Characterization of Spatial and Spectral Distribution of Outdoor Lighting at Wrigley Marine Science Center

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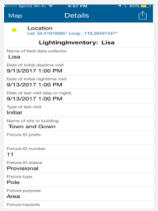
Background

The Wrigley Marine Science Center (WMSC) is surrounded by a pristine scrubland on Catalina Island. This is an ecologically diverse environment and home to over 60 species of plants and animals found nowhere else in the world. The artificial lighting at the WMSC may disrupt the ecosystem balance. Common species include the Catalina Island Fox, marine life, birds, and insects. The cove in the WMSC is home to many spiny lobsters whose eyes may be especially sensitive to changes in natural lighting. Artificial night lighting effects circadian rhythm, suppresses melatonin, increases vulnerability of prey, and disorients migratory patterns. The goal of this project is to 1) map and describe all outdoor lighting fixtures at the Wrigley Marine Science Center and 2) to use an emerging light assessment device, the f.luxometer, to measure light intensities. Spectroradiometers are generally very expensive and can cost $15,000 or more. The economically feasible f.luxometer is an alternative to standard spectroradiometers. This device is used in conjunction with the ArcGIS Collector App, which allows data to be recorded from a handheld device. The Collector App was designed for the purpose of taking outdoor lighting measurements and has been used by the National Park Service and the International Dark Sky Organization. The data was compared among different light sources to document the impact different lighting fixtures may have on the environment.

Methods

Nighttime light inventories were collected at the Wrigley Marine Science Center. All 23 ceiling fixtures on the laboratory we measured on December 4th, 2017, and the 2 laboratory stair lights and 2 walkway lights were measured on March 23rd, 2018. The f.luxometer was used by pointing the sensor on the device directly at the light source. The melanopic lux as well as the PAR were measured to determine the different impacts the lighting had on circadian rhythm and on photosynthetic activity. The data for each light was taken with the ArcGIS Collector App. Parameters recorded included the fixture type, the fixture shielding, the fixture purpose, and the lamp color. The results obtained from the Collector App were mapped on ArcMap to show relative locations.

f.luxometer



ArcGIS Collector App

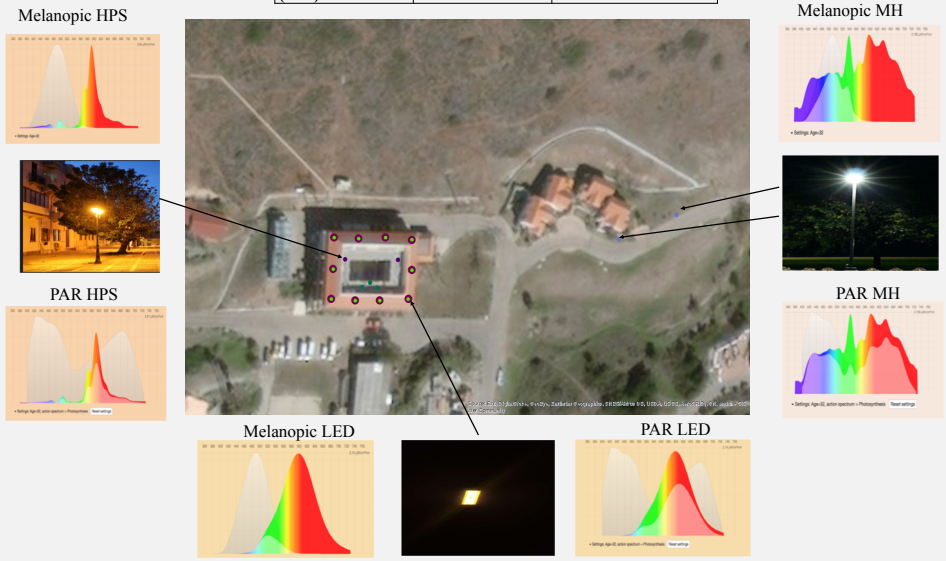
ArcMap

Aerial view of fieldwork site

Results

Table- Melanopic and PAR Numerical Data for Selected Light Fixtures

Fixture Location	Melanopic Lux	PAR ($\mu W/cm^2$)
Filtered LED	215	453
High Pressure Sodium (HPS)	69	208
Metal Halaide (MH)	64	73



Conclusions

The metal halide lights have a greater impact on circadian rhythm and photosynthesis compared to the filtered LED and the high pressured sodium fixtures. A light has the least effect on circadian rhythm and photosynthetic activity when the spectrum does not over lap with the clear portion of the graph. The clear region represents the overlap between the spectral distribution and the response curve for the particular parameter of interest. The melanopic lux and PAR were higher for the LED lights because these measurements depend on both spectrum and brightness. Therefore, although the LED lights have a lower spectrum they have a higher brightness. This shows that LED lights can have greater lux and more illumination than that will result in less impact to circadian rhythms compared to metal halide fixtures. All lights impact circadian rhythm in some form, however, the extent varies because of spectral distribution and illumination of the lights.

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