Environmental Impact Upon Wildlife

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This document contains confidential and proprietary information regarding the spectral tuning of Snow-Bright™ lighting technology. It is not intended for general distribution. Materials contained in this document are solely for the purpose of evaluating Snow-Bright™ technology as it may impact nocturnal wildlife. This document is subject to updates and changes as new information and research becomes available.

Overview –

The most paramount design criteria for Ultra-Tech™ Lighting, LLC are environmental impacts. Along these lines, every major issue is carefully measured and addressed to provide the ultimate environmentally friendly lighting solutions for specific applications. Objectives include:

- Energy conservation
- Reduced carbon footprint
- Non-toxic and environmentally safe components
- Minimal light pollution
- Animal friendly spectral output
- Low heat profile
- Silent operation
- Instant on/off (no warm-up or cool-down)
- No flicker or harmonics
- Feature-friendly aesthetics

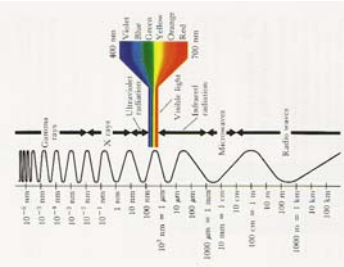
Since most ski areas are located in and around forest and park areas, particular attention was given to the spectral output of Snow-Bright™ lighting. Extensive research was conducted to determine what aspects of lighting intensity, color temperature, and spectral output might affect wildlife. Even the influence of sound that might be generated by the drivers (ballasts) was taken into consideration. Research was compiled into various design characteristics to strike a balance between lighting objectives and effectiveness and environmental impacts.

Vision Characteristics of Nocturnal Wildlife –

A wide range of wildlife considerations exist when designing lighting for snow recreation areas. Nocturnal wildlife includes mammals and birds. Although there are nocturnal reptiles, they generally do not make their habitat mountains and snowy regions. Exceptions include the Tiger Salamander (Ambystoma Tigrinum), Boreal Toad (Bufo Boreas), Boreal Chorus Frog (Pseudacris Maculata), Wood Frog (Rana Slyvatica), Western Terrestrial Garter Snake (Thamnophis Elegans) and the Snapping Turtle (Chelydra Serpentina). Since nocturnal reptiles generally avoid artificially lit areas, Snow-Bright™ lighting has negligible impact upon these species.

Common to most nocturnal mammals are retinas dominated by rod photoreceptor cells which detect shape and light intensity, but do not resolve color. Rod dominance is better in low light and is a feature shared by canines (dogs) and felines (cats). Many nocturnal animals have a reflective layer behind the retina called the *taptum lucidum* that acts to reflect light back onto the retina to intensify image resolution in low light. This exists among foxes, bobcats, cougars, wolves, deer and moose. This layer makes eyes appear to glow in the dark.

Bears are not specifically nocturnal; however, they have active lives during the day and night.



Bears have keen night vision, but share similar retinal characteristics with humans. Bears have both rods and cones and can resolve color in the human visual range from approximately 480nm to 720nm. The expression, “Sees like a bear,” is attributed to the sharp eyesight believed to be inherent in the American Black Bear.

Owls make up the majority of nocturnal birds and have very unique vision. The owl’s eyes are fixed forward in the head and are also rod dominant. The eyes are exceptionally large relative to the brain and capable of processing motion, and shadows. Owls do not resolve color well. They have extraordinary peripheral vision, but must move their heads to change their field of view. Most owls are disturbed by intense singular light sources. They are amenable to full moonlight.

Snow-Bright™ Interaction –

All nocturnal wildlife can be disturbed by artificial light at night. Bright light can be a distraction and may disrupt natural circadian rhythms. The first objective in designing night lighting for areas within wildlife habitats is to balance intensity and utility. This means producing the *minimal* amount of light necessary to accomplish the *necessary* illumination. Snow-Bright™ technology takes a unique and *new approach* by concentrating light within the visually effective range of the human eye while emphasizing spectral frequencies that most effectively reflect off the crystal construct of snow.

Crystals have the capacity to slow down and refract light. The “brilliant” characteristics of a diamond are attributed to the internal refraction within the gem. Water crystals have similar properties. By

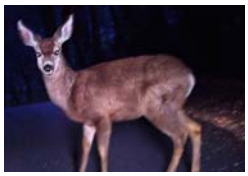
focusing the specialized Snow-Bright™ spectral output at the proper angle to the snow surface, the technology actually transmits light laterally much the same way as a fiber optic cable, but with refractory release along the way. This carefully designed feature reduces glare from the snow and creates an exceptional *glowing effect* that enhances visual acuity *from the snow surface.*

Wildlife presumably sees Snow-Bright™ as a modestly higher intensity than full moonlight on a clear evening. In sharp contrast to conventional lighting that uses high pressure sodium or metal halide bulbs, Snow-Bright™ fixtures can be directly viewed without significant discomfort. This is *impossible* with other modern lighting technologies like light emitting diodes (LEDs) or light emitting plasma (LEP) which will actually damage the retina if directly viewed.

Concerns that Snow-Bright™ lighting might attract wildlife because it does not produce the same "fear factor" as more intense conventional lighting are unfounded. Although animals and birds are less disturbed by gentle Snow-Bright™ lighting, they are sufficiently apprehensive about entering a lighted and active area to keep a safe distance. The important element is to prevent light *over stimulation* and avoid intensity that could be damaging to wildlife vision. Further, Snow-Bright™ fixtures are *full cut-off* which means they do not bleed or spread light beyond their intended focus area.

Specifically, the lower intensity of Snow-Bright™ lighting interacts in a far more healthful manner for animals with tapetum lucidium; the reflective membrane behind the retina. Since the purpose of this membrane is to reflect light back within the eye, the lower the lumen intensity, the *less disturbing and damaging* the light will be. Encounters with animals like the red fox, deer, and moose prove the point. In the case of the red fox, conventional lighting can attract, and then stun. This is demonstrated by a simple experiment where the light is directed at 90 degrees to the fox's path and then turned to face the animal. Snow-Bright™ lights do not have the same effect. The fox is undisturbed by the light intensity *even when directly focused*.

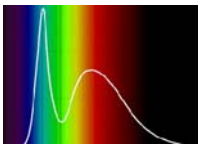
Intense light has a similar impact upon moose and caribou. The tendency is to attract first and then stun; hence, the expression, "A deer in the headlights." Typically, a 1,000W metal halide or 1,200W high pressure sodium light will be replaced with a 300W or 400W Snow-Bright™ fixture. The direct intensity may be reduced by as much as 60%, however, the "visually effective lumens" that can be detected by the *human eye* can be the same *or greater*. This is a major Snow-Bright™ difference. Skiers, snowboarders, and tubers can use the light most effectively while rod dominant species are minimally influenced.



Equally important, conventional lighting is characterized by a small concentrated light source (the bulb) that is dispersed from a mirrored reflector. This concentration is what tends to be damaging to the eye and most disturbing to animals that may become fixated by such intense light. In contrast, Snow-Bright™ light is produced by elongated circular or rectangular tubes that cover a wide area. For example, the diameter of a 300W Snow-Bright™ round magnetic induction bulb is 20 inches. The highly specialized dual-stage reflector uses a nano-

material that is exactly matched to the spectral output of the bulb and produces high dispersion and diffusion. This *softens* the appearance of the lamp for direct viewing and tends to be innocuous to nocturnal wildlife while, at the same time, producing the maximum visual experience for skiers and riders.

LEDs have become very popular, but are *not appropriate* for lighting snow. LEDs tend to have



a high blue and UV bias that can be dangerous for humans and many animals. The LED spectrum is generally concentrated in the lower region with *insufficient light* within the most visually acute areas for human vision. Even filtered LEDs are usually deficient in the transition into green and yellow which are the most reactive wavelengths for the human eye. The effect is called "Green Droop," and is inherent in all III-N LEDs. Although highly efficient, LED light for ski areas tends to be *overly intense* to compensate for a deficient spectral output.

Snow-Bright™ employs a full spectrum light with a color temperature of 6,500K. This is similar to overcast daylight. Certain proprietary tuning is used to create maximum contrast that brings out features like bumps, indentations, slope, distance, and contours. The specialized properties of spectral output, diffusion, focus, and luminance allow photometric designers to lower lighting intensity without sacrificing human visual perception. The principle when accommodating nocturnal wildlife is, "*Less is more!*" By way of example, a Snow-Bright™ 120W rectangular flood can replace a 400W high pressure sodium rectangular flood with less glare and more visual perception, saving more than 70% of the energy with an associated reduction in carbon footprint.

Sound emissions are also an important consideration. Many ballasts for conventional lighting produce a low pitch hum and/or high frequency noise. Of concern is sound pollution in the range of 20,000 to 120,000 hertz which is the frequency range used by bats. Snow-Bright™ drivers (ballasts) operate in excess of 150,000 cycles and are free from high levels of noise. The bulbs have no filaments or electrodes and are absolutely silent. High frequency sound can be disturbing to many canine species as well.

Conclusion –

Ultra-Tech™ Lighting has created highly specialized lighting with particular wildlife in mind. Port-Bright™ models are used to light ports, harbors, and waterways because they eliminate portions of the visual spectrum for sea turtles. Magnetic induction lights (MIL) can be designed to output any light frequencies at various intensities. In all instances where outdoor lighting is the objective, animal-friendly and neighbor-friendly design is a paramount consideration. For indoor lighting, Ultra-Tech™ Lighting has created fixtures that produce the Health-Bright™ full spectrum that has been associated with up 20% greater productivity among office and factory workers as well as students.

All artificial night lighting may influence nocturnal wildlife. The Snow-Bright™ design team provides the least obtrusive and most effective lighting for a very specific application… lighting snow surfaces. The highly reflective crystal white surface of snow presents particular challenges that are only addressed by Snow-Bright™ technology. Even the silence of Snow-Bright™ drivers (ballasts) was an important consideration for the welfare of bats that do not rely upon vision, but can be confused by high frequency hum and noise.

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