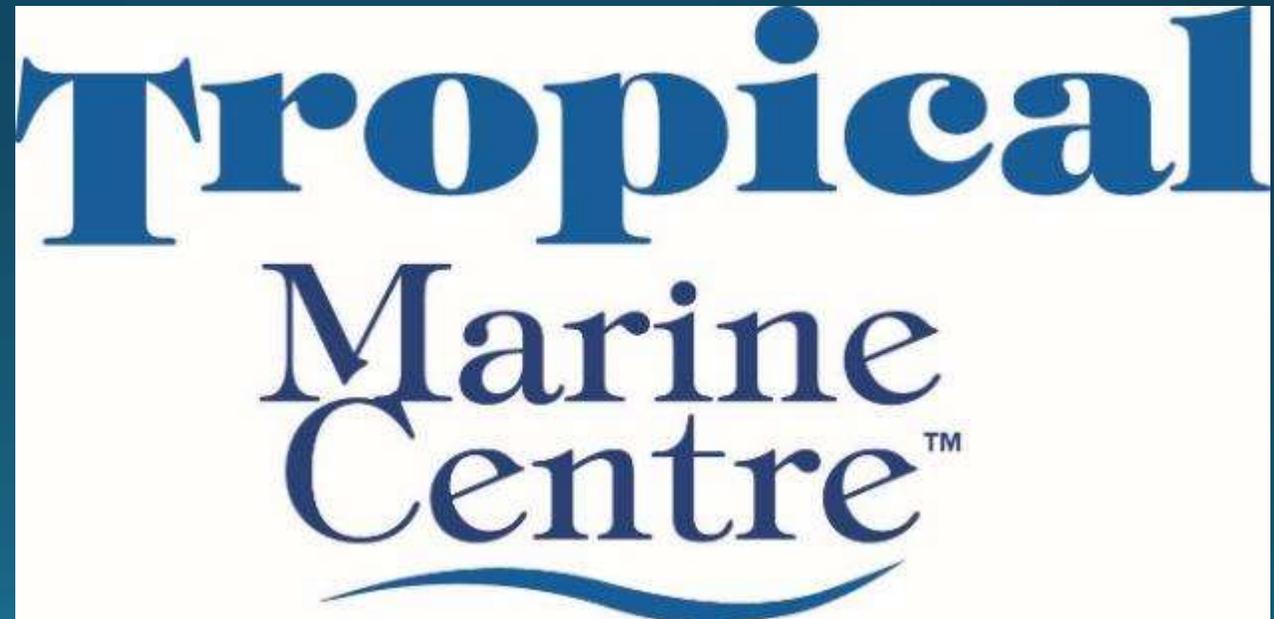




Gyles Westcott

Lighting & Lighting Control Specialist





- **TMC Livestock**

- Tropical Marine Centre was set up over 40 years ago, with the objective of establishing a unique, global supply chain with a focus on short supply chains with ethical and sustainable practices

- This initial objective remains as the beating heart of TMC - not only one of the leading wholesalers of Tropical Marine organisms into the retail sector, but with long-established and proud associations with many public aquariums across the globe.
- We currently have 4 state-of-the-art fish-holding facilities: 3 based in the UK and 1 in Iberia. This passion for livestock and our desire to continually raise the standard of husbandry has led us to diversify and grow so that today, the animals we supply are supported by high-quality frozen foods, salts, additives, and aquarium hardware and filtration systems, developed and tested in-house and now supplied from own catalogues to a global customer base.

- We were one of the first organisations to join up with MAC, and worked with them on shaping best practices. Our hatchery facility was the first MAC certified hatchery in the world.
- We continue to work closely with trade organisations, the scientific community, and also undertake additional investments to ensure that we drive best practice, particularly at source, to ensure ongoing sustainable business at place of origin.

Tropical Marine Centre is a member of the following associations:-



OATA (Ornamental Aquatic Trade Association)

The voice of the ornamental aquatic industry in the UK with the purpose to protect and promote the trade.



OFI (Ornamental Fish International)

World-wide trade association representing all sectors of the ornamental aquatic industry.



EUAC (European Union of Aquarium Curators)

Promoting professional improvement between specialists in the public aquarium field.



AEDPAC (Asociación Española de Distribuidores de Productos para Animales de Compañía)

Spanish Pet trade association.



AIZA (Asociación Ibérica de Zoológicos y Acuarios)

A non-profit organization that brings together major zoos and aquariums in Spain and Portugal.



APCPAC (Associação Portuguesa de Comerciantes de Produtos para Animais de Companhia)

Portuguese Pet Trade Association.



SEDEX (Supplier Ethical Data Exchange)

The largest global platform for sharing ethical supply chain data, empowering responsible supply chains and ethical business practices.

Tropical Marine Centre is also proud to support the following initiatives:-



LINI

LINI's mission is to work with marginalized coastal communities to reverse the degradation of Indonesian coral reefs and raise awareness about responsible and sustainable marine resource use. TMC makes an annual donation which allows LINI to provide full training and education in sustainable mariculture for 10 fishermen



University of Southampton

Tropical Marine Centre sponsors the Coral Reef Laboratory in the National Oceanography Centre, where they are carrying out work on corals, including research into coral pigmentation and fluorescence.

Boundary Lines....

"...using the dynamic interplay between light and water as a route to energy reduction, improved welfare and a new display aesthetic..."

or, to put it another way, the use of LED lighting to make...

Our ANIMALS happy – IMPROVED WELFARE

Our OWNERS happy – LOWER COSTS

Our VISITORS happy – BETTER DISPLAYS

Welfare:

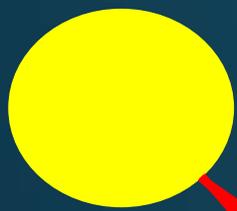
“How do marine organisms interact with light?”

Every aquatic habitat is exposed to light of different and variable brightness, from the sunlit open sea to the heavily-shaded jungle stream...
● **Intensity**

Every location on the planet has constantly changing day-length... days and nights in turn, under the influence of the sun, moon and other celestial forces...
● **Photoperiod**

Water, by its nature, dramatically changes the character and power of the light that tries to pass through it....
● **Spectrum**

How is light influenced by water?



...while the wavelengths of the different elements of the spectrum further influences the degree to which that part of the spectrum either penetrates the water surface, is reflected off it, or is filtered out as it passed through the water column...

The angle of the sun above the horizon, & waves on the water surface, mean that the "angle of incidence" – the angle at which the sun's rays strike the water surface, is constantly changing...

This results in varying amounts of light being either reflected off the surface, or refracted through the surface...

Relative Spectral Intensity of Sunlight II

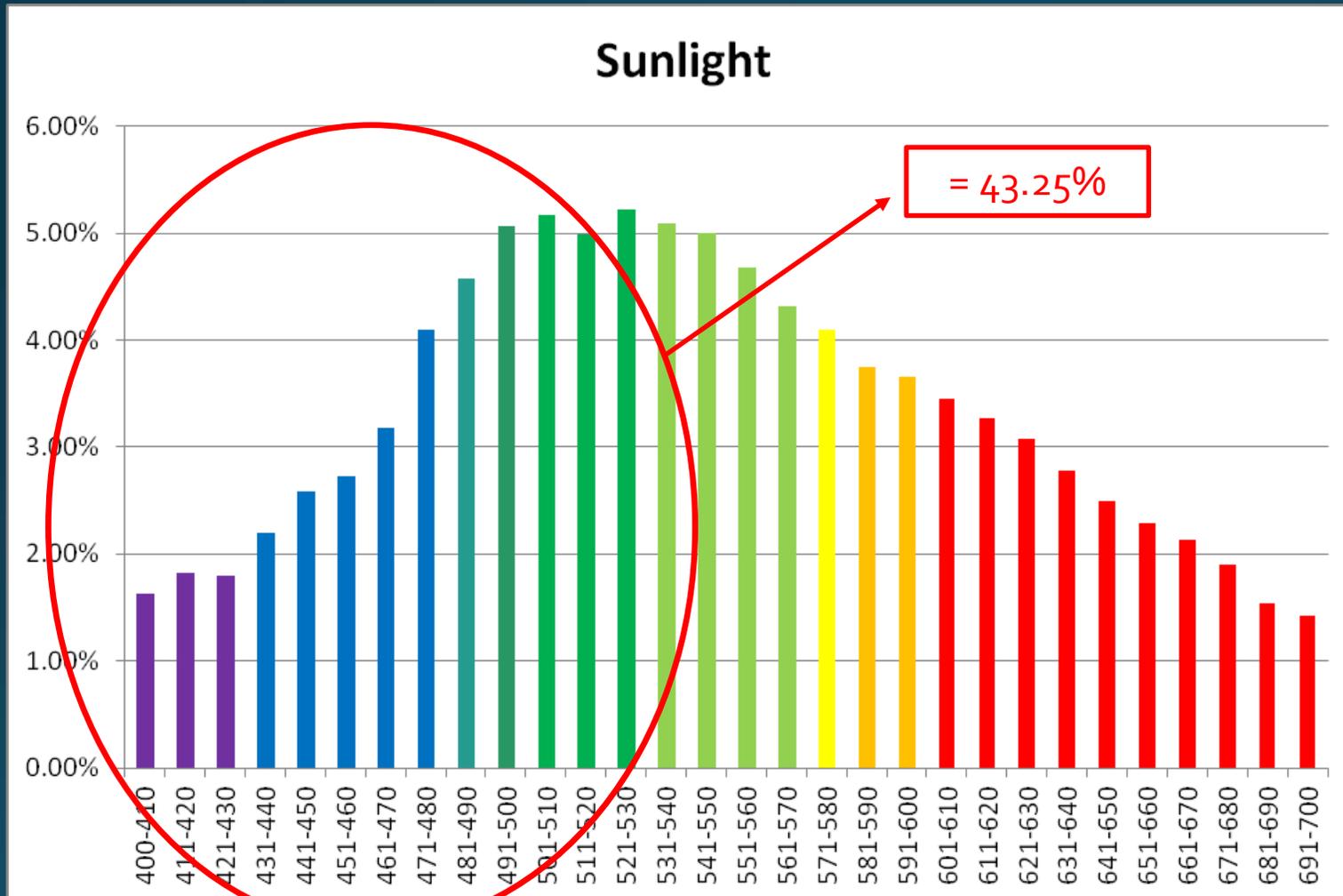
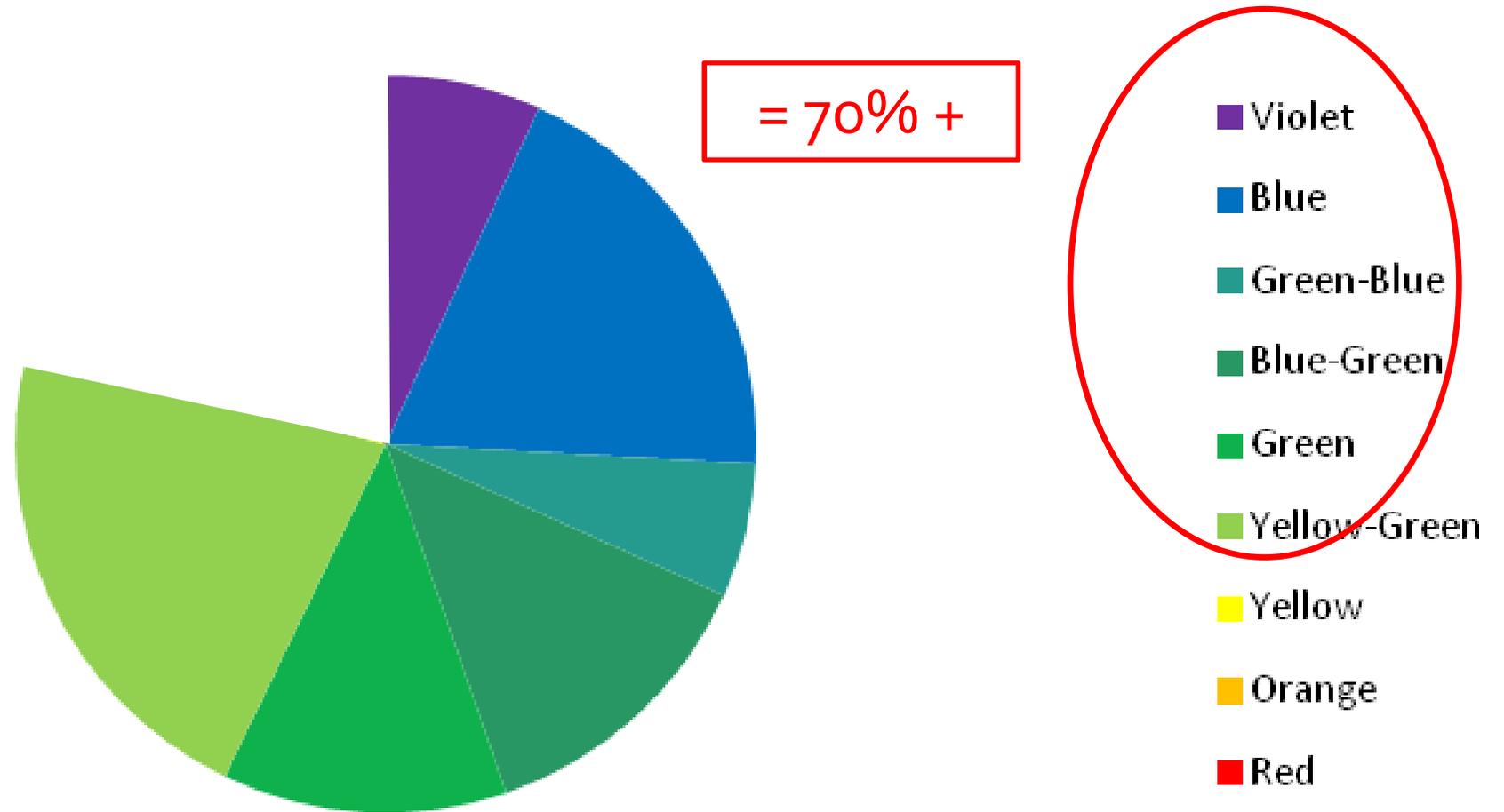


Table 1. Sunlight's spectral composition in per cent per bandwidth.

Color	%
Violet	4.98
Blue	13.85
Green-Blue	4.49
Blue-Green	9.95
Green	9.98
Yellow-Green	19.25
Yellow	4.13
Orange	7.66
Red	25.71

SPECTRAL COMPOSITION OF LIGHT IN CLEAR SEAWATER AT 10 FOOT DEPTH



All life evolved from an aquatic progenitor...

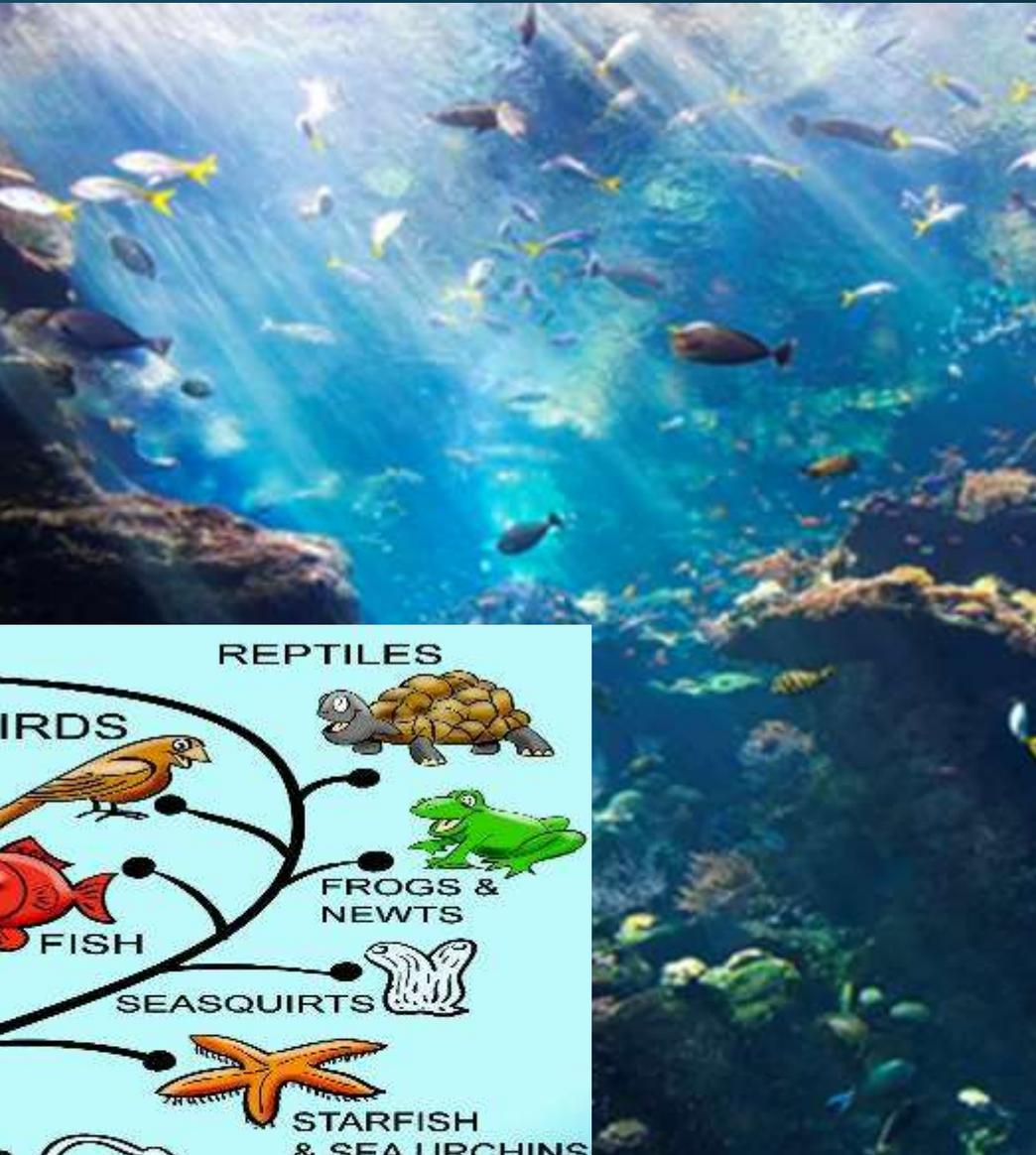
- Light intensity and spectrum is closely linked to circadian rhythms, driven by solar, lunar and astral cycles...



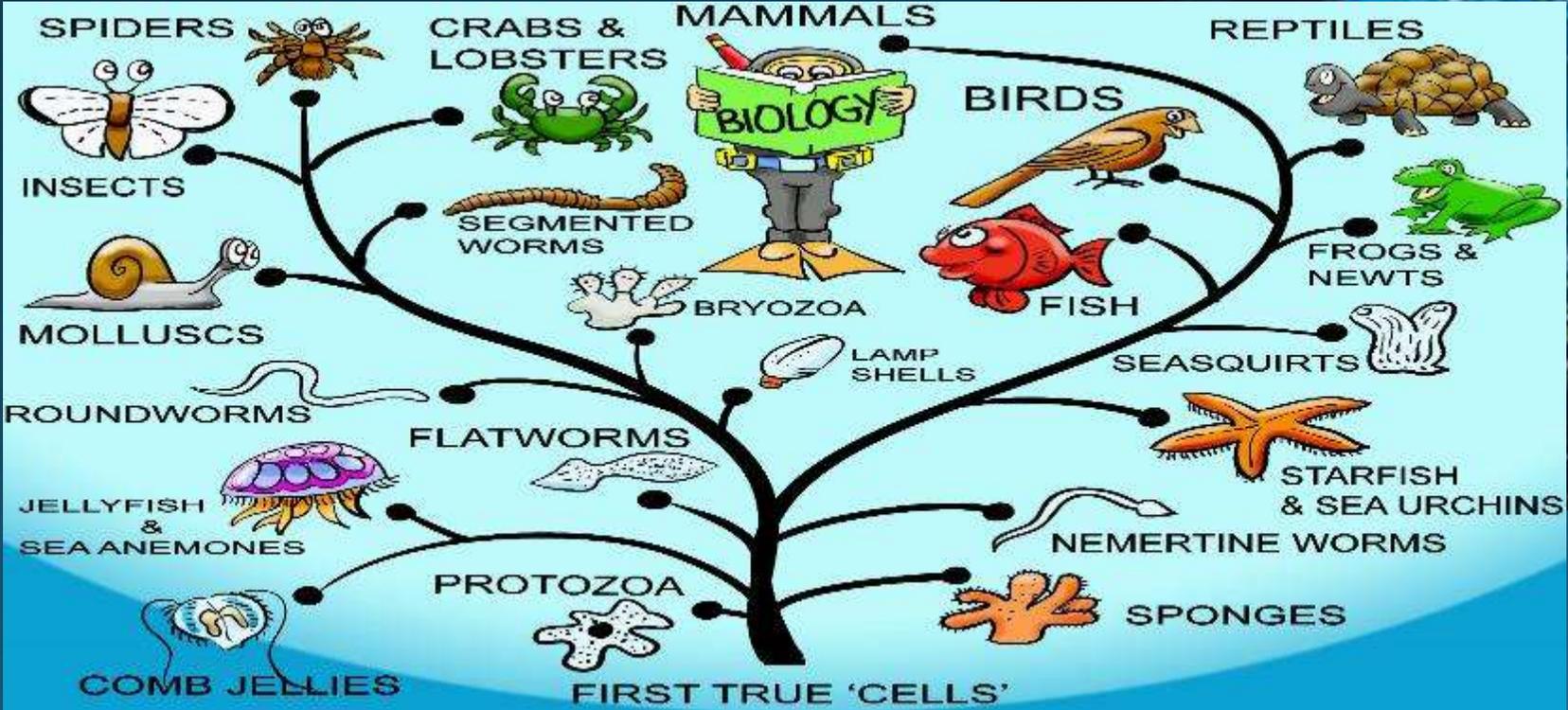
- These cycles are responsible for driving environmental conditions which govern biological productivity to a greater or lesser degree...
- ...in simple terms, they are an accurate cue to behaviour - when to eat, when to rest, when to hide, when to breed...
- ...it follows that the ability to sense and react to the spectrum and intensity of light (and associated variables – temperature, day-length, etc.) becomes a powerful survival tool, and hence, a strongly selected evolutionary trait....

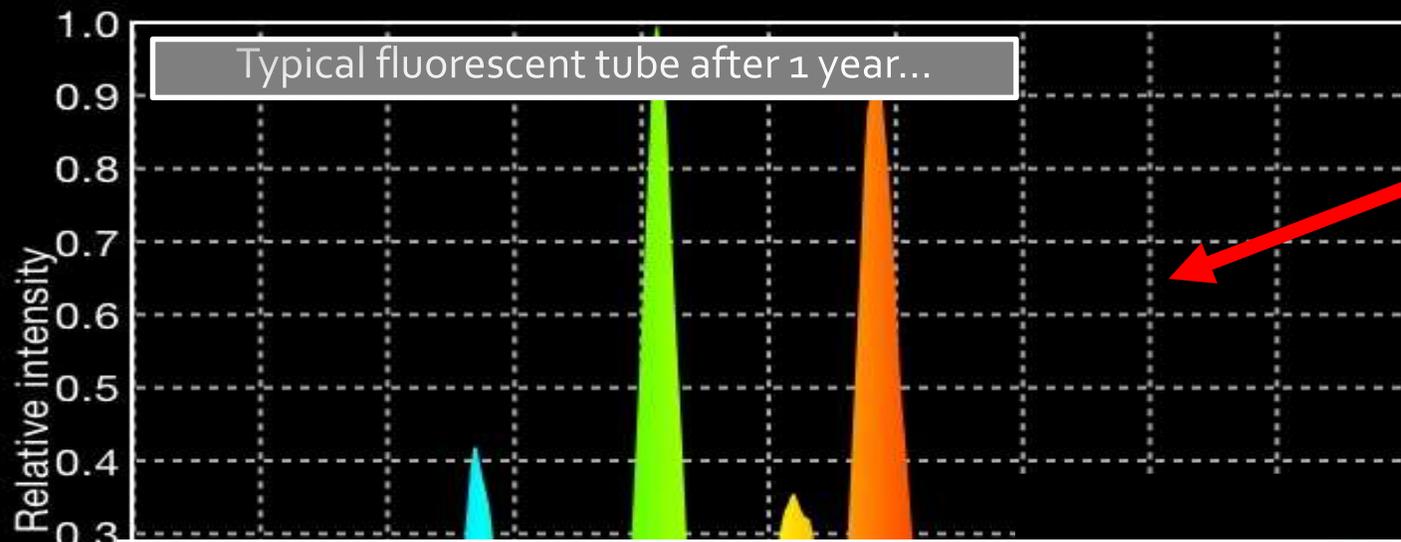
- ...and if the photic profile that defines this primordial aquatic world is BLUE-SHIFTED, then sensitivity to this part of the spectrum becomes an amplifier of that trait over time...

So, it is not surprising that most organisms are more sensitive to blue light than any other part of the spectrum!
When it comes to marine organisms, this fact is amplified...



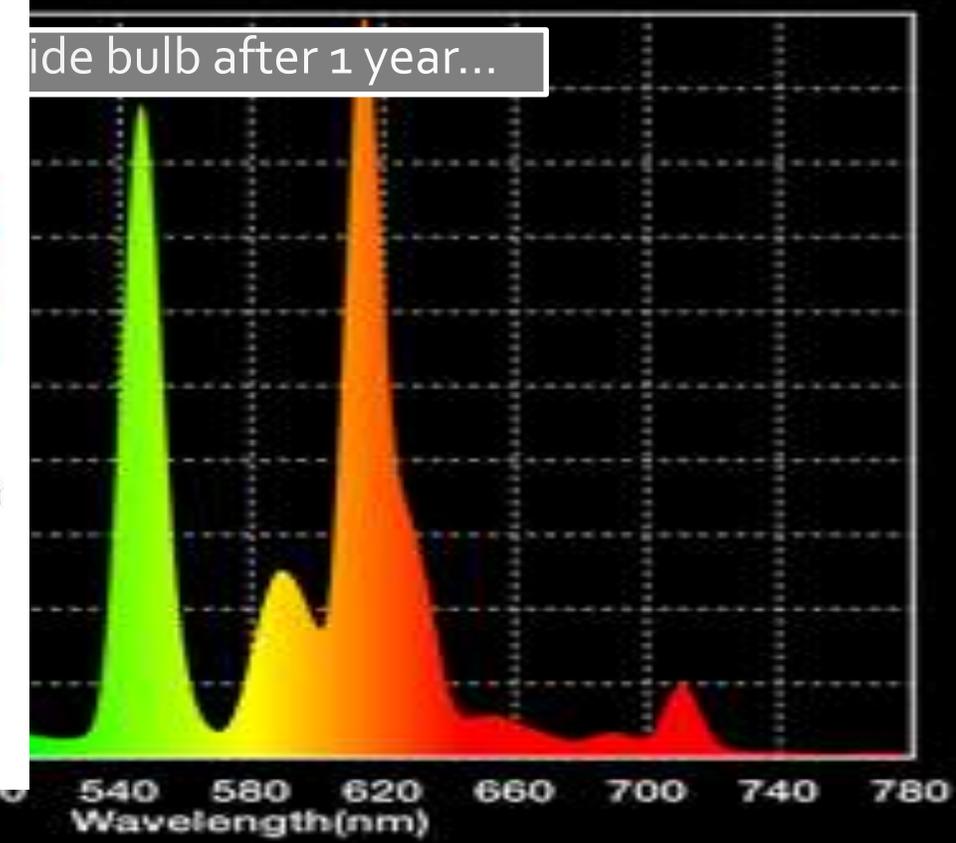
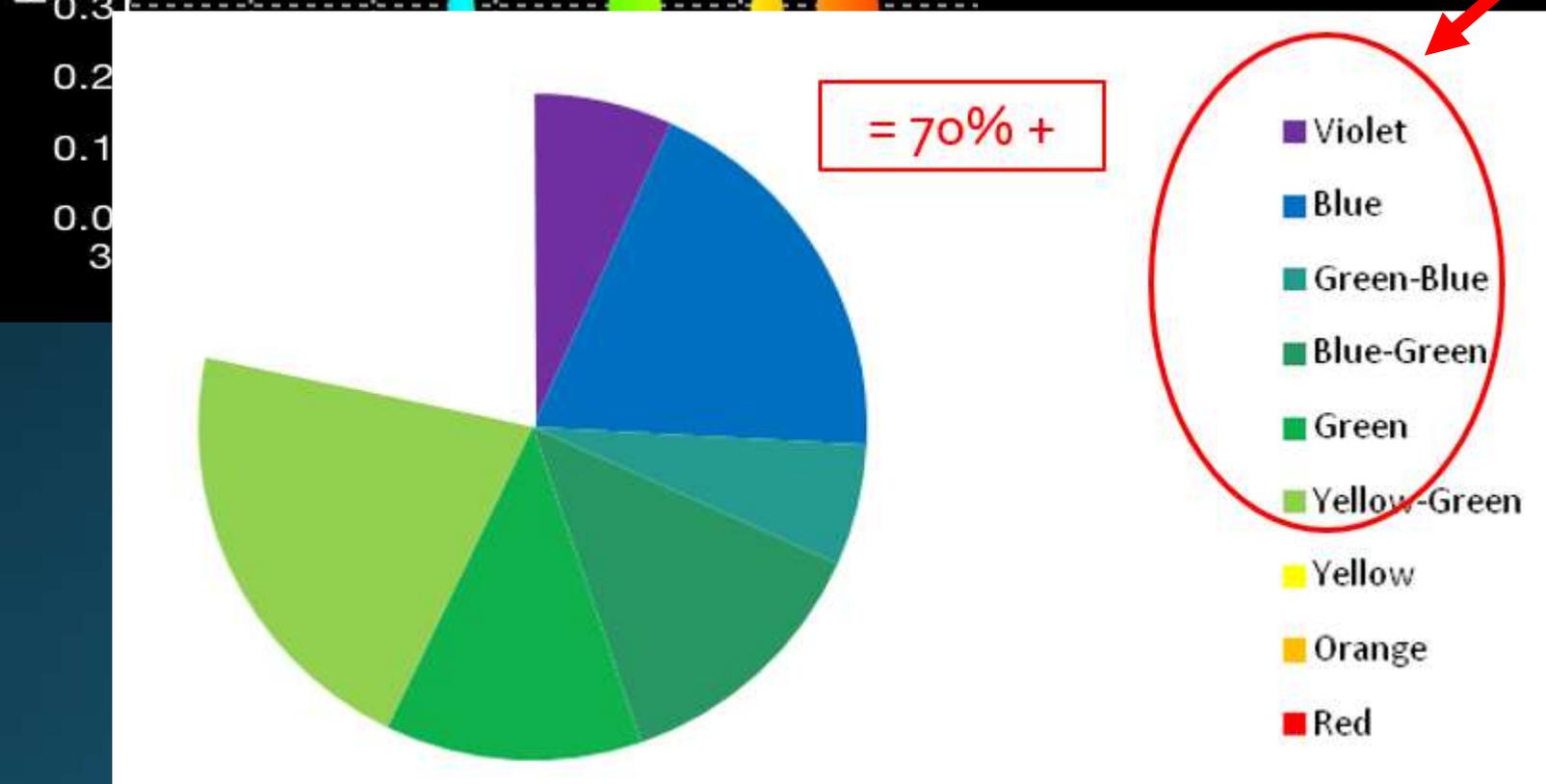
Indeed, for decades, we have known that nature's most important biological processes, from photosynthesis and phototropism in plants, to reproduction in higher mammals, depends, to a greater or lesser extent, on the perception of blue light, through tissue, through bone and through purpose built optical sensors such as the eye.





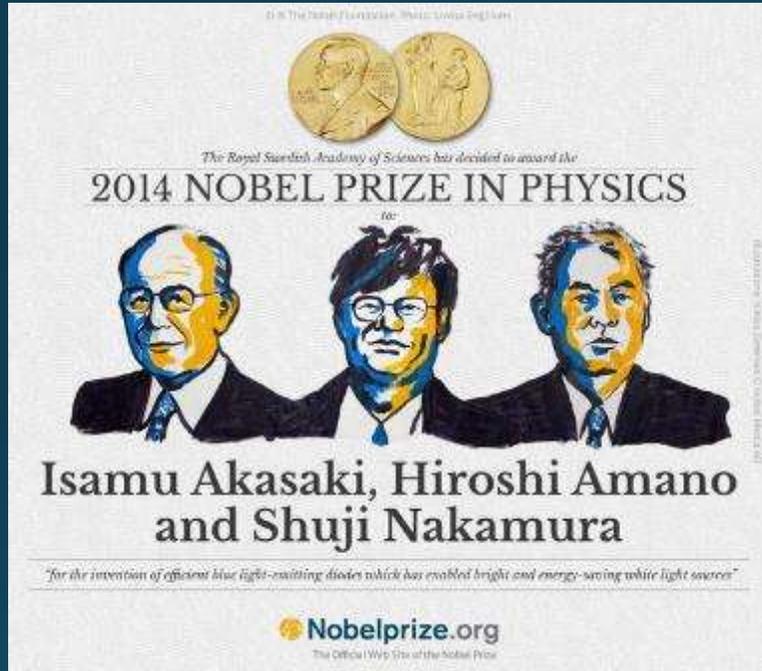
However, tradition we used lighting that looked like this....

Yet, we know that light in the ocean looks like this! Why??



Until relatively recently, we had no choice!

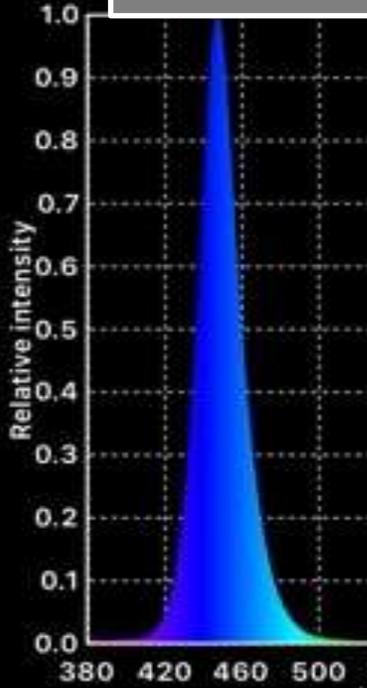
Then in 1990's came the birth of the **BLUE LED...**



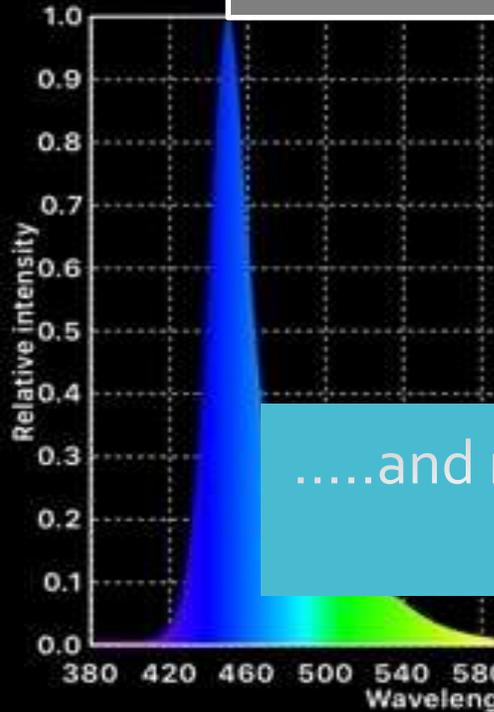
- Mass production of WHITE LED's...
- Output easily regulated by either current or voltage modulation
- Rapid development of phosphors increases colour options...

Now we can create *THE REAL THING!!*

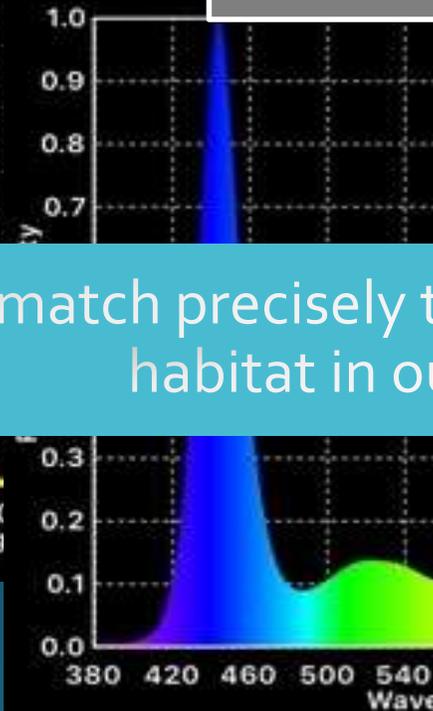
...DEEP OCEAN



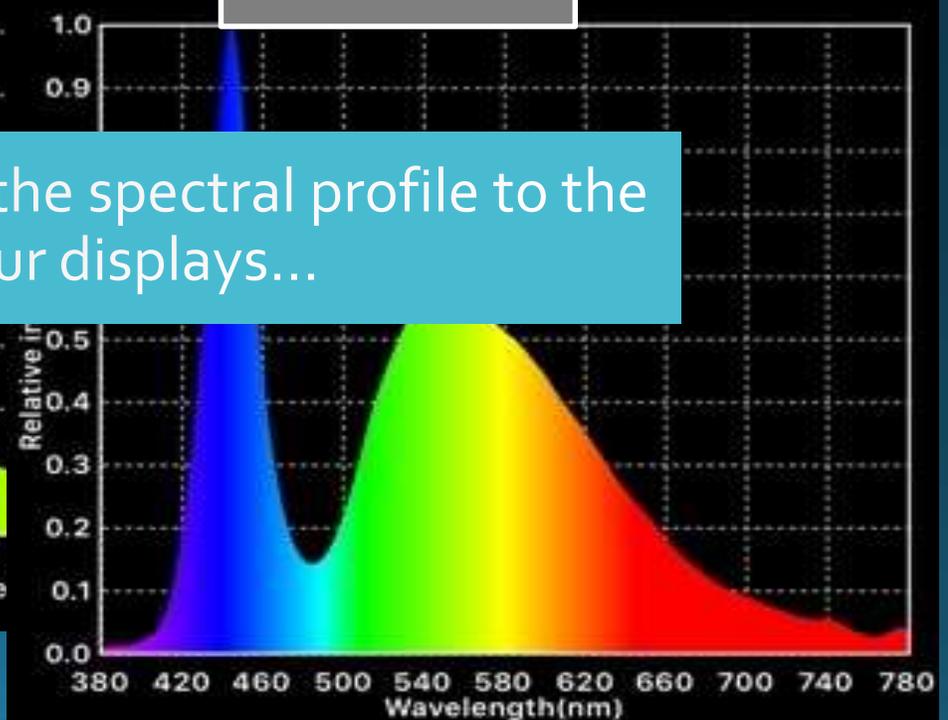
...PELAGIC...



...INSHORE...



...or FRESHWATER



.....and match precisely the spectral profile to the habitat in our displays...

Photoperiod...

Solar

Latitude: to

Longitude: to

Day Offset: to

Min Level: to

Winter Max Level: to
209 W/m² 209 W/m²

Summer Max Level: to
828 W/m² 828 W/m²

Select a serial port: COM3

51-1 Standard 36/25 Standard 51-1 Forward 36/25 Backward Settings

Target: None All Zone 1 Zone 2 Zone 3 Zo

Manual

Valid from: to

Drift: of days

Simple

Sunrise: to

Sunset: to

Duration: to

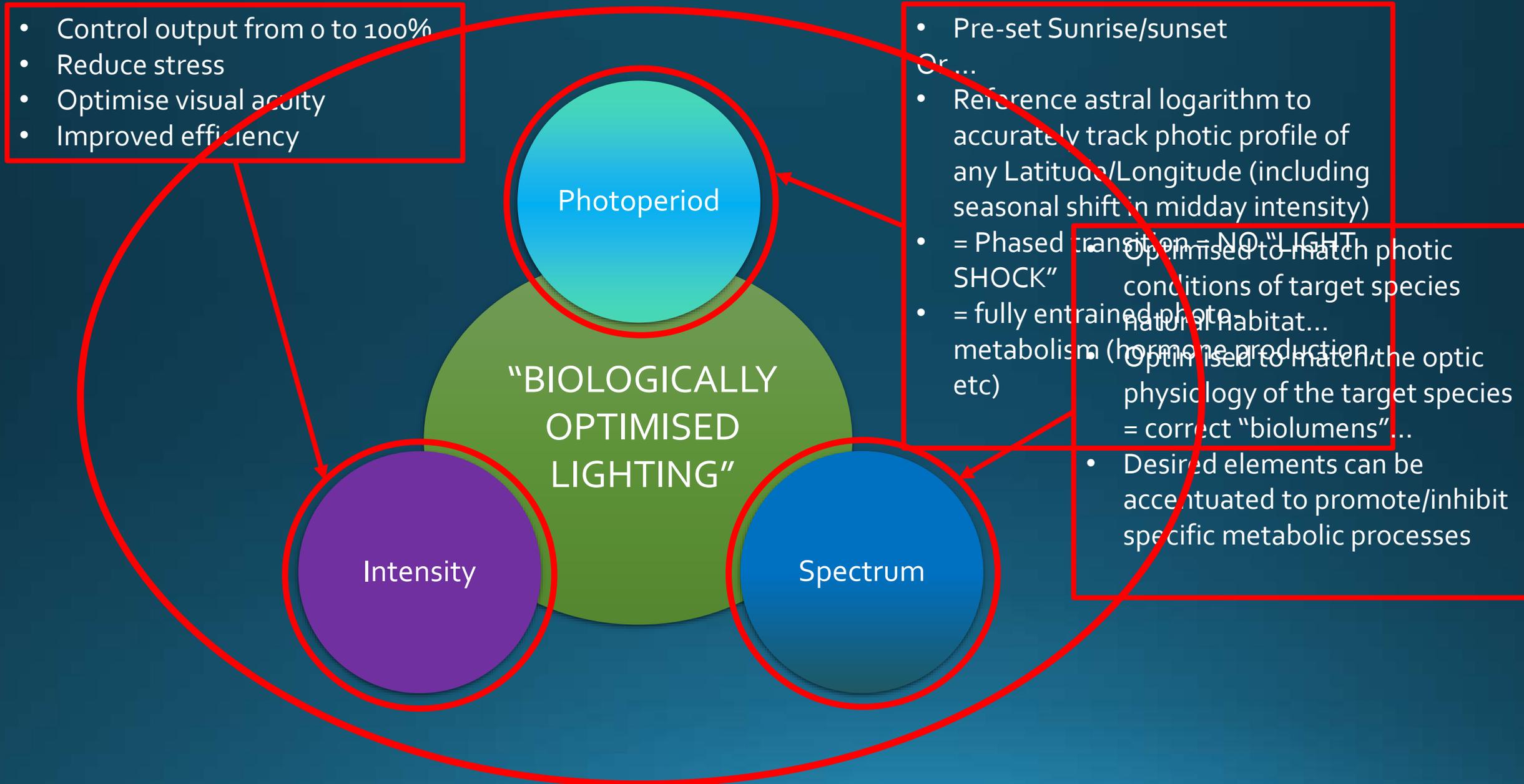
Min Level: to

Max Level: to

Intensity...

Sunset: 21:13
Noon Today: 828 W/m² (level 185)
Now: 689 W/m² (level 154)

FOR THE FIRST TIME, WE CAN NOW FULLY DEFINE ALL ELEMENTS OF THE PHOTIC ENVIRONMENT....



Low-energy, low-maintenance, long-lasting = LOWER COST!

AQUARAY®



BioLumen
LIGHTING SOLUTIONS TUNED TO NATURE

PLEASE NOTE: only blue cells are intended for user input

	T5 lamps	AquaRay lamps	Comparison of savings in Electricity, Maintenance, and CO2 Emissions	
Number of lights	24	12		
Price per KWH for electricity	£0.11	£0.11	Savings per year	£455.19
Number of hours of use per day	8	8	Savings over period	£2,275.97
Watts consumed per lamp	36	28	Percentage saving	80%
Total electricity cost per year	£277.52	£107.92	Reduced CO2 emissions (tons over specified period)	4.04
Total maintenance cost per year	£285.60	£0.00	Total reduction in CO2 emissions	61%
Total cost per year	£563.12	£107.92		
Unit cost	£40.00	£72.00	ROI	
Time period (years)	5	5		
Total costs over specified period	£2,855.58	£611.62	AquaRay unit price	£72.00
CO2 emissions (tons over specified period)*	6.618	2.573	Total investment in AquaRay lighting	£864.00
			Total savings per year	£455.19
*based on Carbon Trust figures 0.5246Kg of carbon per KWh			Total savings over specified time period	£2,275.97
			Payback period on initial investment (years)	1.90

The relationship between light and water is one of the most dynamic and complex interactions in all of nature. The shimmering, shifting, rapidly-changing patterns we see as shafts of light penetrate the deep, or create kaleidoscopes of colour and shifting shapes on the reef or sandy sea bed are the visual cues of this relationship....

The surface of any body of water is the boundary line – it flexes and bulges and folds, dramatically changing the nature and structure of light from the sun and moon and stars....

Today, we know more about the nature of light and the vital role it has to play in the lives and life-cycles of all animals and plants. At the same time, new technologies mean we can be ever more efficient in the way we use light in the aquatic environment. However, it is not only about lower-energy and attractive displays! There is a new frontier, where biology and technology meet, and understanding this is the key to resolving the conflicting priorities of commerce (lower cost, greater efficiency) and environment (improved sustainability and welfare) that are challenging aquarium curators around the world.