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**ORIGINAL ARTICLE**

# Investigation of Ecological Effects of Artificial Light scattering Systems

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**ABSTRACT**

*Due to the important role that artificial light plays in human life, it is also important to examine the ecological effects of light scatteringsystems. A properly designed lighting system can have positive effects not only in energy consumption,butin gathering very important benefits such as public safety, crime reduction, creation of physical and psychological comfort, and in overall it cause good feeling in the community.But the phenomenon of "light pollution" can act in contrary to it. Since this phenomenon has many negative effects, including environmental impacts on plants, animals and in general wildlife ecosystems, its impact on astronomy, energy loss, causing or aggravating illness, the ambiguous image of the stars in the night sky, the study about that - as in other developed countries has been perceived - has important positive consequences. The purpose of this paper is to identify the damaging effects of light pollution from the perspective of ecological light scattering systems and the strategies that have been proposed to reduce the effects of light in the desired light distribution and performance improvement systems.*

***Keywords :****Light Pollution, Ecological Effects, Good Lighting, Artificial Lighting Scattering*

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## INTRODUCTION

The increasing use of light at night causes problems known as the light pollution. This term is used for a few years, but in most cases it refers to reduction of the human analysis and opinions about the night sky (invisible stars). Artificial light at night may have harmful effects on wild and human life. Light signals in biological false timecaninterfere with normal behavior of plants and animals [1].

Additional or disturbing light is due to bad design or implementation of a lighting system and creation of more light than expected brightness. The extent of light pollution is very broad. For example, it includes a variety of factors such as light domes, buildings, towers, light of roads, lights of fishing boats, hazard lights, light of vehicles, fire and gas wells offshore as well as subsea research facilities.

Since this phenomenon has many negative effects, including environmental impacts on plants and animals and in general wild life ecosystems, its impact on astronomy, energy loss, causing or aggravating illness, the ambiguous image of the stars in the night sky , the study about that - as in other developed countries has been perceived - has important positive consequences [2].

## ECOLOGICAL EFFECTS

Here the effects of artificial night lighting on plants, animals and humans are discussed. In general, more research is needed in each area to clarify the ecological effects of poor lighting at night in the appropriate form.

### Human Physiology

Despite great advances in the last century in applied electric lighting field, only a portion of the adverse effects of artificial light is recognized[3]. The new researches that focus on the relationship between light

and cancer have shown that the brightness of the light, especially at night, is a matter of public health threats. In industrialized countries, the risk of breast cancer is 5 times greater than less industrialized countries. However, unlike the direct relationship between lung cancer and smoking, no clear relationship between breast cancer and the extent of industrialization has been accomplished. Today, there is an idea that the increase in breast cancer has significant relationship with disturbance the life cycle of life, in particular the modernization of the electric lamp. Studies have shown that workers who work in shifts are at greater risk for developing breast cancer and blinded women face a lower risk of breast cancer. As mentioned above, most studies have been carried out during the night, nor the light of day. Forejt et al. conducted a survey among Czech people and came to the conclusion that 5% of people suffer from interference from external unwanted light that is one of the main reasons for sleep problems. More than 7%believed that the light is more than tolerance level, and more than 20% stated that the decrease of bedroom light issedative.5% also complained that due to prevention of artificial light entrance into bedroom at night, the natural light cannot be understood in the morning. Authors suggest that optical threshold of less than a millimetre luxury is compatible with most people. Most studies that have emphasized on the importance of darkness in human physiology have been performed on a makeshift staff. It is not clear that howmuch of the development in shift work is related to high brightness during labour and how much is related to regularly sleep in the dark.Several mechanisms are involved in this adaptation; dream is to be a coordinator itself. It is also possible that the powerful effect of the observed phase shift was due to complete established sleep where light has a small role.Finally, there is still much room for further research to investigate the disease associated with light and darkness. Biological and medical effects of light are shown on the table [1].

| Effects | Direct | Indirect |
|---|---|---|
| Physiology | - Inflammation of the skin<br>- Accumulation of pigments in tissues<br>- Increasing the thickness of the outer skin<br>- The combination of vitamin D<br>- Blood levels of the amino acid<br>Safety systems – | - Visual<br>- Reactivation of genital<br>–Preventing the synthesis of melatonin |
| Pathology | - Porphyrin drugs sensitive to light<br>- Sun and toxic substances<br>- Eye Injury<br>–Production of Cancer | –Effects of poor medical and behavioral characteristics |
| Therapeutic | - Hyperbilirubinemia<br>- Rickets<br>- Pathology<br>–Drug interaction of light (lateral and leukemia ( | - (SAD) seasonal effective disorder.<br>–Fatigue and depression due to travel between latitude regions |

Table 1: medical and biological effects of light

## LIGHT POLLUTION AND CANCER

Most research that has been done about the effects of light on human health were about the possible impact of the light pollution on the incidence of cancer in women, especially those who work in day and night shifts under artificial lighting. This is due to the effects of artificial lighting on melatonin which can severely affect the activities of the human body at night. Melatonin is a hormone in the body that is made in response to periods of darkness and light, day and night. This important body hormone that was discovered in 1950 is secreted by the pineal gland in the brain. Melatonin is a protective hormone and a powerful antioxidant that has existed for thousands of years in animals and plants.This hormone is secreted during the night and its production at night is 10 times more than the day and in addition to its other duties, it regulates body functions during sleeping. Melatonin is a protective hormone that should be allowed to be discharged in the early hours of the morning. This hormone due to its secretary association to light will help us to regulate sleep and wakefulness. Melatonin helps to regulate other hormones in the body. These hormones regulate the rate and pattern of 24 hour responses and actions of the body.It also regulates and controls the timing and release of female sex hormones and effects on puberty, menopause and menstrual periods.

High levels of melatonin in the body are also responsible for the process of aging. Children have the highest levels of nocturnal melatonin. By age increase, this hormone becomes less and less. Low levels of melatonin causes people to sleep earlier and wake up earlier and may suffer from this disorder pattern. However, the use of this hormone modifies the sleep patterns in people who suffer from insomnia due to low levels of melatonin such as the elderly and children who their sleep behavior disorder are as a result of "autism", epilepsy, cerebral palsy, and Down syndrome.

**The effects of different wavelengths of light on the biological cycle**

Light can have profound effects on core temperature during the night. There are scattered reports that suggest by human exposure to light with a wavelength of 509 nm for one hour at different intensities; the secretion of melatonin is inhibited. In albino rats and hamsters, blue-green light inhibit melatonin secretion. Although there aren't regular studies about the effects of light on core temperature and melatonin in humans, the light of different wavelengths has received special attention. Long wavelength light, such as low temperature light(3000 ° K) and red light have less effect while the mean wavelength and high color temperature light (6500 ° K) and the green and blue light is more effective for the biological cycle human. blue or green light prevented core temperature decrease during the night (the decrease cycle) and rise its increase in the morning (the increase period), because green or blue light prevented increase of melatonin secretion of the pineal gland during the night and increase its reduction in the morning. These effects are reflected in the behavior of core temperature. Study of ambient light in relation to its effect on the health, welfare and human biological cycle is important. The trading range for core temperature strongly depends on sleepiness. Light with a low color temperature should be used at night while light with high color temperature should be used be in the morning when a higher level of intensity is needed. People who have limited behavior such as the elderly, the disabled and rural people whom the facilities are more important than the ambient lighting, requires knowledge about light during the day and night [4].

**Body rhythm and light**

Light throughsends signals new photoreceptor cells and the distinct nervous system from the biological clock (biological), which in turn regulates great variation of seasonal and circadian rhythms of body processes. Cortisol (stress hormone) and melatonin (sleep hormone), play an important role in the control of sleep and wakefulness. Cortisol increases blood sugar to provide energy to the body and the immune system (protection from disease). However, when the cortisol levels increase up a specifiedlevel; this system becomes ineffective and is depleted. Cortisol levels increasesin the morning and prepares the body for activity on the same day. Cortisol in daylight reachesat a high enough level thatstays in the middle of the night and eventually falls to a minimum value. Melatonin levels drop in the morning and sleepiness reduces. To prevent melatonin secretion in the morning more light intensity is needed compared with the afternoon. Then normally when the weather is dark, it will increaseagain and allow healthy sleep. (Cortisol is in its minimum value).It is important for body that this rhythm was unduly undisrupted otherwise the light bright days helps to restore normal rhythm.

In a natural environment light especially morning light synchronized internal body clocks with earth's 24-hour light and dark cycle. Without setting a 24-hour light and dark cycles, the internal clock of humans will fluctuate 15 to 30 minutes in an average period of about 24 hours. This deviation increases body temperature, melatonin and cortisol levels. The absence of regular hormonal rhythms will cause an incorrect rhythm of alertness and sleepiness that finally leads into consciousness during the hours of darkness and sleepy feel during the day. Rotating shift workers experience the same conditions due to similar reasons after each shift change for a few days. The effects of light and melatonin on the core temperature vary depending on the wavelength of light. Long wavelength of light, such as low color temperature and red light has limited effects on the human life cycle. On the other hand, green light and blue light with shorter wavelengths, such as high color temperature have more effects. It is recommended that the light with a lower color temperature is used in nights and higher color temperature light is used in the morning.

**Brightness, alertness, mood and stress**

Many research projects were about comparison the light effects on people's health, welfare and consciousness that their work has already been done under different lighting conditions. Pattern of brain waves (EEG) of people were studied who were in an office as a laboratory with environment similar to those they work in, once with a relatively high level of light (1700 lux) and once with a relatively low surface brightness (450 lux). EEG showed a significant difference. Delta waves are much higher in more brightness levels. This means that the effect of light have the alert effect on the central nervous system. Much research on the effects of light on alertness and mood was carried out under the night shift, because the effects are expected to be more severe in these circumstances. Other studies show that the use of higher light levels causes resting and really makes the people stay alert longer.A study was

conducted about levels of stress and complaints of people employed in domestic environments with a comparison group of people who work exclusively under artificial light and those who work under a combination of daylight and artificial light.

**Light Immunology**

All wavelengths of light have the potential to alter the immune response. This includes annual and circadian variations of light. Duration, intensity and wavelength of light help to the situation of impaired immunity (immunity). Ionizing or non-ionizing radiation, ultraviolet light (below 400 nm) resulted in inhibition of immune function. This is an intermediate skin reaction. Visible radiation via mechanisms between the brain and the eye and also the middle crust may affect the immune system. Wavelengths greater than 400 nm can penetrate to the membrane and outside layers of skin and directly have interactions with mobile cells those are responsible for immunity for state immunity. There is possible indirect mechanisms that are involved with light with a wavelength of 400 nm transmitted from the retina to the brain. Stimulation of certain regions, such as the pituitary, hypothalamus and pineal gland, produces chemical nerve agents that could directly alter immune function. Either one or both pathways may be involved [5].

**Skin intermediate reaction**

Wavelengths of light transmitted between different invisible layers of the skin from small to large mammals. Longer wavelengths of light have the greater the influence on the skin. The shortest wavelengths of ultraviolet light will cause the strongest immune response, while the inner skin response to visible light is poor but understandable.

**Physiology of Plants**

Plant physiology is influenced by biotic or abiotic biological signals from their environment. Bio-signals include disease and insect and other those bigger vegetarians infestation. Non bio-signals include phenomenon such as changes in temperature, changes in water content, nutrient limitation, osmotic pressure and the ambient light. The emphasis is on plants' photoreceptors that detect optical signals and thus affect the physiological responses of plants to light. Although much research on the quality and quantity of the light spectrum and the length of time has been done on plant growth, but its primary focus were on use of artificial light for plant growth, like greenhouses. Recently the focus of these researches is the use of LEDs for optimum plant growth in the greenhouse and space exploration. However, there is no detailed study on the effects of artificial night lighting on the plant. More research is needed in this area [6]. There are four receptor groups in plant tissues: Phytochrome, Cryptochrome, Phototropin, and photoreceptor FKFI. These receptors are mediators of physiological responses and plant growth. Usually studies of the photoreceptor are performed by the model plant of Arabidopsis thaliana plants that frequent mutant plants without the photoreceptor have found among them.

**PHYTOCHROMES**

Photoreceptors of Phytochromes are responding to different wavelengths of light inactive and non-active forms. These transformations are used for ambient plant adaption with lighting conditions of plant growth; photoreceptors are in two forms of mutable light: the Pr and Pfr. Pris biologically inactive and by absorption of red photons is converted to an active form of pfr. This active form converts to pfr byred photons elimination. Figure 1 shows absorption spectra for pr and pfr. Absorption spectrum Max Phytochromes occurs at wavelengths 665 nm and 730 nm. Absorption bands overlap and thus optical radiation below 700 nm enable both pr and pfr transformations.

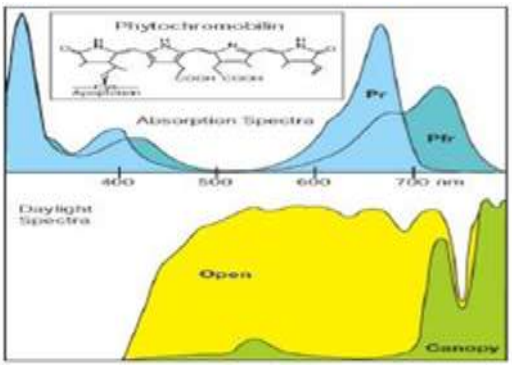


Figure 1: light transformation of some intermediate forms in both directions to create balance between Pr and Pfr

Plants used Phytochromes as sensors and changed their growth and forms shade - avoidance syndrome. Escape the shadow plant shows plenty of growth depends on a sense of the proportion of Low - red: Far - red and if this work is successful, its leaves will expand into areas that receive more light.Phytochromes create plants with temporary signals that have the biological clock phases and other signals that ensure

the critical developmental stages of the life cycle are located in appropriate locations. Andvzhnz cyclic rhythms coordinate with the changing seasons, such as the incubation period of flowering in different seasons. In these processes, Phytochromes do not work alone, and often Cryptochromes are responsible for initiating the germination and growth and plays an important role in the acquisition of colour[7] .

**Cryptochromes**

In the past few years great progress has emerged in determining plant photoreceptors that are active in the blue spectral region of UV-A. Recent studies have shown that there is at least 4 active signaling pathway for blue color in Arabidopsis. As a result, there are at least 4 types of blue light receptor. These receptors include Cryptochrome 1 (cry-1) and Cryptochrome 2 (cry-2) respectively. It seems Cryptochromes participating in inhibiting stem elongation by induction of blue colour, cry-2 is more sensitive to the lower light intensity compared to the cry-1. So two Cryptochrome have important role in growth inhibition, but their effect is seendifferent light intensities. Recent studies have demonstrated that cry-1 and cry-2 has a similar spectrum of activity. However, there is still the possibility that they may respond to different wavelengths in different forms. Recently, A third type of Cryptochromes as crydash (cry-3) is seen in some organisms such as flies and humans, in addition to Arabidopsis and cynanobacteria. But the role of cry-3 in plants is unknown.

**Phototropins**

As mentioned before, the blue light (500-390 nm) and UV (590-320 nm) reduced physiological responses in the plant. In the meantime, there are four important reactions that increase the potential for photosynthesis in poor light and prevent damage to photosynthesis organs in bright light. These actions include: phototropism (plant moves toward or away from the light source), stomatal opening by light (small horizons in the leaf or stem epidermis that control alveolar ventilation by opening the flaps in response to environmental stimuli) Chloroplast movement (tiny particles that are responsible for photosynthesis in plant cells) is in response to changes in light intensity and tracking the sun that is made by the leaves of certain plants.All the above reactions have similar spectrum of activity (Figure 2). Theyshow bonds with one major peak and two minor absorption peak in the blue region of the spectrum and a broad absorption band in the UV-A. These spectral features are characteristic of a Flavoprotein photoreceptor.

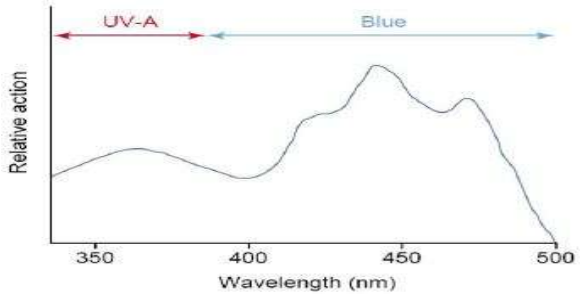


Figure 2: Absorption spectra for mediating reactions of phototropism the main peak at 450 nm, the minor peaks at 425nm and 470nm in the blue spectrum range. This structure is seen at365nm absorption band in the ultraviolet spectrum.

**Photoreceptor of FKF1**

After the publication of the complete DNA sequence of the plant model Arabidopsis thaliana that is used in the studies of photoreceptors, the search of this database was begun to find related proteins with known photoreceptors.

We have 3 types of protein FKF1, ZTL, LKP2 that each contains a range of simple LOV (light, oxygen, voltage) which is very similar to the LOV domains in Phototropins and show similar photos chemical properties. Experimental results of Imaizumi et al. show that an important part of the CO discharge throughout the day is due to the cyclic control FKF1 discharge and is caused by light-dependent FKF1. Furthermore, genetic and biochemical evidence suggests that FKF1 acts as a photoperiodic receptor. Their findings also demonstrate that FKF1, ZTL, LKP2 are family of blue photoreceptors in Arabidopsis form, but secrets about ZTL and LKP2 is more than FKF1. Ground absorption spectra (Figure 3.alf) and light-induced difference spectrum at the LOV domain related to FKF1 was consistent with the LOV2 domain related phot 1 (Figure 3.b) that it proves that they have similar photo related chromoform links and photochemical properties. Compared with Phototropin LOV domains, LOV domain related to FKF1 was black and no recovery was observed (Figure 3.b, black spectrum). Max FKF1 absorption spectra were at 450 nm with a vibrational sidebands and a smaller peak in the UV-A region (Fig 3.alf). After exposure to light, a fall in absorbance at 450 nm and an increase in absorption at 390 nm are seen that is shown in figure 3.b.

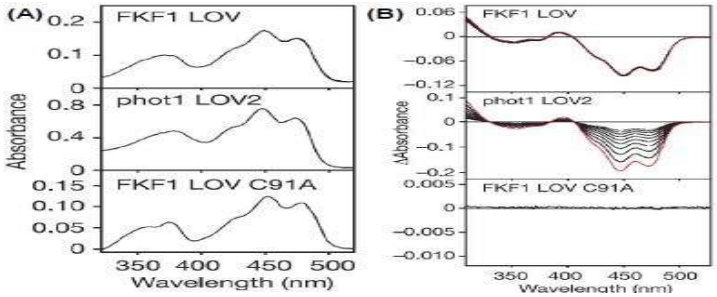


Figure 3: a) The absorption spectrum of FKF1 LOV, PHOT 1 LOV 2, and 1A FKF1 LOV CB) Light minus dark difference spectrum of FKF1 LOV, PHOT 1 LOV 2, and 1A FKF1 LOV C

**Animal Physiology**

It should be noted that when you speak about animals it should be considered that the mode of perception of light is different from the way humans understand and observe. In the measurement of the flux, greater emphasis is on the waves of light that the human eye perceives it well not the flux that human eye is weak or powerless in perceiving them.Since other organisms see light differently - like seeing waves that are the invisible for man - in future studies on ecological light pollution of these reactions must be determined and the light must be measured. Most studies on the adverse effects of nocturnal light fixtures focused on mammalian physiological cycle failure but most of these studies were measured in vitro.Only two studies compared artificial light with daylight to assess their effects on the physiological circadian clock. Physiology of mammals is not investigated in this area closely and focus will be on the effects of light pollution that is less well known. Night artificial lighting like natural lighting, is important in launching - or destroying - the circadian clock and may change this time about 1-2 hours [8].

**Birds**

Many species of birds migrate at night and it clarified that fire and artificial light can be absorbed during migration by them, especially when the sky is dark. The case of bird attraction tolight is used for bird hunting in parts of the day. This phenomenon is used to boost ecotourism in Africa. But the mechanism of how the light catches the attention of chickens is unknown. It would be said that when a bird flies into the light at night, loses its visual cues about the horizon and the uses the artificial light that it resulted in the route diversion. Also it is noted that immature birds that migrate are mistaken more rather than to the mature birds. Avian visual system is different from the human visual system, because they have a 5 different vision pigment and 7 different photoreceptor type: bar, twin, cone, and four single cones whereas man has only 3 cones. Additional cone in bird reacts to wavelengths ranging from UV spectrum. In addition, the bird's eye has oily droplets of different colors that narrow the receiver sensitivity. The spectral sensitivities of the various oil droplets, cones and phototopic vision can be seen in Figure 4. It is likely that the bird sees the environment differently than human sense. This issue is related to the solving problem of the absorption of bird migration to artificial light at night.

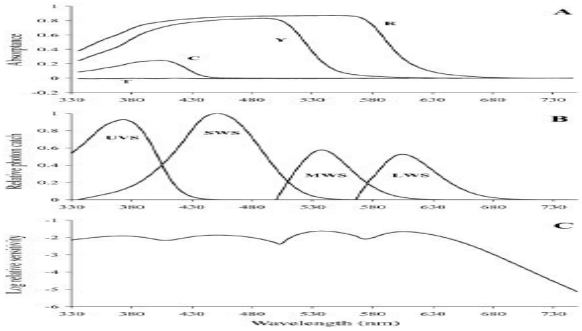


Figure 4: The spectral sensitivities of the simple cone cells, which are calculated from data micro spectrophotometer.

Initial detailed studies about bird's attraction to the light, lanterns and marine vessels impact on migratory birds have studied in the late 1800s. Studies have shown that fixed white lights have more pernicious influence than colour odor spinning lights. For example when the light beam of lighthouse in Canada became narrower and more limited, significant reduction in mortality in birds occurred. Average annual mortality of 200 birds in autumn and 39 birds in spring decreased to 18.5 and 9.6birds in spring and autumn, respectively. But these early studies are not consistent with other studies.

**Reptiles**

This group includes amphibians (such as lizards) and amniotes (a subset of amphibian vertebrate) animals that their embryo is surrounded by a membrane and members of Sauropsida. Artificial lighting at

night for baby of sea turtles is an important lethal factor. The turtles nest on beaches far from the sea in the dark. Nightly light will lead turtle could not find its home and also have negative effect on baby's movement behavior to the ocean. To reduce the adverse impacts for turtles in coastal environments, it has long been trying to put filters on existing light. Filtered light absorbed the turtles too. This absorption can be returned to the sea by powerful natural symbols. Response to certain signals in two different types of turtles was different due to their different spectral sensitivity to light. Filtering HPS lamp will be less attractive to turtles. This absorption also depends on the light intensity. The lamps used in the United States were replaced with LED lamps on the road surface with the distance of one kilometer from the beach (Figure 5). Before When the primary lamps were lit in road, precession in the turtles were seen, However, when they were turned off, or when the LED lights were turned on or both lights were turned off, no diversion was observed.


Figure 5: The comparison of HPS lamp with LED lamp

Since in the coastal roads of Florida, precession of large turtles can be seen, therefore, a research group composed of representatives from industry, government and state Federal and specialists enacted an instruction set for beach lamps use that solved the problem. There are 3 elements in this instruction: Keeping lights away from shore or covering them or their reinstallation, reducing lighting by turning off the lamps, lamps installation of less lamps or lamps with lower wattage, and reducing damaging wavelengths using optical filters or LPS lamps. In conclusion, the effects of artificial night lighting on sea turtles in comparison with other areas involved in ecological light pollution are relatively more known. But the solutions of this problem are not so easy. In Florida, for example, by reducing the number and type of lamps, light emitted into the sea was reduced but the light sources within the city that is growing day by day and increase the red sky is not solved yet. In addition to problems for turtles, reptile so rapidly disappears that is comparable to amphibians, but this issue attracted little attention. In some studies, reptiles called with the name of night lighting that have no relation with pollution. This technical termis used for some reptiles that come out their nest at night. In these species there are reflective layers in the eye called tapetum lucidum that causes light to be reflected from the target (such as crocodiles).

**Amphibian**

Now the whole world experiences the period of population decline and diversity. Although anecdotal reports about the impact of artificial light on the life history of the common frog is common(Fig. 6), but few studies have examined night lighting on amphibians, particularly these group. Since job hunting and feeding of frogs is done in a moderate form of light, artificial lighting at night can have a tangible impact on them. Necessary light for the formation of visual images in low light with larger retinal areas with more light receptors and receptors for several purposes that stimulate a single neuron and the transient summing by the optical receptor that collect multiple photon before excitation of neurons will reach to maximum value, the maximum is reached.For example Tree frog has excellent visibility in low light. Anuran likely has colour vision. Although it is still unknown that the colours of light have meaning in low lighting, most frogs have a tri-chromatic colour vision like human. Probably they have the vision with tetra chromatic sensitivity to UV wavelengths too. It is believed that frogs tend more to blue light. This sensitivity is an advantage for the animal because at the time of feeling dangerous they will go toward the water.

Figure 6: Night lighting effect on Amphibian

It is noteworthy that the frogs like gather around the poles because many insects are attracted to light and they can hunt them. If the frog has always constant move away from its original and natural position to light sources, this issue will become a classic example of evolutionary traps. Lighting can also increases the chance for a good spot to hunt and feed for frogs. Artificial light also affects mate selection. Female frogs were tending to choose their mates under dark conditions that this behavior has now changed. There isless information about the negative effects of artificial lighting on the cyclic rhythm of frogs. The first studies investigate circadian activity cycle in both groups and found significant differences in individual responses compared to the luminance. While constant luminance proves very poor damaging effect on the pattern of normal activities, melatonin interferes in the control of many biological frogs 'processes, such as involvement discoloration, gonad development and reproduction.

**Fish**

Man's use of intensified light causes marine animals are also exposed to intense light. More than half the world's population live within 100 kilometres of ocean. In most areas of aquaculture and recreational vessels and offshore oil and gas, constant light is used. During night, fishing vessels use high-intensity lights to attract prey. Light effects on marine animals is well known, but few studies have been done on the results of the impairment on circadian cycles, and seasonal lunar caused by human activity. Aquatic life as a result of evolutionary getsadaptation with light regimes of amphibians those factors such as the moon, the stars. Bioluminescence and cloud cover have influence in this life style. While light pollution alters the intensity, spectrum, frequency and length of time that light penetrates to the surface at night. Bony fish constituted about 96% of fish and huge part fishery products of the world and also includes commercially important species. Their feeding practices and migration collective life depends on the particular light intensities. The eyes of this species is composed of the cones and rod shaped cells that such as the human eye, the cone ones are sensitive to light of high intensity and rode shaped one is sensitive to low intensity light. Differences in the capacity of vision in light absorption can be determined by genetics and location and the capacity changes by the optical spectra of the animal life environment.

For example, when young fish from fresh water enters to salt water its pigments change from prophiropsin to Rhodopsin pigment. Further studies on marine fish behavioural changes in sweet water are required. Reaction of fish to light can be categorized to the response to luminance (cd / m2) and luminescence (lx). The main reactions are variable even among species and depend on many factors, such as fish characteristics, ambient conditions (darkness or lightness) and the characteristics of life. Given the duration of the light, except the light fluctuations caused by the movement of waves, clouds, and sun underwater conditions, the large amounts of light entrance to the water is considered a nuisance to fish. Fish maybe exposed to intensified light in power stations. To reduce the fish arrival to the channels that damage to them, the light can be used. Researchers often use mercury vapor lamps to attract fish. These lamps have a great energy at ultraviolet and blue spectrum. It was proven in a study that at first fish avoid mercury vapour light but after their adaption to it, they will attract to it.In another study it was shown that the fish activity in response to mercury vapor light increased compared with strobe light and their avoiding reactions are less.

**Invertebrate**

Among invertebrate, insects are the most important factors in pollen distribution and key members of the food chain. The adverse effect of street lamps and light on them theoretically could leave serious ecological bad results. Many researchers have investigated adverse effects of artificial night lighting on butterflies in particular and insects in general. There is still a lot of work. Light trap sampling is a semi-quantitative method to study the reactions of insects to artificial light. The efficiency of light traps in relation to the intensity and phase of the moon, moon polarization and other environmental factors is studied. Insects' attraction to the lamp can be distinguished as "near" and "far" effects. Most studies were performed about the effects of "near" while far effect is caused by the change in the brightness of the background illumination caused by the moon or other ways [8].

## CONCLUSION

According to a joint study conducted about ecological effects of light on the humans, plants and animals, the importance and necessity of providing strategies to reduce or eliminate light pollution will appear. Due to the fact that this issue in Iran is not addressed in an appropriate manner in comparison to other countries, the need for research in this field is feeling.

So in this paper, we try to explain complex ecological effects of light and with precautionary based principles, a few practical suggestions for proper design of the lighting in interior and exterior environment which can be used for human health, and around are mentioned below:

• The best light to use in an environment is the day light and if there are no windows in some offices a non-radiant light and bright white light must be used to be reminded so that natural light to be reminded.

• Internal space should be dark at night. Blue wavelengths must be removed and the wavelengths of light must be yellow or orange. Using neon light instead of fluorescent lamps with blue light causes the eye is not placed in exposure of blue light.
•Darkness is preferred for sleep. TV and the bedroom lights must be switched off at night.
• In the street lighting shield must be installed in accordance with standards of protection and to minimize the entry of light into the house.
• Because the blue light emission of sodium lamps is less so it is recommended.
Installation of metal halide and mercury vapor has less impact and emits broader range of blue light.
•The low-pressure sodium light can be most effective. For example low-pressure sodium compared to other external light sources emits the highest lumens per watt. Low-pressure sodium emits a single wavelength of 589 nm. Therefore, it causes melatonin decrease in lower range. The lamps are preferred by astronomers because it can easily be filtered.
•Holding workshops about the biological effects of light pollution on humans, plants, animals.
• Training and guidance of lighting systems agents.
• Training and guidance lighting installation contractors (particularly in the streets).

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