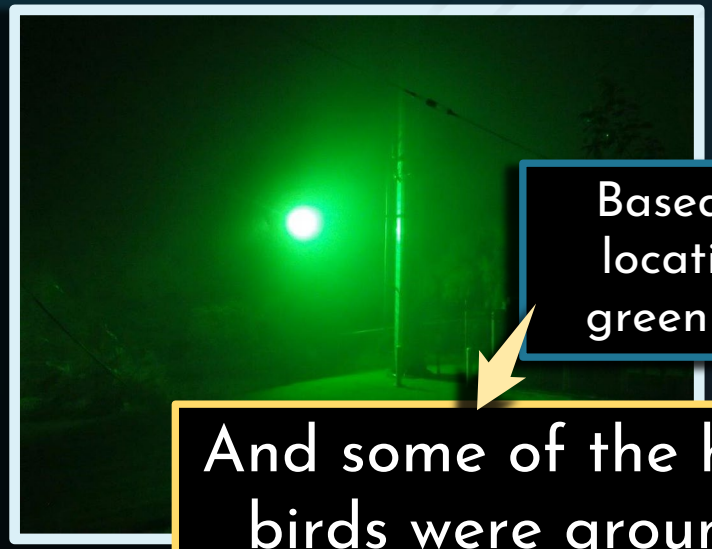
Unable to fly again, they are typically hit by cars or killed by predators

Turning off lights is ideal but not always possible

Changing light spectra to stop attraction is a popular idea

but...

Behavior studies of light spectra and attraction have mixed/conflicting results at best



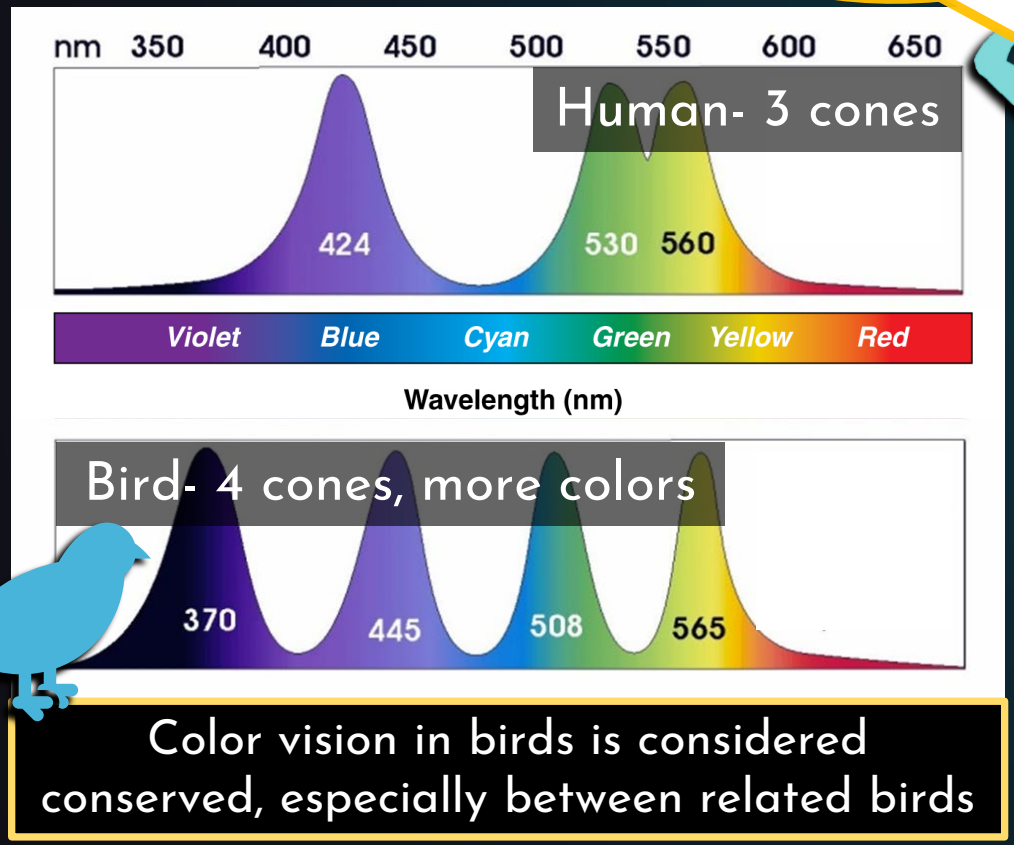
Based on a popular study, a location in Hawai'i installed green lights to save seabirds.

And some of the highest numbers of birds were grounded in one night

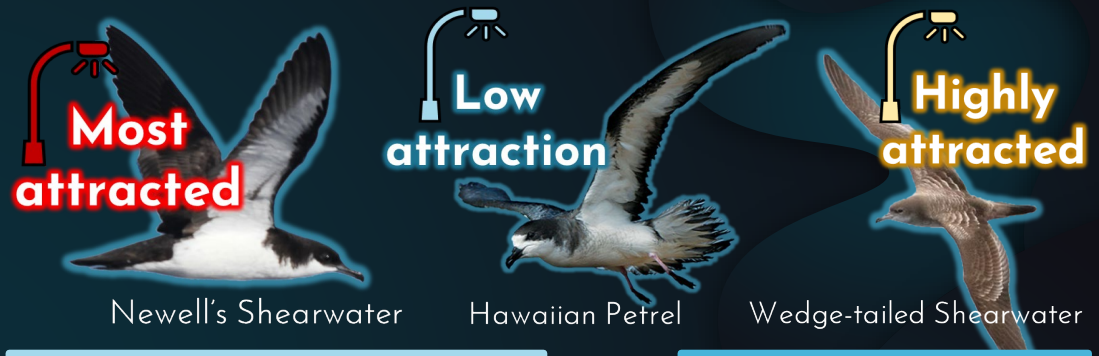
If we want to design bird friendly lighting, we must stop guessing at spectra and study avian visual systems

Humans and birds have VERY different color vision

and our visual bias is STRONG!



Color vision in birds is considered conserved, especially between related birds



In Hawai'i, light attraction varies between related seabirds.

+

Juvenile birds are far more affected than adults

Questions about vision physiology and light attraction:

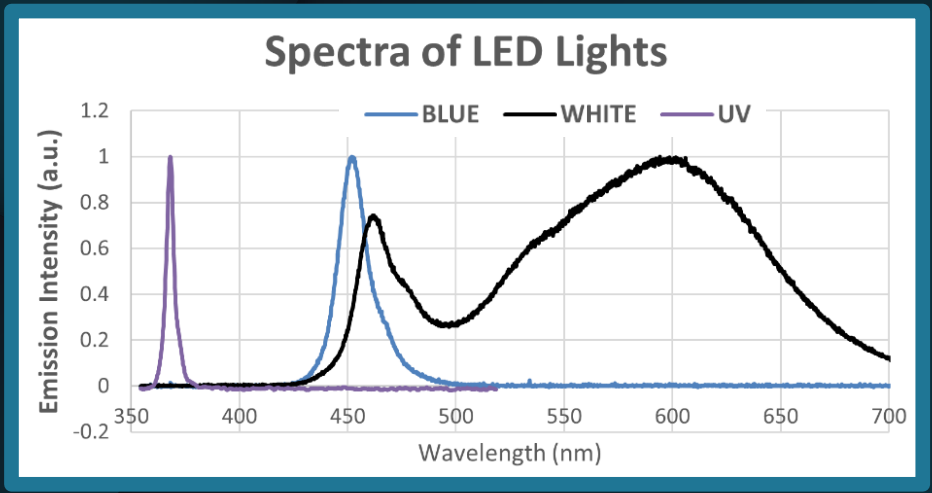
1. Does spectra affect speed or strength of retina response?

2. Does response vary between species, age, or sex?

Methods

This work involved live endangered birds rescued after grounding. Safety was the priority. Birds were tested opportunistically, and time was limited

Lights Tested



2 different tests: *(birds assigned randomly)*

Blue Light 451nm **(3 intensities)**

UV Light 380nm *(5 intensities)*

+

"Long Wavelength" Light (LW) peak @ 594nm *(3 intensities)*

Isolated by adapting the eye to blue light and flashing a white light

Birds Tested *(38 total)*

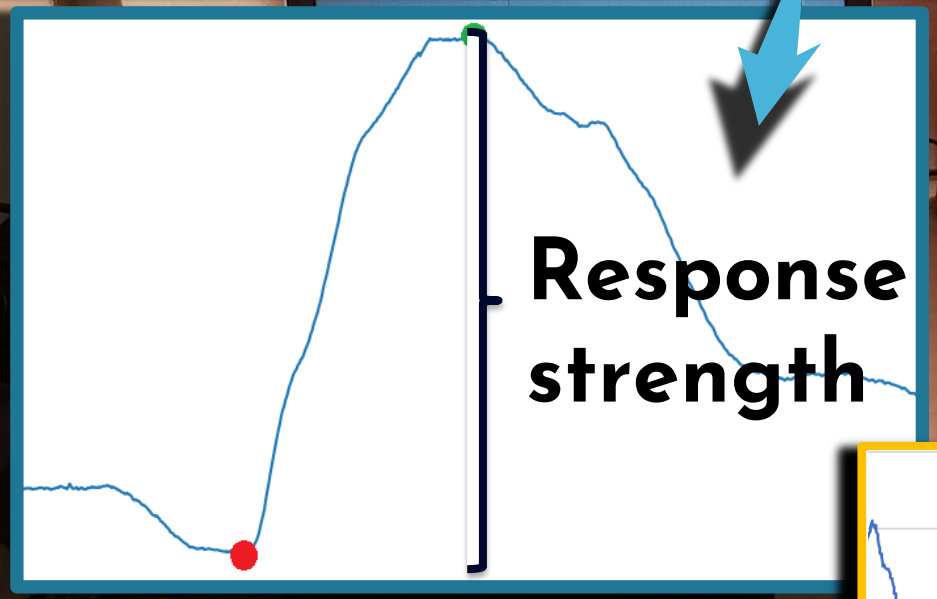
Determined by blood test

Birds per light test key: UV Blue/LW

5 8	5 6	2 1
Juveniles	Juveniles	Juveniles
2 2	3 4	NA
Adults	Adults	

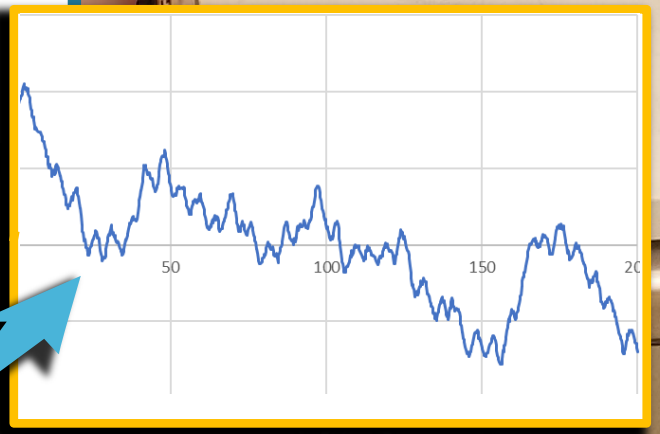
Electroretinography Setup

Measures electrical response in the eye in microvolts in real time



Flashing LED Light

Measurements recorded w/non-invasive electrode

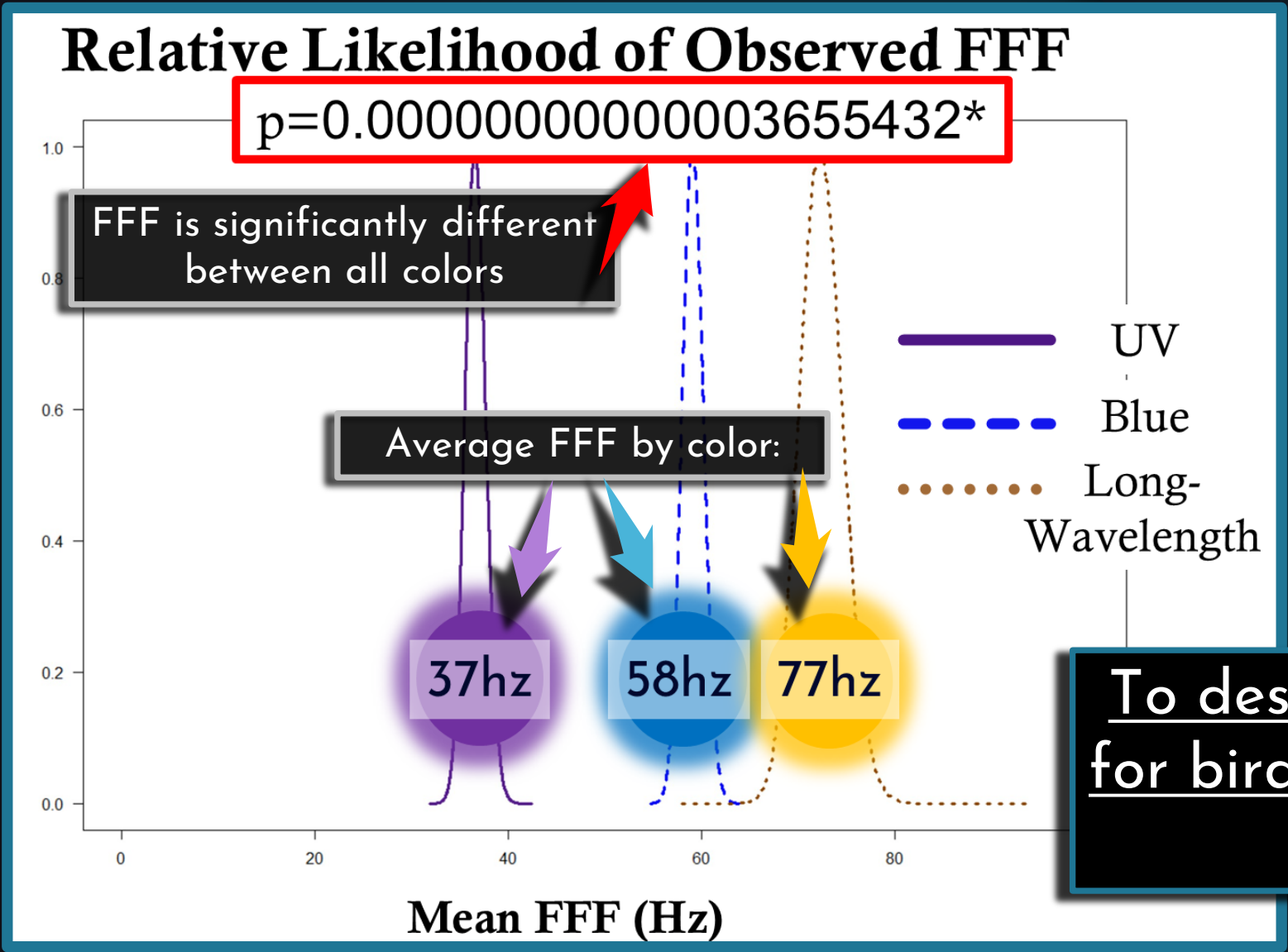


Flicker Fusion Frequency

(FFF) Response Speed. Rate a light must flash (Hz) to be perceived as constant

Anesthetized bird goes here

Results: Flicker Fusion Frequency (FFF)



Sex, age, and species had no effect on FFF

2nd study to document how spectra affects flicker fusion in birds

As a group, seabird response is unique

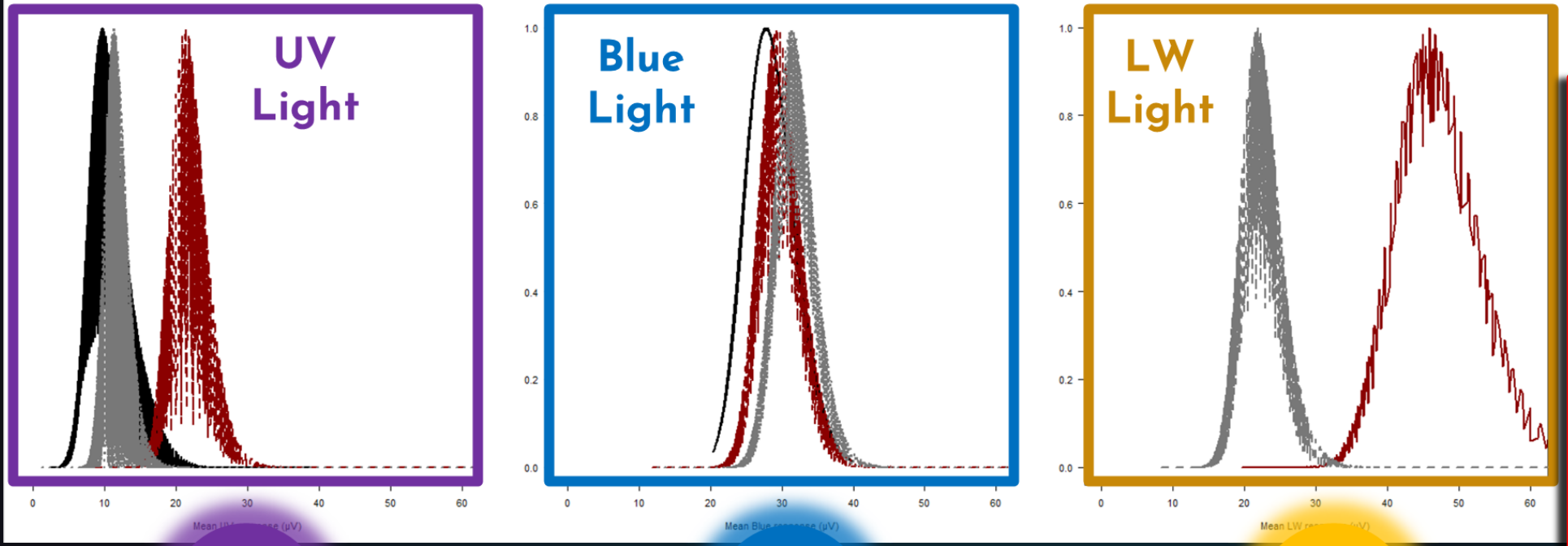
To design lights around flicker for birds, target bird group and spectra matter

Results: Response Strength

Surprisingly, age had no effect on response strength

Also unexpected, females had consistently weaker responses to light than males

Relative Likelihood of Observed Response Strength in Microvolts



p=0.0063*

p=0.67

p=0.017*

Response to UV and LW challenges idea of highly conserved color vision in birds.

Key Takeaways

These data are a broad test of response to light

further studies on how specific parts of the eye filter and detect light, and how they vary between species are necessary

Lots of potential for targeted management by combining vision studies with new lighting technology

Vision is complicated

Management decisions about lighting should be made with caution. Not all studies are well executed or have broad application

Color vision isn't whole puzzle

Even for seabirds and lights. There's still so much we don't know.

THANK YOU!

Hannah Moon

@SeabirdsEyeView

hmoon@hawaii.edu