Light Transmission in Turbid Water Environments for Marine Bycatch Technology

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***Abstract*— Fisheries bycatch is a cause of worldwide risk to marine biodiversity, which is largely detrimental to fisheries and marine environments. Marine megafauna such as sharks, sea turtles, and sea lions are susceptible to entanglement and possible death as incidental bycatch. Previous studies have shown that green lights on fishing gear effectively deter marine species and prevent entanglement in nets and longlines [1]. Various light sources will be placed in turbid marine environments with their transmissivity recorded to find the most effective wavelength of light for a given marine environment.**

Keywords - *turbidity, bycatch reduction technology, Lindgren Pitman, light transmissivity, marine conservation*

I. INTRODUCTION

The incidental capture of marine megafauna in fishing gear, termed fishery bycatch, is a direct threat to both individual animals and entire populations [2]. In some cases, bycatch is even more extreme because it largely applies to reproductively mature adults or older juveniles, which would soon begin to reproduce, supporting local populations.

Emerging bycatch reduction technologies (BRTs) use green Lindgren Pitman © lights to significantly reduce incidental bycatch without reducing target take [1]. However, these studies have only tested the presence or absence of light and their effect on bycatch. These studies have not tested various wavelengths of light and their effect on bycatch.

The operating principle behind light-based BRTs is that light travels through a marine environment to induce a behavioral response in a marine species. The ability for light to travel through a marine environment is greatly impacted by the turbidity of said environment as well as the range of sight of marine megafauna, which is largely understudied [3]. Turbidity causes light to scatter/diffuse which is the process of a light beams deflecting into many directions.

Marine environments are turbid due to silt, algae, clay, and other suspended material. Turbidity is the cloudiness of a fluid due to suspended particles. Turbidity can be measured in nephelometric turbidity units (NTU). These units refer to the amount of light scattered 90 degrees from a light source by a turbid medium [4]. Furthermore, turbidity fluctuates in bodies of water, which could change the effectiveness of bycatch reduction technologies [5].

Therefore, this study will assess multiple marine environments with various turbid conditions. A relationship between a light source's transmissivity and an environment's turbidity will be found. These values will be graphed as wavelength v. transmissivity for a given turbid environment. The spectrum of wavelengths will be composed of narrow bands of wavelengths provided by our light sources: green Lindgren Pitman lights, green LEDs, and lasers (red-650nm, green-532nm, blue/violet-405nm).

These findings will help determine the optimal configuration of light-based BRTs. The optimal light source to use in a BRT will be directly related to the light source's ability to transmit through a turbid environment. Sources and intensities of turbidity vary across marine environments and within the same environment based on time of day and time of year. Because of this wide variation in turbidity, an in-the-field experiment is necessary to provide real-world results of how light transmits through turbid water environments.

II. METHODS

Data collection will begin when the sun is at its apex and is unobstructed by clouds in accordance with conditions in which a Secchi disk can be used to measure turbidity. Data collection will continue for 12-16 hours with samples collected electronically every 15 minutes.

Each experimental setup consists of a pair of submersible electronic packages encased in a clear polycarbonate cylindrical structure. Each package contains a microcontroller, light emitter, photodetector and data storage device to complete the actions of emitting, measuring and recording light signals (Figure 1).

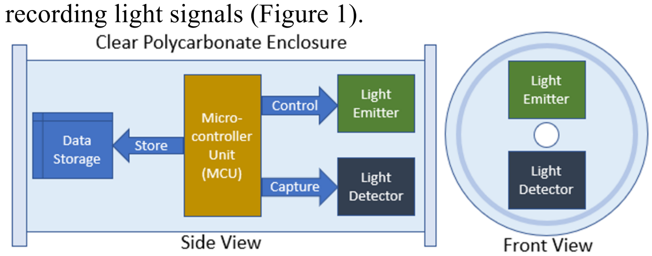

Figure 1: Diagram of the electronics package and its internal functionalities.

Each device will have its light source aligned with a corresponding photodetector. This configuration will allow us to measure the intensity of light from one device to another (Figure 2). These intensities will be used to find the amount of light transmitted from the corresponding light source and thereby find the transmissivity of that light source's band of wavelengths. These structures will be deployed in varied turbid environments in Arizona (i.e. Lake Pleasant, ponds in Papago Park, etc.).

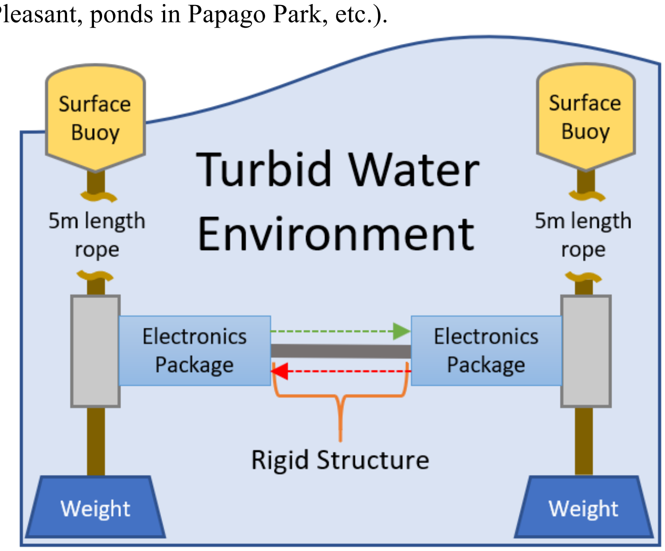

Figure 2: Example set-up for controlled experiments testing the transmittance of light through different turbid mediums.

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