Hawaii Fisheries Disaster Relief Program
Final Report

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2. Title of Project: Developing a turtle safe lightstick

3. Fishery Targeted: Longline fisheries

4. Award received: $69,521
Actual amount spent: $69,521

5. Project Objectives:

A common practice in longline fisheries is to attach light sources near the baited hook on the branch lines in order to attract fish. Laboratory experiments have shown that lightsticks used in the longline fisheries also attract turtles. The goal of this work is to characterize the light produced by these lightsticks and to develop lightsticks that may potentially be less attractive to sea turtles. Objectives outlined in our proposal include:

A) Measuring the irradiance generated by commercially available and modified lightsticks.
B) Develop and field test lightsticks potentially less attractive to sea turtles based – potential modifications include shaded lightsticks and blinking LED lightsticks.

6. Describe how the objectives were met. Focus your response on the activities you accomplished with the award funding. You may also briefly present results if you choose. Your accountability is whether you spent your funding as you specified in your award proposal, with less importance given to the specific results.

A. Radiometric measurements of commercially available lightsticks and modified lightsticks:

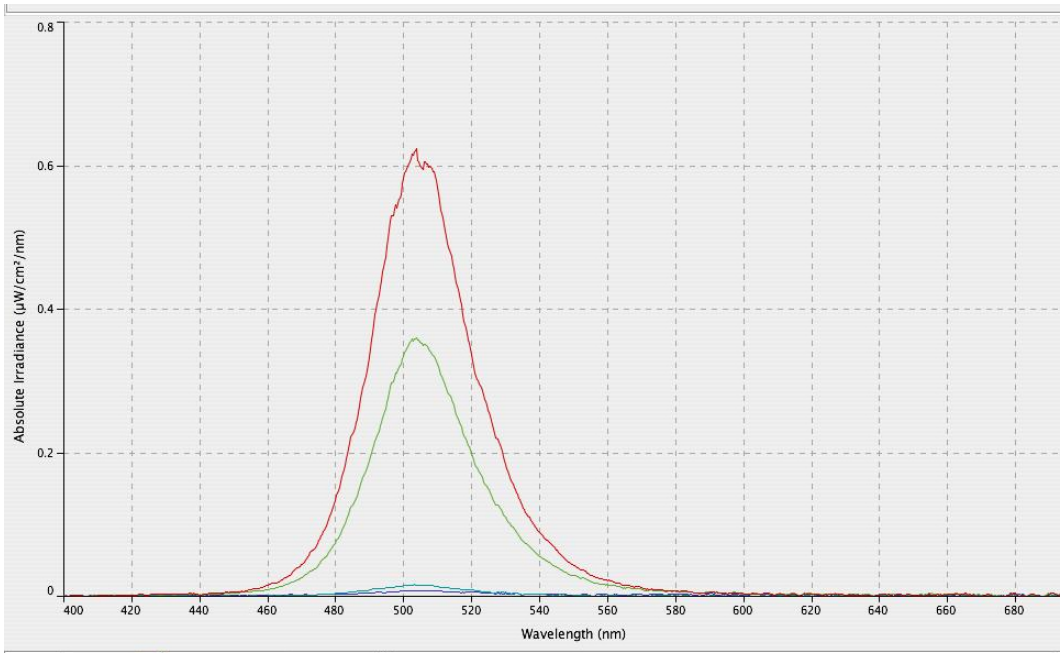
Using an Ocean Optics USB2000 spectrometer fitted with a CC-3-UV-S cosine detector containing a spectralon diffuser, we were able to measure irradiance (intensity of light normal to the probe's surface). By calibrating the absolute spectral response of our system with an Ocean Optics LS-1-Cal tungsten halogen light source we were able the determined the absolute irradiance values at wavelengths from 300-1050nm (encompassing the wavelength values of all tested lightsticks) of the light generated by lightsticks used in longline fisheries.

Using this radiometric system, we examined the irradiance of commercially available lightsticks (LP orange electrolume, amber electrolume, green electrolume, blue/geen electrolume, yellow chemical lightstick, blue chemical lights, and violet chemical lightsticks) and the 2 modified electrolume lightsticks tested on pelagic longlines. Measurements were conducted in a darken room with the lightstick held such that the radiometric probe was positioned exactly 10 cm away. The Ocean Optics irradiance probe was placed a) directly below the lightstick (180°), b) directly above the lightstick (0°), c) to the side of the light stick (90°), and d) at a downward angle with respect to the lightstick (135°). Using Spectra Suite software we were able to take absolute irradiance measurements for wavelengths between 300-800nm from each lightsticks and from each angle (see Table 1, and Figure 1 for example of results).

Table 1. Absolute irradiance measurements at the peak wavelength of lightsticks used on pelagic longlines.

Lightstick	Peak Wavelength	Absolute Irradiance (mW/cm^2/nm)			
		180°	**135°**	**90°**	**0°**
LP Green Electrolume	524.59nm	6.66E-01	2.06E-01	5.76E-02	8.45E-03
LP Blue/Green Electrolume	504.01nm	6.23E-01	3.60E-01	1.53E-02	7.19E-03
LP Blue Electrolume	460.16nm	6.21E-01	3.32E-01	2.35E-02	7.43E-03
LP Orange Electrlume	594.24nm	3.41E-01	9.91E-02	7.26E-02	4.80E-03
Wide Shade Electrolume	594.24nm	3.29E-01	9.30E-02	0.00E+00	0.00E+00
Narrow Shade Electrolume	594.24nm	3.29E-01	0.00E+00	0.00E+00	0.00E+00
Lightstick	**Peak Wavelength**	**Single point measurement**			
LP Green Duralume	510.30nm	4.96E-02			
LP Blue Duralume	447.13nm	7.59E-02			
LP Violet Duralume	469.51nm/619.18nm	1.83E-02	3.48E-02		

Figure 1. The absolute irradiance measurements of a blue-green electrolume lightstick taken from different angles. The red line indicates irradiance measured when the radiometric probe was positioned directly below the lightstick, the green line are results with the probe pointed at 135° to the lightstick, the blue line are results with the probe pointed at 90° to the lightstick and the purple line are results when the probe was pointed directly above the lightstick.



B. Developing and testing the feasibility of modified lightsticks for use in commercial fisheries.

We examined several modifications that incorporated shading (thus decreasing the amount of light shining upwards towards the surface). Four modifications were developed for lightsticks (2 for LP LED based Electralumes and 2 for LP Duralume chemiluminescent lightsticks). These modifications were simple shades placed on the lightsticks such that the amount of light emitted upwards was limited. Laboratory experiments with juvenile sea turtles suggested that reducing upward light emission would reduce the attractiveness of the lightsticks to sea turtles.

The two modified LP LED Electrolumes were incorporated onto night-time, shallow set longlines targeting swordfish. These prototype-shaded lightsticks were tested on the R/V Oscar Sette to determine their feasibility for use on commercial longlines and to examine the effects that the shades would have on the sink rates and vertical migration of the branchlines during soak time. A total of 84 experimental branch lines were deployed across 7 longline deployments. Each branch line had either a modified lightstick or a control lightsticks attached 1 meter above the hook joint. To determine the effects of the shaded lightsticks on the vertical migration of the branchlines, two TDR (temperature-depth recording units) were placed on each branch line. One was attached near the hook and the second was attached to the mainline adjacent to the branch line clip. A total of 168 TDRs were deployed. These TDRs provided information on sink rates and depth fluctuations. Adjacent branch lines were used to examine differences between the effects of control lightsticks and the modified lightsticks.

In addition, through communication with Eric Brooks of Lindgren-Pittman (a longline gear manufacturer) as well as Rick van Lent of SaveWave (an European company specializing in the development of technologies aimed at improving fisheries), several commercial products that utilize blinking LEDs in lightsticks designed for pelagic longline fisheries were found. LP has produced a line of lightsticks that incorporates a small chip to regulate the blink rate of their battery powered Electrolume lightsticks. Depending on the desired blink rate, different chip designed can easily be incorporated. Likewise, SaveWave has produced flashing battery powered LED lightsticks as well and has expressed interest in changing the flash rate to fit the on-off profile thought to reduce the attractiveness of the lightsticks to sea turtles.

7. Discuss differences between work anticipated in your proposal and work that was actually completed.

A. Radiometric measurements of lightsticks.

We had proposed to take radiometric measurements of lightsticks in the open ocean. After consultation with colleagues who specialize in vision and optics in seawater, it was suggested that measurements in air would be more appropriate since light transmission through water could be modeled based on our results. It was also pointed out that we would have no control over the water quality in which we would be conducting our work, thus creating a confounding factor.

8. Discuss differences between expected and actual costs.

There were no significant differences in expected and actual costs.

9. List all publications, posters, brochures, and other informational material published with project funding. Submit copies of publications to JIMAR

Wang, J.H., Fisler, S., Swimmer, Y. (in manuscript). Developing sea turtle bycatch reduction strategies: testing visual alerts.

Swimmer, Y., and J. H. Wang. (2007). Sea turtle and pelagic fish sensory physiology workshop, September 12-13, 2006. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-11, 35 p.