The next time you go outside on a clear night, look up and count how many stars you can see. Living in
the middle of a large city, the number may be a small as ten. In a smaller city, such as Provo, the number may
be closer to 100. Under a completely dark sky, away from the city, the number climbs to upwards of 3,000 stars
visible to the naked eye, not counting the millions of stars visible in the Milky Way. What causes this drastic
reduction in the number of stars visible? Light pollution. But light pollution has more serious consequences than
drowning out our view of the stars. The improper use of artificial light at night can have serious affects on
human and animal health and safety. Fortunately, the problem has a relatively simple solution.

Light pollution is the use of the wrong amount of light in the wrong place. In general, there are three
main types: sky glow, light trespass, and glare. Sky glow is probably the most visible type, as it is this that
drowns out the view of the stars. Sky glow comes from numerous sources. Any light that shines upwards into
the sky will contribute to the sky glow, which appears as an orange glow present over a city at night. This glow
can be visible from over a hundred miles away if the city is large. Even more obviously, the light that causes the
sky glow can be seen in satellite pictures of the Earth at night. These pictures show the night side of the Earth as
a network of interconnected points of light, growing as the world becomes more and more industrialized. Many
major highways in the United States and Europe can be traced by the string of small towns shining in the
darkness along their path. In Russia, the Trans-Siberian railroad can be traced in the same manner. Even the
borders of some countries can be traced, most obviously the line of the Demilitarized Zone between North and
South Korea. There are very few places on Earth which experience true darkness anymore (Earth at Night). It is
this type of light pollution that most worries astronomers, as it seriously jeopardizes their research. If the sky
glow continues to increase in the cities around astronomical observatories, it will soon be impossible for astronomers to view the stars.

On a more down to earth level, the other two types of light pollution affect nearly everyone. Light trespass occurs when a light shines where it is not meant to shine. This commonly occurs with security lighting on houses shining into neighbor’s windows, or streetlights shining into houses. This is generally seen only as an annoyance. Glare, on the other hand, is usually perceived as dangerous. Glare is any light that shines in such a way as to temporarily blind passersby, clearly putting drivers in a dangerous position when they experience glare (“Frequently Asked Questions”).

Light pollution is quite clearly an annoyance, especially to amateur astronomers, but it has much more serious and far reaching affects. Nearly all organisms on earth have adapted to life under a cycle of light and dark. Now, within the past 100 years, we as humans have disrupted that cycle. The invention of the electric light bulb has become both a blessing and a curse to the world. The First World Atlas of Artificial Night Sky Brightness, a worldwide measure of artificial lighting, shows that use of the electric light has become so prevalent at night that over one fourth of the world’s population never experiences true darkness. The sky at midnight is as bright due to artificial light as the horizon at twilight. About one fifth of the world’s population has skies bright enough to drown out any view of the Milky Way. This problem affects the entire world, although it is most prevalent in the United States and Europe, where nearly the entire populations live under light polluted skies (Cinzano).

According to Dr. Kristen Navara, assistant professor of Endocrinology at University of Georgia, and Dr. Randy Nelson, distinguished professor of Psychology and Neuroscience at Ohio State University, the disruption of the light/dark cycle has had serious consequences for many animals. One of the most obvious examples is insects. Anyone who has set out a lantern while camping knows that most insects are attracted to lights at night. Large numbers of streetlamps in an area will attract large numbers of insects. This in turn will attract large numbers of the animals that prey on insects, in particular birds and bats. The insects, due to their natural attraction to the light, experience an increased risk of predation. Bright streetlights may in fact affect the
survivability of some insect species due to the increased predation.

Artificial lighting has a more directly deadly affect on birds. Night migrating birds tend to be attracted to lit structures. Cities present a serious hazard, as many skyscrapers remain lit at night. Other tall structures, such as communication towers, are required by law to be lit. Spotlights, such as those used to decoratively light building exteriors, are even more dangerous. As migrating birds are attracted to these structures, they fail to see the glass on skyscrapers, and run a serious risk of colliding with the buildings and being fatally wounded. Also, when large numbers of birds are attracted to a building and surround it, they run the risk of colliding with each other, and are under greater risk of predation. According to the Fatal Light Awareness Program, an organization devoted to reducing bird deaths due to collisions, up to 100 million birds are killed each year in North America alone due to collisions. Collisions are not the only ways for birds to be killed by lights. When a bird enters a lighted area, possibly even the tube of light created by a spotlight shining into the sky, they are reluctant to fly out of the light. They will continue to fly in circles in the light until they die from exhaustion (“Nocturnal Collisions”).

In a less deadly way, many common urban birds can become confused by excess artificial light. The increased sky brightness can cause songbirds to initiate their song even though dawn has not yet come (Miller). This behavior may not be particularly harmful to the birds, but it is alarming to see how our behavior as humans has affected the behavior of other animals.

There are other animals that experience an increase in mortality due to artificial lighting. One of the most commonly mentioned is the sea turtle. Sea turtle eggs hatch at night, and the hatchlings orient themselves toward the ocean using light cues. Beaches are usually backed by sand dunes, which cast a shadow on the beach, and the waves reflect small amounts of light from the moon and other sources. The hatchlings orient themselves away from the dark sand dunes and towards the light from the waves. If there are artificial lights present on the beach, the hatchlings tend to become confused, and either die of exhaustion trying to reach the ocean or are eaten by the numerous predators which prey on sea turtle hatchlings (Navara). As many sea turtle species are seriously endangered, this is a cause for great concern.
Artificial lights can have a more subtle effect on the survival of animal species as well. Since nearly all species on earth have adapted to a light/dark cycle, many hormone systems are based on the amount of light received by the organism. Some of the most significant of these cycles include the reproductive cycles of many organisms. In domestic chickens, for instance, it has long been known that egg production can be increased by increasing the chicken’s exposure to light. Some species of frogs, when exposed to artificial light, cease their reproduction. Artificial light can also change the timing of the reproduction of species to the point that they are no longer in sync with the optimal environmental conditions for reproduction. This can have serious consequences on the future of the ability of the species to survive (Navara).

The disruption of this light/dark cycle also has effects on humans. Most basically, it disrupts our circadian rhythm, or our internal clock. This clock is regulated by the detection of light in cells in the retina. The signals are collected in the brain, and used to regulate body functions (Navara). A disruption of this circadian rhythm is most commonly seen as jet lag (Reiter 357). Excess light at night can have a similar effect, causing improper sleep patterns and the corresponding health effects (Navara).

The circadian rhythm also controls many of the body’s hormone cycles, most especially the melatonin cycle, which in turn controls many for the body’s functions by controlling other hormones. The production of melatonin in the body is regulated by the cycle of light and dark, with production peaking in the middle of the night. An increase in exposure to artificial light during the normal hours of darkness, even at very low levels, results in a suppression of the production of melatonin. This suppression of melatonin has potentially very serious consequences.

One of the functions of melatonin in the blood is to help suppress tumors. Melatonin functions to shut down the metabolism and growth of tumor cells. It can also act to inhibit the action of an enzyme called telomerase, which acts in tumor cells to keep the integrity of the DNA. At the end of chromosomes, there are regions of repetitive DNA, called telomeres, which shorten each time the cell divides. Without the action of the enzyme, which keeps the telomere from shortening, the chromosomes of cells become less and less stable over time. This is the reason normal cells die, helping to keep cells from turning into cancers. In tumors, the action of
telomerase allows the cells to continue dividing almost indefinitely. Suppression of this enzyme by melatonin helps greatly to suppress the growth of tumor cells (Reiter 357).

Because of this tumor suppressing capability of melatonin, there is an inherent risk in the suppression of melatonin due to light exposure at night. A study done using rats to show the effects of light at night found that the incidence of tumors in rats constantly exposed to light was significantly higher than the rate in rats experiencing a 12 hour light dark cycle (Anisimov). Epidemiological studies using large numbers of subjects have indicated that there is possibly a similar link with women and breast cancer. Women who work night shifts, disrupting their circadian rhythms, tend to be at a higher risk for breast cancer; however, the link between night exposure to light and increased cancer risk has not been clearly established (Haus).

Circadian disruption also can have effects on metabolism. These changes include shifts in insulin resistance and in the breakdown of carbohydrate and lipid breakdown. These shifts in metabolism, combined with the lack of quality sleep that tends to accompany working night shifts, may account for the increased risk of cardiovascular disease in those who work at night (Haus). Reduction in melatonin levels also correlates to an increase in heart disease and hypertension (Navara).

Clearly, excess exposure to light at night can have severely detrimental effects on human and animal populations. It is very difficult to live in an area that experiences light levels low enough to avoid all chances of consequences, as 99% of the population of the United States lives in areas above the threshold for light pollution (Cinzano). Fortunately, the problem can be solved relatively easily. Most of the problem is due to ignorance, and education is the solution.

By far, the most effective solution would be to turn off all unnecessary lights at night. Most buildings do not need to be lit all night long. Decorative lighting and lighting for advertising could be turned off after a certain time of night, since it serves no purpose when there are no people around. Many businesses, such as car dealers, unnecessarily leave all of their lights on all night long. If these excess lights were turned off, a large portion of the problem would be solved.

One of the main arguments against changing our lighting is security. Most people seem to have a
perception that the more light there is in an area, the more secure it is. This has not, however, been proven to be true. In fact, the opposite may be true. Increased lighting allows criminals to more easily choose victims. Improper security lighting can also create areas of higher contrast, making it easier for criminals to hide. Glare from lights makes it difficult to see into the shadows. Increased lighting may actually make an area more dangerous if the lighting is installed improperly (Eck).

The majority of sky glow is caused by light fixtures that have been improperly designed or installed. The problem can most easily be demonstrated with streetlamp type fixtures. The worst possible fixture is the globe type, which allows a large portion of the light to flow directly into the sky, serving no purpose except to waste energy and money. Better is a fixture that would be referred to as a partial cutoff fixture, which has a shield that directs most of the light toward the ground. Best is a full cutoff fixture, which directs all of the light produced toward the ground, which is the purpose of having a streetlight. All light that goes directly into the sky is a waste.

Much light pollution is caused by the lighting on our roadways. The cobra head type lighting, probably the most common fixture, is very poor at directing light only toward the road. The type of lens it is fitted with allows the source to be seen from several miles away. Variations on this fixture help to direct light better, but increase the glare and light trespass experienced by the surrounding area. Economical alternatives to this lighting exist that will prevent all three major types of light pollution (Kramer).

A further consideration in light pollution, particularly for astronomers, is the type of bulb used in the fixture. Many streetlights use low pressure sodium bulbs, which produce the familiar dim orange yellow glow. These lights are the most preferred by astronomers, since they emit light on a very narrow range of wavelengths, meaning their light can be filtered out. This also reduces their effects on humans and animals. Broad spectrum lights, which produce a white light, are the worst, both for astronomers and for the effects on the circadian rhythms of humans and animals. Such bulbs include the mercury vapor lamps at stadiums. These lights are the worst for light pollution, because they cast their light for many miles.

In my own experience, some of the most annoying light trespass is caused by misdirected motion
sensing security lighting. These fixtures tend to be installed and left directing their light into the neighbor’s windows. The simple act of checking the direction of the light your fixture is producing can be a great help in reducing pollution.

With a simple, concerted effort over time, the problems of light pollution can be solved by the use of proper light fixtures and bulbs. The deaths of millions of animals and disease in many humans may be prevented by the simple act of dimming the lights.
Works Cited


<http://www3.interscience.wiley.com/cgi-bin/fulltext/118521354/HTMLSTART>.
