Light Bulb Moments with Penguins and Alcids



ASAG General Session

AZA 2014 Mid-Year Meeting

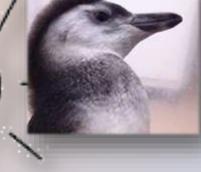


Linda Henry, SeaWorld San Diego Linda.henry@seaworld.com





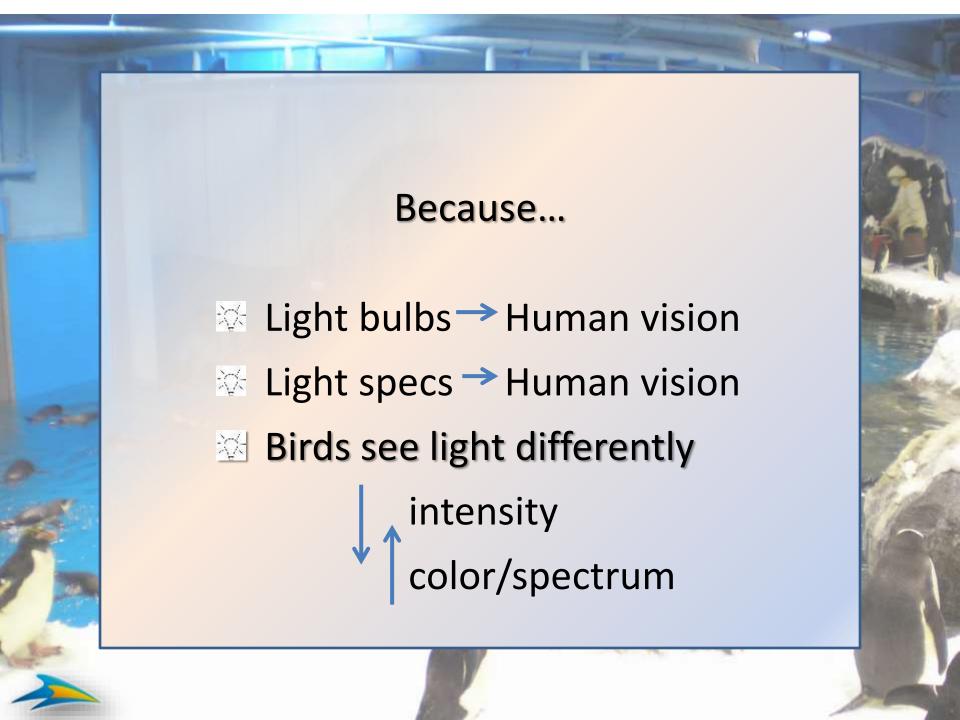
Shining a Light



- Light provision: it should be easy
- And the research says?
- Talk the talk: Spec Sheets
- The FAQ
- A Brighter Future?



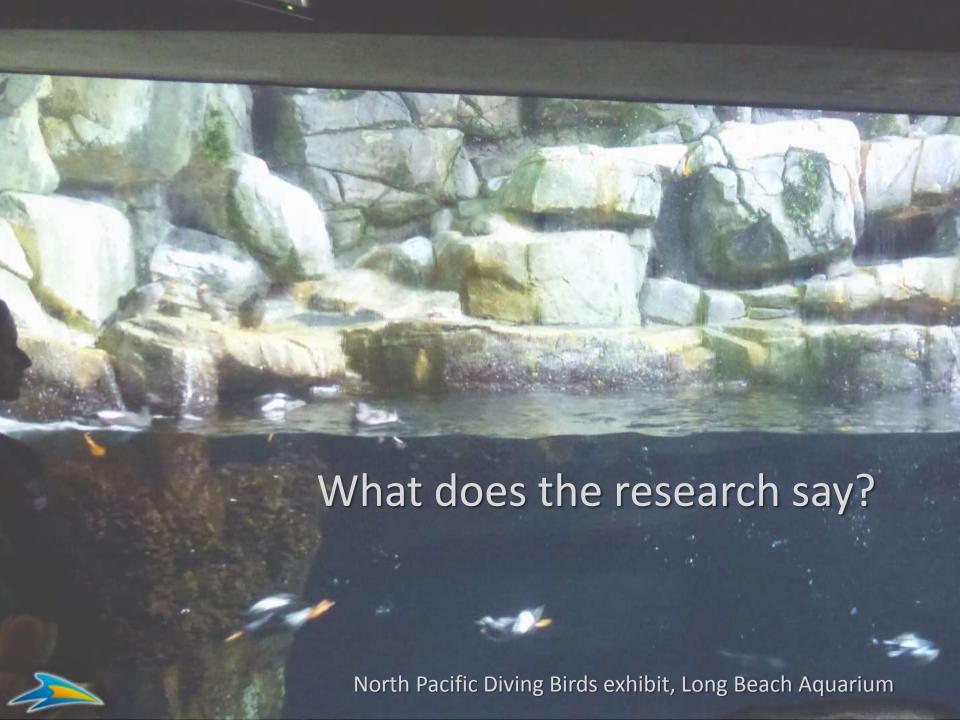






- Other considerations
 - Size Matters:
 - Inverse Square Law
 - Design matters:
 - Direct vs Indirect light
 - Theatrical effects
 - Access
 - Holding and chick rearing areas





So far, it says...

- Birds see light differently: tetrachromats
 - Red, Green, Blue and Violet/Ultraviolet
 - ☑ Violet-sensitive (VS) or Ultraviolet sensitive (UVS)?
 - VS: DNA sequencing
 - Humboldt (UVS)
 - Adelie
 - Razorbill
 - Common Murre
 - UV Reflectance
 - Emperor and king
 - Yellow-eyed, crested



What else?...

- May be important for
 - Intensity perception
 - Color perception
 - Signaling?
 - King penguin auricular patch
 - Ross et al
 - UV+ preference: penguins, tufted puffin
 - Flicker
 - Perceived at higher frequencies in birds
 - Increases with short wavelength
 - Unknown if flicker perception has consequences



And ...

- Circumpolar; high light dwellers
- Perhaps greater tolerance for high UV environments
- Some research contends UV perception is rare in seabirds
- Other factors
 - Diving to depth
 - Crepuscular activity
 - Nocturnal foraging



Light Provision

What constitutes optimal light?







Light Provision

- Photoperiod
- Intensity
- Wavelength
- Source
 - Outdoor: sunlight
 - Indoor: artificial
 - Best of both
 - Daylighting
 - Seasonal access



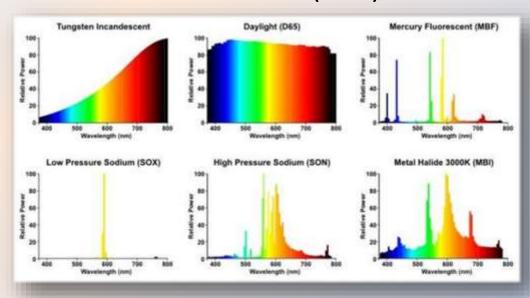
Calgary Zoo Facebook Photo

Daylight (D65)

Talk the Talk

Based on human visual range

- CCT = Correlated Color Temperature (Kelvin)
- CRI = Color Rendering Index (to 100)
- Lm = Lumen
- Spectral Distribution Curve (SPD)





candescent Daylight (D63

Talk the Talk

- "Full Spectrum"
 - Has no technical meaning
 - Use the SPD graph
- Flicker
 - LED
 - Instantaneous response

- Photo by Paul Ponganis
- 2X line frequency (2x60Hz = 120Hz)
- Fluorescents
 - Electronic ballast (kHz)
- HID, Halogen less
 - Heated gas = longer response
 - (HID flicker at start)

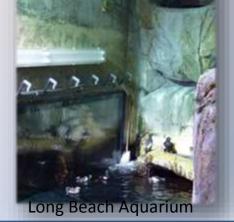


Incandescent Daylight (D6:

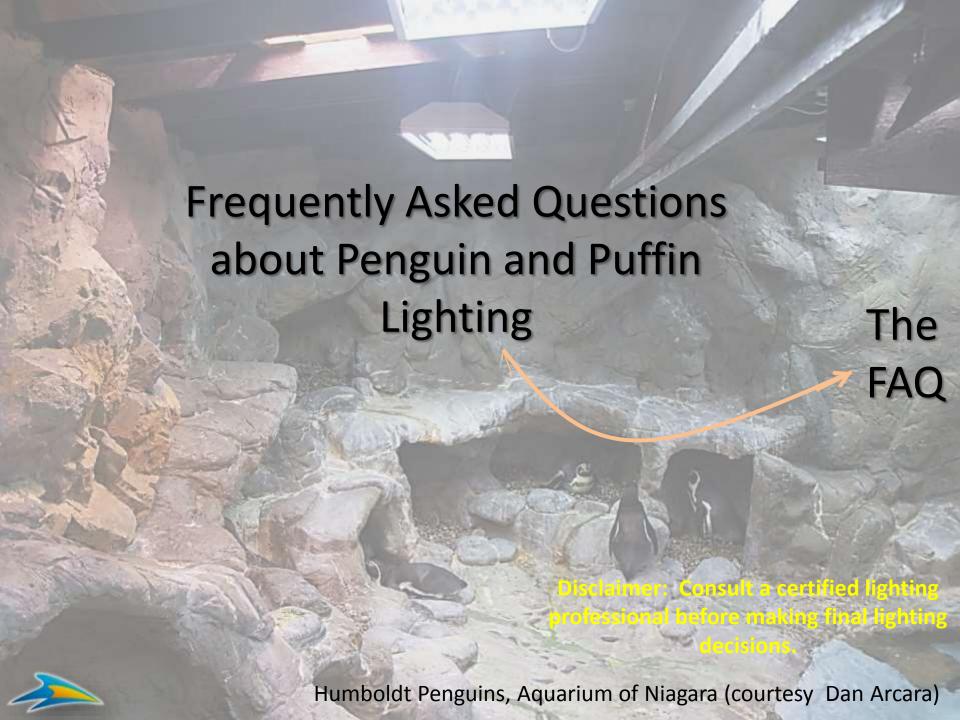
Talk the Talk

- Group re-lamping: scheduled replacement of light bulbs (% rated life)
 - E.g., metal halides should be relamped annually or bi-annually due to spectral shift
 - Determine optimal relamp schedule based on rated life
 - Fluorescents should also be relamped









What types of lights are used for birds that are housed indoors 24/7 or several months of the year?

- High Intensity Discharge (HID)
 - Metal halide (MH)
 - Mercury vapor (MV)
 - High pressure sodium (HPS)
- Fluorescent
- Halogen: quartz (QH), tungsten
- Light Emitting Plasma (LEP)
- Light Emitting Diode (LED)

The FAO

Type of light	Advantages	Disadvantages
source		
HID Metal Halide	-Large areas/high bay	-Spectral shift with age
(MH)	applications	(annual relamping)
	-Long life to 24000 hrs	-Not dimmable
	-High Lumen output	-Warm up and re-strike
	-High efficiency	time >10 min
	-No or reduced flicker	-High heat production
	-CRI 60-90 range	-Mercury (special
	-CT 3000K-20000K range	disposal)
	- Good SPD	
HID High Pressure	-Large areas	-Poor CRI
Sodium (HPS)	-Long life to 24000 hrs	-Sodium is hazardous if
	-Good lumen output	glass broken
	-CRI 20-30	

The FAQ

The FAQ



Type of light	Advantages	Disadvantages
source		
Halogen (Quartz, Tungsten)	-Small size -Low cost -Dimmable -No warm up time -Use for long wave length needs	-Heat production -Incorrect bulb handling can affect life of bulb -Low efficiency -CRI varies (20-30)
Light Emitting Diode (LED) What are your thoughts on LED lighting for bird exhibits?	-Small areas or short distances -Energy efficient -Long <i>rated</i> life -Won't break like glass -Color changing capability -Focused light (but needs	-Lumen output drops with age (rated 50K hrs, drops after 10K) -Flicker -Sensitive to heat -Circuit board (special disposal) -Failure often requires
	diffuser)	entire fixture replacement

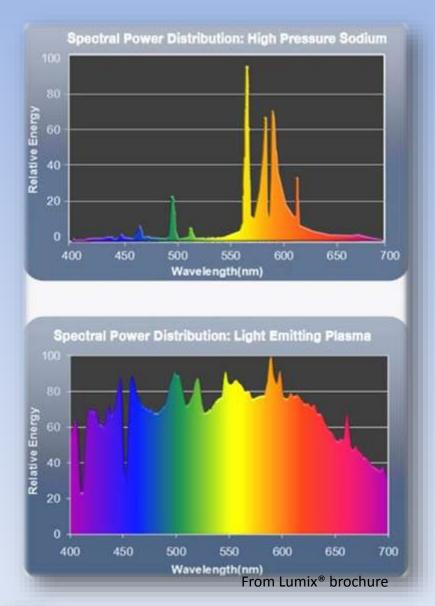


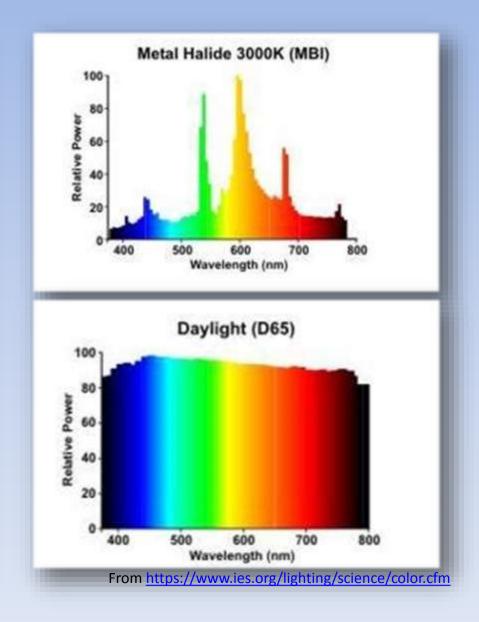
Type of light	Advantages	Disadvantages
source		
Light Emitting	-Large area/high bay	-New technology
Plasma LEP®	applications	-Mercury (special
(Luxim)	-Directional light source	disposal)
	-High lumen density	-Emit radio frequency
	-Good lumen	and electromagnetic
	maintenance (>70%)	radiation (but can be
	-CRI claimed to 95	shielded to meet
	-Good SPD	regulations)
	-Dimmable to 20%	-Strike delay <1minute
		and re-strike <2 min

The FAQ

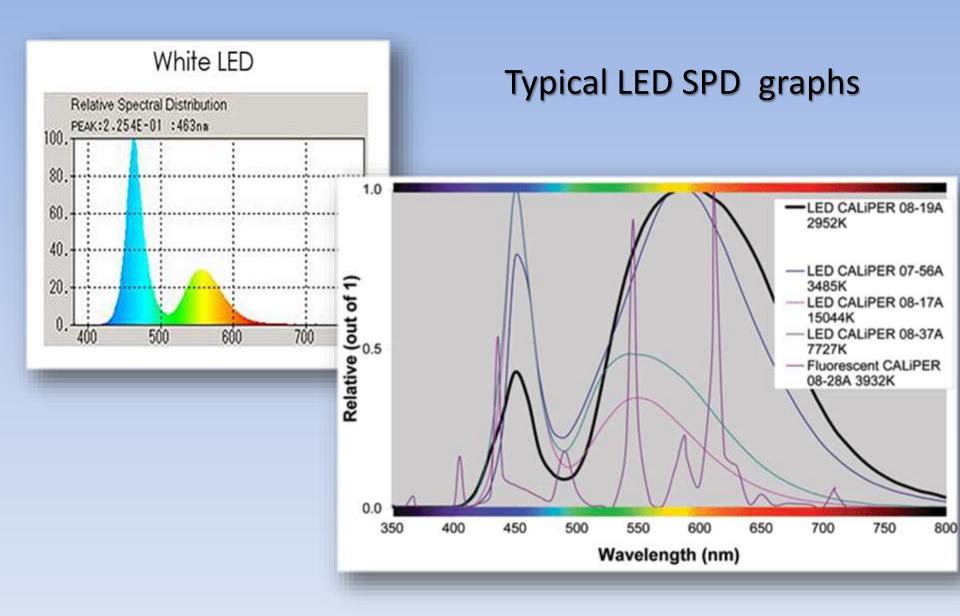


What is your goal lighting spectrum?









How often should the spectrum be measured?



What type of light fixture is best?

- Depends on the application
 - Larger vs smaller exhibits
 - Location-Location
 - Right light : Right job
- Lighting professional



The FAQ

How do skylights help, or do they?

- Improve energy efficiency
- Build in twilight periods
- Natural spectrum that can be supplemented
 - Ultraviolet source? UV transmissible glass



Are there types of lighting that should not be used?

- Depends on application
 - Heat production considerations
 - Access

Have there been any proven negative results from using a certain type of light?

- Anecdotal data
- Poultry data
- Right light for the right job
 - Awareness of avian visual system differences

The FAQ



What emergency lighting is recommended in the event of power failure?

- Emergency lights should be installed to code
- Check with local agencies about orange filtering lights to avoid light pulses during dark phase of cycle

What lighting is used for night time illumination?

- Long wavelength light
 - Dimmed halogen
 - Orange- or red-filtered
 - Action spectrum: 492 nm

The FAC



Is there anything you can share that will help get the most efficient lighting that is best for the birds?

- More light than you "think" you will need
 - Lights can be turned off
 - Changes in "furniture" make a difference to outcomes
- Get ALL the information before you commit
 - Hard to make changes after installation

Do you have any publications on penguin or puffin lighting requirements?

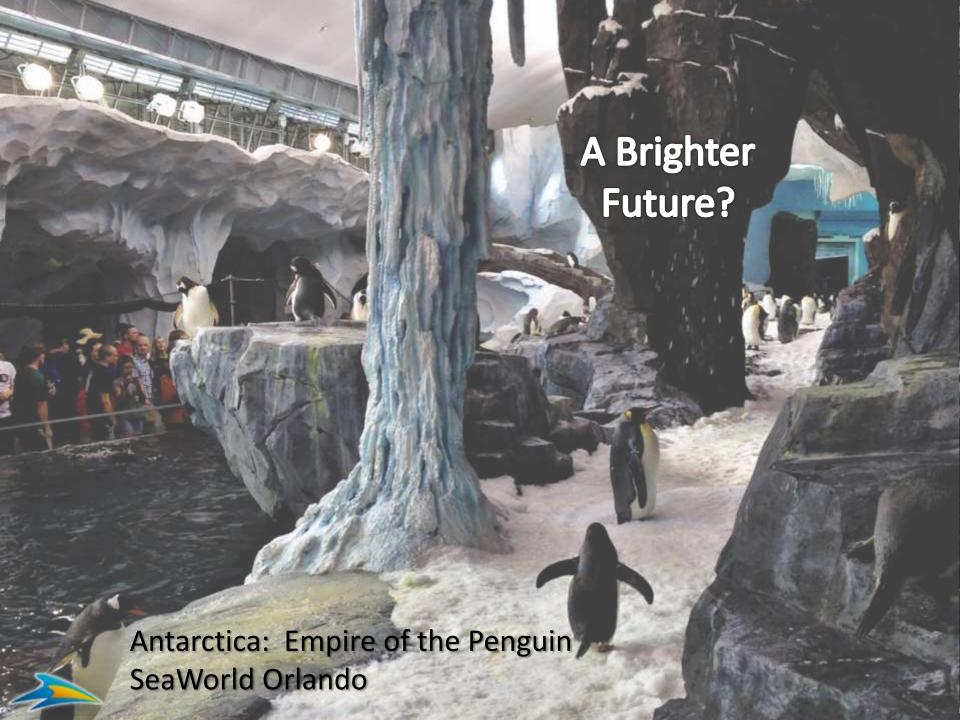
Reference list is general

The FAQ



The Bottom Line

- Ask questions
 - •"Ask twice, buy once"
- Stay informed
- Monitor outcomes
- Leave room for modifications



Recent Builds and Plans

- SeaWorld Orlando: Combined light sources including fluorescent, LED wash and UVA floodlights, metal halides
- Kansas City: High Bay LED
- Calgary Zoo: Incorporated UVA and UVB strip lights
- Detroit Zoo: Plans to incorporate daylighting (skylights); metal halide; LED for underwater highlights



Thank you

Sincere thanks to the Avian Scientific Advisory Group

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