WILDLIFE

Jane Slade

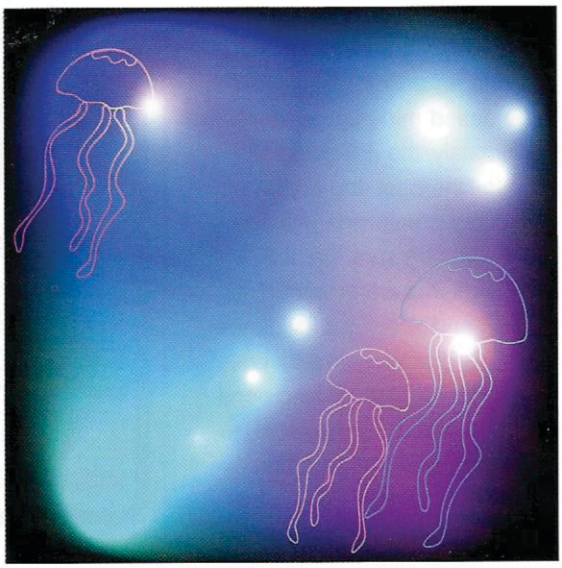
The Hidden Toll The earth's glowing waters can impact both ends of the marine food chain

Underneath the mirrored surface of the Earth's waters, there exists a hidden world of living things, richly diverse, interdependent and deeply sensitive to light—sometimes by intensities as low as starlight.[1] Recent environmental changes have put enormous strain upon these aquatic ecosystems. Stray light and skyglow have created permanently glowing waters around human developments. We have only begun to take notice of behavioral changes in species, and the total impact upon aquatic ecosystems is unknown. A recent MIT study estimates that by 2050, 52% of people will live within regions that are water-stressed.[2] While the lack of darkness in this underwater world has fallen outside the purview of human concern, the health of the Earth's water systems is vital for life itself.

In aquatic ecosystems, trillions of plankton form the base of the food chain. Derived from the Greek word for wanderer, planktos, zooplankton (micro-animals such as krill) and phytoplankton (micro-plants such as algae) were named for being drifters. Unlike their name suggests, however, modern scientific study has revealed that zooplankton, specifically, are not completely passive in their movement. Due to their vulnerable and tiny size, these animals evolved to protect themselves in the dark depths of water from predators and UV light.[3] Through exquisite light sensitivity, zooplankton utilize the changing cycle of daylight to time their travels safely, vertically migrating at sunset to feed on phytoplankton at the water's surface.[4]

What is remarkable is not the individual distance traveled by each organism, but the synchronization of trillions of organisms, tuned to the light across oceans, to migrate at the same time. This small but mighty migration has been likened to jet propulsion, helping to churn and redistribute nutrients in aquatic environments with the jet of water that follows behind this giant vertically-moving mass of organisms.[5] Moreover, zooplankton are indispensable in the carbon cycle, bringing carbon home with them as they migrate back into the depths of water. Yet, the presence of artificial light has been shown to suppress vertical migration of zooplankton.[6] Potential impacts include impeding the carbon cycle, toxic algae blooms, and in general, greatly changing the balance of life within aquatic ecosystems, such as altering the feeding habits of other animals, like whales.

> “Scientists concluded that whales used the view of the stars and the moon in order to migrate such vast distances



Whales are at the top of the food chain in marine ecosystems, migrating upwards of 10,000 miles to feed upon krill in the cold waters near the Earth's poles, and back again to the tropics to breed in warmer waters. In one study, humpback whales were tracked via satellite over a span of eight years. Over the course of time, the tracking revealed that the mammals always migrated within 5 deg of their route, and often within only 1 deg—a precision that led scientists to believe that the whales had to be using more than geomagnetic migratory mechanisms, as geomagnetic forces are not consistent across the Earth's surface.[7] Therefore, the scientists concluded that the whales had to be using additional migratory mechanisms, such as a view of the stars and the moon, in order to migrate such vast distances through turbulent and unpredictable waters with such unfailing accuracy.[8]

YET, LIGHT POLLUTION AND SKYGLOW can reach more than 100

miles from the source, obscuring a view of the night's sky, the subtlety of the moonlight cycle and the faint light of the stars—all sources of light that speak to the unique language of circadian rhythms across aquatic species. Therefore, at either end of the marine food chain, both zooplankton and whales have a biological need for the natural daylight cycle. Moreover, many species of whale feed upon zooplankton, further compounding the issue.

The effects of light pollution pervade far more than just whales and plankton. Other aquatic animals, such as salmon, change their migratory habits in the presence of light. One study showed that when no artificial light was present, salmon migrated according to the daylight cycle; in the presence of streetlight however, salmon migration randomized.[9] The desynchronization of salmon migration poses a threat to salmon by throwing the species out of rhythm with the environment and cascading into unforeseen consequences, such as potentially changing relationships between predators and prey.

In one such case in California, stray light created a very dangerous situation for salmon. The city of Redding's Sundial Bridge for pedestrians is a proud landmark and an engineering marvel of see-through glass pavers. Yet, it was once so brightly lit for human enjoyment that migrating salmon were unable to hide from predators in the river below, inadvertently swimming through a beacon for predators to find and prey upon them.[10] Upon becoming aware of the issue, the city intervened by installing newer lighting with refined optics, improved light color for marine environments and reduced intensity, reallowing the salmon hiding spots along their migratory journey.[11]

The City of Redding is a profound example that creating awareness about light pollution can bring about positive environmental change, and that a lack of awareness is one of the greatest design barriers. One of the most pernicious factors of light pollution is that it is not well understood by people and therefore not considered, as it is often twisted with counterintuitive concepts: the air is seemingly invisible, and yet it creates clouds of light through the soft particulate and dust hidden within it; the water's dark mirrored surface actually penetrates light far beneath; animals and plants, whose voices cannot be heard, have circadian rhythms that are deeply impacted by light pollution. It is not as though people want to be creating these impacts—it is simply not information that is at hand.

Another common barrier is psychological: the idea that designing for the environment must be complex. This thinking has often resulted in little to no action at all. Perhaps this is merely a reminder that the simplest of solutions may be the best. There is no better intervention than turning lights off at night.

While unseen, artificial light is creating an enormous impact upon aquatic ecosystems. Water is the basis of all life, making up to 65% of adult human bodies. Life on Earth depends on a healthy cycle of water, therefore lighting for human activity alone is simply not sustainable. All ecosystems need access to a natural daylight cycle and there is no replacement for darkness. As humans, the next step is perhaps philosophical—to accept that more light is not better and to reacquaint ourselves with the darkness of the night.

Jane Slade, MID, LC, Member IES, is the specification sales manager for Speclines in Massachusetts, a recent Richard Kelly Grant recipient and a member of the IES Committee for Outdoor Environmental Lighting. For questions or comments, please email: jane@speclines.net.

References

1 Rich, C., & Longcore, T. (2013). Ecological Consequences of Artificial Night Lighting. Washington: Island Press. Page 372.
2 Fabrique [merken, D. &. (n.d.). Water Stress to Affect 52% of World's Population by 2050. Retrieved from https://waterfootprint.org/en/about-us/news/news/water-stress-affect-52-worlds-population-2050/
3 Rich, C., & Longcore, T. (2013). Ecological Consequences of Artificial Night Lighting. Washington: Island Press. Page 374.
4 Ibid
5 Houghton, I. A., Koseff, J. R., Monismith, S. G., & Dabiri, J. O. (2018). Vertically migrating swimmers generate aggregation-scale eddies in a stratified column. Nature, 556(7702), 497-500. doi:10.1038/s41586-018-0044-z
6 Moore, M. V., Pierce, S. M., Walsh, H. M., Kvalvik, S. K., & Lim, J. D. (2000). Urban light pollution alters the diel vertical migration of Daphnia. SIL Proceedings, 1922-2010, 27(2), 779-782. doi:10.1080/03680770.1998.11901341
7 Horton, T. W., Holdaway, R. N., Zerbini, A. N., Hauser, N., Garrigue, C., Andriolo, A., & Clapham, P. J. (2011). Straight as an arrow: Humpback whales swim constant course tracks during long-distance migration. Biology Letters, 7(5), 674-679. doi:10.1098/rsbl.2011.0279
8 Ibid
9 Riley, W., Bendall, B., Ives, M., Edmonds, N., & Maxwell, D. (2012). Street lighting disrupts the diel migratory pattern of wild Atlantic salmon, Salmo salar L., smolts leaving their natal stream. Aquaculture, 330-333, 74-81. doi:10.1016/j.aquaculture.2011.12.009
10 Hacker, T. (2016, March 23). New LED Lighting on the Sundial Bridge Saves Salmon. Retrieved from https://cbmcinc.com/new-led-lighting-on-the-sundial-bridge-saves-salmon/
11 Ibid