The Effect Of Light Pollution On Sea Turtles

The creation of the light bulb and electricity made it possible for humans to have cheap and efficient artificial light to see in the dark, and it is one of the defining moments in the history of the human race. Ever since the creation of artificial light and its transition to a household commonality, light has become an ever-present source that is not often truly thought about. The increased use of artificial light has brought an increase in light pollution which has led to modified light-dark cycles for many organisms. These modified light-dark cycles have led to problems for the normal circadian rhythm and patterns of many organisms especially those that are light sensitive or nocturnal (Dominoni et al. 2016). With such a rapid expansion of artificial light, organisms do not have the opportunity to adapt to the quickly changing situation which has led to the threatening of biodiversity (Silva et al. 2017). One specific problem with artificial light, especially on the coast, has to do with the nesting habits of sea turtles. Increased light pollution leads to a greater likelihood of hatchling and female nesting misorientation, and this leads to a host of other problems including increased predation, population decline, and eventual downstream changes to the ecosystem. Only recently have humans begun to realize and understand the detrimental effect that light pollution is having on the environment which is why there is still a high amount of light being emitted (Silva et al. 2017). As humans emit more light, sea turtle populations decline which results in ecosystem changes that affect not only other marine organisms and but also humankind.

Over the years, artificial light has had many benefits for humans. It has allowed us to have an easy and efficient way to continue lighting our homes into the dark hours of the night. This has allowed humans increased time for work and social activities which have ultimately re-organized societal interactions. An increase in artificial light has played a part in vehicle accident prevention and given humans the mindset that light equals safety in terms of crime (Gaston et al. 2015). Light not only provides a sense of safety but is also recognized as a socioeconomic status for a country. The more light that a country is emitting means that the country is more developed, and many use this as an indicator of development within a country (Gaston et al. 2015). As previously stated, the detrimental effect of light pollution on other organisms and even on humans has not been touched on until recent years, and even now, the effects are not fully known. The fact that negative effects are not fully understood and the sense of security and economic stability light provides humans has allowed the unprecedented expansion of the amount of light they use without having to think about the consequences on the environment. Light pollution is classified as any excessive or obstructive light, and each year the amount of light pollution has grown at a rate of 6% per year (Silva et al. 2017). While humans are massively benefiting from this increase in excessive and wasteful light emissions, other organisms, particularly sea turtles, are detrimentally affected, and the changing of the ecosystem due to sea turtle declines does indirectly have an impact on humans.

The direct impact of light pollution on sea turtles has been proved in recent years, and it not only affects hatchling turtles but also female nesting turtles. Hatchling sea turtles naturally use the light of the moon reflected off the water to guide them to the ocean when they emerge from their shells, but artificial light on the coasts interferes with this natural process (Hu et al. 2018). Light pollution from surrounding civilizations is so bright that hatchlings will move inland towards it rather than out to sea. This misorientation leads to higher mortality rates due to predation and

dehydration from becoming entangled in mangroves (Silva et al. 2017). Light pollution though goes beyond affecting hatchlings into affecting female nesting sea turtles. Female sea turtles can also become disoriented by the light when they are crawling up to lay the nest, and it makes them think that it is still day which can lead to the deposition of their eggs into the sea instead of on land (Silva et al. 2017). A study has been done to show that different species of sea turtles are more likely to nest in areas with low light pollution, and fewer turtles nest in areas with high light pollution (Hu et al. 2018). This leads to a higher density of nesting turtles in unlit areas which leads to decreased emergence rate, increased predation, and a higher likelihood that another female will disrupt others' nests. Many anthropogenic activities including fishing, destruction of habitat, and pollution have all contributed to the decline in sea turtle populations, but light pollution has played a major role in this decline (Silva et al. 2017). All of the impacts of light pollution on sea turtles are leading to a population decline which in turn affects the entire ecosystem that sea turtles interact with. This all goes to show that increased light pollution by humans affects sea turtle hatchlings and the likelihood of an adult sea turtle nesting which in turn affects many organisms surrounding the life of a sea turtle.

Declining sea turtle populations have caused a change in the oceanic ecosystem that in turn affects many organisms. Sea turtles are an important part of the oceanic and land ecosystem through mineral cycling, top-down food web effects, and their high biomass contribution, so a change in sea turtle populations would affect the entire ecosystem in a top-down manner (Lovich et al. 2018). Specifically, sea turtles are an important control of seagrass populations, and since sea turtles are a major predator of seagrass, a declining sea turtle population would mean a large increase in grass populations. Seagrass beds are therefore allowed to overgrow, which creates the perfect environment, high shade, and nitrogen content, for slime molds, and the uncontrolled seagrass can also obstruct currents. Ultimately, this creates an increase in nitrogen concentration of the seabed creating an unsuitable environment for the grass to actually grow in, and this eventually leads to a decline in seagrass numbers. The decline in productivity of the seagrass leads to a decline in the productivity of the food web which includes many other organisms, including many species of fish that humans use as a resource (web 2). Other sea turtles graze on sponges which are advantageous competitors to coral, so a decline in turtle population leads to increased sponges, decreased coral, and a decrease in nutrients released into the ecosystem as the turtles graze on the sponges (Lovich et al. 2018). Sea turtles are also a top predator and one of the few jellyfish, and once again as turtle populations decline, jellyfish are no longer kept in check which allows their population to immensely expand. Combined with another anthropogenic-caused issue of overfishing, jellyfish are left with virtually no competition for food, and as jellyfish proliferate, their high numbers make it very difficult for the overfished populations to recover because jellyfish eat their eggs and larvae (web 2). As is evident by these few examples, declining sea turtle populations have the possibility to reshape the entire ecosystem by starting a top-down chain reaction, and many more examples of this re-organization have been directly correlated to sea turtle decline. While all of these examples have been about marine organisms, the ecological changes brought about by declining sea turtle populations due to the anthropogenic increase in light pollution also affects ecosystem services provided to humans, but if nothing is done to stop the decline of sea turtles, the entire oceanic and even some land ecosystem could be affected by this change.

With anthropogenic, sea turtle population decline causing ecological shifts, the flow through the ecosystem ends up indirectly having negative consequences for humans. The increase in jellyfish populations due to the loss of predation by turtles has led to a decrease in populations of fish stocks. Overfishing has caused a decrease in fish that humans deem important for food

and other products, but the increase in jellyfish populations has made it difficult for these populations to recover. Jellyfish eat fish eggs and larvae which has led to a continued population decline affecting the human fishing industry (web 2). Also, the loss of seagrass as previously explained means loss of habitat for many fish and other marine organisms to breed and live in which also leads to a decline in marine organisms that humans gather (web 1). A decrease in the number of female turtles nesting also leads to a decrease in mineral cycling and transfer of nutrients because the lipid and energy-rich eggs are no longer available for land predators and plants to utilize (Lovich et al. 2018). With a loss in nutrients, dune vegetation will decline to result in the erosion of beaches. Humans use beaches for many different social activities such as fishing and sun-bathing, and a loss of beaches would result in a loss of many of these activities (web 1). As can be seen, the light pollution put off by humans, while it does have many benefits, directly and negatively impacts sea turtle populations and indirectly impacts other marine organisms and even humans.

Overall, it can be shown with sea turtle populations and light pollution that changing the dynamics of a single organism within an ecosystem can cause the entire interconnected web of organisms including humans to change. Some experience positive effects such as the abounding jellyfish populations while most others experience negative effects like seagrass and humans. Circularly, though, humans emit light pollution that affects sea turtle populations, declining sea turtle populations affect the marine ecosystem, the changes to the marine ecosystem affect ecosystem services that humans receive, and since humans do not fully know the effects light has, they continue to increase the amount of light used continuously feeding into the loop. Unless humans limit the amount of light emitted or better conservation efforts are put in place to return sea turtles to their once abundant numbers, the ecosystem will eventually reach a point where it will not be able to recover.