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Consequences of pollution in wildlife: A review

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Abstract
In human dominated landscape, effects of human activites and disturbance exceed those of wild animal habitat and natural predators. Human disturbance and pollution caused by various sources can influence wildlife behaviour, which have negative impact on wildlife populations and lead to the decline of many species, both directly and indirectly. Mechanism which can explain coexistence of both human and wildlife together is the degree to which a species tolerates human disturbance and pollution. With advancement in technology day by day, humans are causing changes in the environment that hurt both animals and plant species. Humans take up more space on earth for their homes and cities compromising the space for habitat of wild animals. So, animals and plants have gone through a hard time for their survival on earth. It is estimated that over two thirds of the animal and plant species that once lived with harmony in nature are now extinct and some more are on the verge of extinction.

Keywords: human activites, loss of wildlife habitat, pollution, and wildlife

Introduction

Living organisms cannot live by themselves, their interaction with each other balances the nature with all living organisms as well as physical surroundings that forms collectively an environment. Pollution is the introduction of potentially harmful chemical or physical constituents into the environment, in which substances substantially harm individual species metabolisms, or which strongly and rapidly alter a stable historic ecosystem composition (Hogan, 2010). Human has modified the environment and imbalance the nature for several means that results into pollution. Environmental pollution is the major reason in which humans have caused drastic modifications of wildlife habitat. Previously, we neglected the air, water, and soil pollution that surround us as waste receptacles and underestimated the ecological consequences of our actions. As a result, wildlife is facing a bewildering array of pollutants of various types that are released into the environment either intentionally or accidently. At worse, air and water pollution can cause death of many organisms in a given ecosystem, including humans. Carnivores (>40 kg) which are large in size such as tiger, leopard and wolves are more susceptible to human disturbance like road building, settlements, farmlands, logging, poaching, grazing and quarrying and changes in the configuration and connectivity of habitats such as habitat fragmentation and loss (Dusit *et al*., 2007, Bishnu and Pavel, 2013) [20, 8]. Some studies have suggested that the prey abundance and the human disturbance are the most important parameters for tiger occupancy, and serious disturbances can cause prey depletion and tiger extinction (Bishnu and Pavel, 2013) [8]. In recent decades, conflict between human and wildlife survival has narrowed much due to exponential increase in the human population and much interference of wild habitat by increasing human activity (Pettigrew *et al*., 2012) [69]. In some cases due to increasing anthropogenic activities and pollution, wildlife populations have suffered severe losses or even faced extinction. The most important causal anthropogenic activities are habitat destruction, overexploitation, pollution and the introduction of alien species to an environment. Habitat destruction elements include agricultural land conversion, deforestation, overgrazing and urbanization; within these activities the process of habitat fragmentation is sometimes hidden cause of major biodiversity loss. Among them, habitat destruction is the greatest contributor to the extinction of many species; moreover, impacts to biota from habitat fragmentation are a critical mechanism for species extinction. Human-induced rapid environmental change has altered the animal behavior, species interactions in wild and also species declines, including extinctions and range shifts (Jackson and Sax 2010) [41]. This destruction is ongoing in both terrestrial and aquatic biomass, with approximately 80% of all extinctions being attributed to human caused habitat destruction. For example, the small island of Saba (five square miles and ten species lost); Montserrat 33 square miles and 25 species lost; Puerto Rico (3435 square miles and 40 species lost); and Cuba (44,164 square miles and 100 species lost). Overexploitation of natural resources in earth by humans to enrich their own lives has threatened the existence of many species in wild. In the aquatic biomes, overfishing is a worldwide manifestation of over-exploitation. In the case of terrestrial ecosystems, overgrazing and intensive cropping systems are the chief elements of over-exploitation. For example tigers have been an integral part of traditional Chinese medicine for over 1000 years and as such, they have been hunted to the brink of extinction as a product of the lucrative trade in tiger body parts (Hogan, 2009) [36]. Reduction in species numbers anywhere within a food chain obviously affects the other members of the ecosystem. Pollution is one of the primary ways by humans which has caused drastic modifications to wildlife habitat. Widespread, air pollutants are sulfur dioxide, carbon dioxide, carbon monoxide, and oxides of nitrogen which ultimately recycled in the form of acid rain, continuous accumulation imbalance the whole ecosystem in a specific zone. Water and soil pollutants of concern are heavy metals and a large category of chemicals including pesticide, herbicide and other compounds. Surface water pollutants uniquely associated with power plants release effluents and oil spill accidents i.e. PAHs (Polycyclic aromatic hydrocarbons) pollution causes huge loss of aquatic biota as well as terrestrial fauna and flora. Thus, indiscriminate use of synthetic chemicals, exposure of excess toxic minerals, oil spill accidents and acid rains disaster are the major consequences of unbalanced wildlife ecosystem.

Effect of chemical pollutants on wildlife

Scientific studies have revealed that the present and future generations of human beings and wildlife would be exposed to the harmful effects of various industrial chemicals, pesticides and unintentional by-products. Some of these substances are persistent, toxic and accumulate in human and animal tissues, which bio magnify with time leading to serious health concerns (IPEP, 2004) [39]. Persistent Organic Pollutants (POPs) are, as the name suggests, persistent and extremely toxic and IPEP (2004) [39] categorized POPs into three classes i.e. pesticides (DDT, Aldrin etc), industrial chemical products (PCBs and HCBs) and unwanted products (Polychlorinated dibenzo-p-dioxins, Polychlorinated dibenzofurans etc). The extensive use of N-fertilizers and synthetic chemicals for crop production to control pests, principally insects, weeds, and fungi became a common practice in agriculture land since a few decades. Pesticides are widely sprayed in agriculture land to control pests in soil and crop (UNEP, 2002) [88], but they contaminate air (emissions during spraying), water (Leakage from stockpiles, Industrial effluents) and soil (Production waste, Agricultural and other soil run). Lindane, DDT and aldrin have been the predominant pesticides observed and were extensively used by developed and developing countries (CPCB, 2002) [17]. Organochlorine like DDT was one of the most widely used pesticides. Organochlorines are strongly attracted to fats present in cells and tissues of living organisms and also inhibit Gamma-Amino Butyric Acid (GABA) receptor in brain, affect the central nervous system. Since organochlorines resist degradation in living system, these compounds gradually accumulate to high concentrations in tissues of vertebrates. By the late 1960s wildlife biologists realized that DDT was producing disastrous side effects in wildlife species (Davis, 2012) [18], still DDT applied in the US in the early 1970s is present in the environment (Davis, 2012) [18]. In 1970s, most developed countries banned the use of DDT because of its deleterious effects on wildlife and, ultimately, humans. Mitra *et al.*, 2011 [58] reported widespread population decline of raptorial birds due to DDT like the peregrine falcon, the sparrow hawk and bald eagle. The well-known effect of DDT (dichloro diphenyl trichloroethane) is eggshell thinning of the peregrine falcon is caused by its highly persistent metabolite DDE [1, 1, bis-4- chlorphenyl) - 2, 2 dichlorethylene]. DDT has highly persistentency in soils with a half-life of 10-15 years and 7 days in air. DDT is metabolised to DDE and exhibits high bio-concentration factors of 50,000 in fish (UNEP, 2002) [88]. Endrin used as an insecticide in cotton, rice, sugarcane and other crops and also used as a rodenticide. Highly toxic to fish, aquatic invertebrates and phytoplankton, it is banned in India since 1990 still residue found in fish and other aquatic invertebrates because of its high persistency in soil up to 10-12 years. Benthic fish species are considered more prone to endrin contamination (Wei *et al.* 2014) [91], as they tend to accumulate sediments bound contaminants than pelagic fish (Qadir and Malik 2011) [72]

IPCS (2006) [40] reported birds posses high risks of acute poisoning due to ingestion of contaminated water and seeds. Heptachlor primarily used against soil insects and termites and also used for plant insects and malaria vectors. It bioconcentrates and metabolised in soil, plants and animals to heptachlor epoxide, which is more stable and carcinogenic, in soil of temperate region (half-life of 0.75-2 years). Even a small concentration in water may hamper the life of aquatic vertebrates; Kannan (1994) observed that hepatachlor is one of the prominent causes for sudden decline of Ganga Dolphin in river Ganga. In birds, it induces behavioral changes, reduced reproductive success and mortality. Hexachlorobenzene (HCB) used for seed treatment, completely banned in 1997 in India. HCB is very persistent, estimated half lives in soil from aerobic and anaerobic degradation range from 2.7 to 5.9 years causes reproductive failure and suppression of the immune system in various wild animals. Kumar *et al.*, 2001 [47, 48] reported toxicity effect of HCB in migrant (0–4.7 ng/g tissue sample) and resident (0-1.2 ng/g tissue sample) birds and bat (0-5.6 ng/g tissue sample) in south India Polychlorinated dibenzo-p-Dioxins (PCDDs) and (PCDFs) Polychlorinated dibenzofurans release from solid waste incineration, Sewage sludge and Ship breaking industry used in raw material for industrial processes. Kumar *et al*., 2001 [47, 48] measured Polychlorinated dibenzo-p-Dioxins (PCDDs) and Polychlorinated dibenzofurans (PCDFs) concentration in tissues of humans, fishes, chicken, lamb, goat, predatory birds, and Ganges River dolphins collected from various locations in India. Among fishes, meat, and wildlife samples analyzed, concentrations of PCDDs/PCDFs were found in the following order: country chicken < goat/lamb fat < fishes < river dolphins < predatory birds. Polychlorinated biphenyls (PCBs) have been linked with a variety of adverse effects in aquatic organisms, including birth defects, reproductive failure, liver damage, mutation, carcinogenicity, wasting syndrome, and death (NRSMRP, 2004) [64]. Coelhan *et al.*, (2006) [16] found the accumulation of organochlorines (DDT and HCH) in 12 edible fish species from the Marmara Sea Turkey at higher levels in their tissues showing reproductive failure, kidney/liver/heart damage, tremors, beak deterioration, and loss of muscle coordination, behavior alterations, and eggshell thinning. Malik *et al*, (2007) reported the contamination of organochlorine insecticide residues in muscles of fish of Gomti River and found that total organochlorine pesticides ranged between 2.58 - 22.56 ng/g with dominance of α- HCH, β- HCH and p,p'- DDE in total organochlorine concentration. Recently Kaur *et al*, (2008) [42] studied the levels of organochlorine pesticides residues in five types of freshwater fish species in Punjab State, India and where DDT was the predominant organochlorine contaminants in all species with p,p'- DDT and p,p'- DDE and HCH isomers at lower levels. Because of their higher potency, efficiency and comparatively low cost than other pesticides, organochlorines are still being used (Akinnifesi *et al*., 2006; Idowu *et al*., 2013) [2, 37].

Oil Spills

Oil spills in oceans can affect the animals and the vegetation, half of the world's oxygen is produced in the ocean. Phytoplanktons form the bottom of the chain in food chain. They live in the vulnerable marshes near the surface of the water, where they obtain their nutrients from organic matter from marshes, sunlight, and water. In return they convert carbon dioxide to oxygen. Oxygen is important for rest of the food chain to survive to balance the ecology. In addition, phytoplankton provides direct nourishment to many sea creatures higher on the food chain. And some of those animals actually begin life in the marshlands, too. Shrimp mature in the marshlands, and then migrate to the ocean where they become food for fish. These fish provide nourishment to birds and animals (Barrington, 2010). Fossil fuels are comprised primarily of compounds called "hydrocarbons." In the recent decades the use of fossil fuel increased abruptly to obtain more energy, to extend the market globally. The toxicity of hydrocarbons in aquatic organisms mainly due to uptake of dissolved hydrocarbons and it can lead to a wide variety of physiological responses (NRC, 2003) [63]. The most deleterious effects of oil spills on wildlife are the deaths that occur immediately after the spill, due to coating of animal fur or feathers with oil and cut the oxygen supply due to exposure to high concentrations of the toxic components of crude oil. Oiled animals may absorb acute doses of hydrocarbons through their skin or inhaled, or accidentally swallowed. Oiled animals also intentionally swallow the toxic material as they preen their bodies. Recovered animals when examined often suffer a multitude of symptoms due to inundation of their internal organs with toxic chemicals. The presence of persistent toxic chemicals on the beaches, in the water, and in the food web may result in a variety of impacts on wildlife, including impaired reproduction, decreased resistance to disease, anemia, eventual development of cancerous tissue growth (particularly in fish), neurological damage, and birth defects in offspring. Patel *et al.,* 2006 [67] reported hydrocarbon exposure in polluted environments results in reproductive and developmental defects in fish. Nonpolar narcosis and photoxicity (Ccanccapa *et al*. 2016) [12] as well as mutagenic and carcinogenic efficacy may put serious threats to marine organisms. Apart from these, PAHs (Polycyclic aromatic hydrocarbons) have deadly effects on the reproductive status during embryogenesis and early stages of development aquatic biota (Incardona *et al.,* 2005) [38], PAHs also compromise the immune system of fish and other aquatic organisms (Auffret *et al.*, 2004) [3]. Toxicity levels for larval and juvenile fish may be as low as 0.1–5 μg/l for sub lethal effects (National Oceanic and Atmospheric Administration, 1999) [62]. These alterations at higher levels of biological organization may alter vital functions that affect the survival of organisms (Peterson *et al.,* 2003). In 1989, oil spill of Exxon Valdez affected 1460 miles of Alaskan coastline in which 36,466 dead seabirds, 1,015 dead sea otters, and 144 dead bald eagles were recovered from the spilled area (Graham, 2003) [26]. Heneman (1989) [34] reported the mortality of oiled birds probably exceeded 100,000, the highest losses of birds recorded for any oil spill in the world. In the year 2010 oil spill in the Gulf of Mexico affected several species found dead about 6,104 bird populations, 609 sea turtles, 100 mammals and few reptiles reported by U.S. Fish and Wildlife Service, 2011. Balseiro *et al*., 2005 studied the pathological lesions of oil spilled birds (*Uria aalge, Alca torda and Fratercula arctica*) after ''Prestige'' oil spill on 19 November 2002 in northwestern part of Spain. The main gross lesions were severe dehydration and emaciation. Microscopically, hemosiderin deposits, related to cachexia and/or hemolytic anemia, were observed in those birds harboring oil in the intestine. The main cause of death was dehydration and exhaustion. Hemolytic anemia induced by ingestion of oil has been described in sea ducks and Atlantic puffins (Yamato *et al*., 1996) [96].

Toxic Minerals

Toxic metals are naturally found in the earth's crust throughout the ecosystem. Cadmium (Cd) and lead (Pb) are among most toxic food chain contaminants where Cd damages the lungs and causes Itai-Itai disease while Pb causes multiorgan failure (blood, Kidney, Liver and nervous system (Malhat, 2011) [55]. Human activities include burning of fossil fuels, metal refining, agriculture, mining operations, and wastewater discharge, results in the increase of toxic metals to reach a level posing hazards to living organisms and naturally cycle through air, soil, and water of the earth. The mechanism how most of the heavy metals, such as Pb, Hg, cadmium (Cd), and arsenic (As) are metabolized is meager in most vertebrate animals, but it is confirmed that high concentration of heavy metals impairs metabolism, behavior, reproduction and neurologic functions (Chan, 1998) [13]. Heavy metals in excess quatity have a negative impact on the immunocompetence, oxidative status and reproductive performance of birds (Vermeulen *et al*., 2015) [90]. Uncontrolled release of tannery effluents has increased the health risks to different organisms (Praveena, 2013) [71]. The Cr^{6+} salts have several applications especially in divers industries but their indiscriminate use into aquatic ecosystem poses a great threat o growth and survival of aquatic species, including fish population (Pandey *et al*., 2014) [66]. Possible source of toxicity and deficiency of elements can be evaluated by analyzing samples from soil and water near the home range of animals, and also by studying the behaviour pattern of animals including their migration and movements (www.google.com 2013).

Other heavy metals are released into the environment from fossil fuel combustion (e.g., Cr, Co), fertilizers (Cd), and other industrial uses (Adriano, 1986) [1]. Ohlendorf (1989) [65] reported the death of 1000 migratory birds (adults, embryos, and chicks) at Kesterson lake in US during 1983-1985 as a probable result of feeding on plants, invertebrates, and fish with elevated selenium concentrations showing symptoms like severe emaciation, muscle atrophy, liver degeneration, and abnormal loss of feathers. Some adult birds which tolerated the contamination well enough to survive and attempt to reproduce, their offspring were born stillbirth or deformed. Developmental abnormalities found in embryos were missing or abnormal eyes, beaks, wings, legs, and feet. Mercury poisoning was first reported in wild animals in North America diagnosed in a clinically-ill wild mink (*Mustela vison*) on the basis of clinical signs, histopathologic lesions and tissue mercury concentrations (Wobeser, 1976) [94]. The main source was ingestion of fish found in South Saskatchewan River contaminated with mercury. Dey *et al.*, 1998 [19] estimated the level of mercury in body hair of *Felis bengalensis,* which was across the toxic limit, while in *Panthera pardus, Vibera zebitha* and *Petaurista magnificus*, the concentration was within the toxic limit. Deposition of Hg in the hair is proportional to that of blood, after ingestion of the metal (Berg and Kollmer, 1983). Effect of methyl mercury rather than inorganic mercury into the environment has a more direct ecological impact and a large amount of mercury deposit is reported in the Himalayan belt (Seiler *et al.,* 1998). A study was conducted by Gupta, 2013 where feed and water along with the soil in cages from the particulate air pollutants was analysed which indicated that the air pollution was the primary cause of high concentrations of heavy metals toxicity due to high density of traffic in that area.

Clark (2001) [15] found that most of the body concentration of mercury in piscivorous birds is stored in the plumage and 50% of the remaining body burden of mercury is transferred to the growing feathers following molt; the plumage thus provides an important elimination pathway for methyl mercury in many birds. Reproductive dysfunction has been observed in mallards (*Anas platyrhynchos*) with eggs containing 6–9 μg/g mercury, no effects on hatching or fledging occur in eggs of herring gulls (*Larus argentatus*) contaminated with up to 16 μg/g mercury (NRSMRP, 2004) [64]. Prater (1971) [70] reported Hg toxicity in Leopard cat preys upon Hg contaminated seed-eating birds and small animals. Some of the characteristic toxic effects of mercury observed in the animal were redness of skin, blisters, salivation, loss of appetite, and photophobia (Berg and Kollmer, 1983). Miller *et al*., 2011 observed epidermal Hg concentration was positively related to age (P,0.001) and negatively related to height of the stratum spinosum (P,0.05) epidermal biopsy samples collected from free-ranging common bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida, USA. In aquatic organisms, concentrations of 0.1–200 μg/l have been shown to produce adverse effects; toxicity increases with age of the organism, exposure time, temperature, lowered salinities, and the presence of other metals (NRSMRP, 2004) [64]. Eisler (1987) [23] observed mercury tissue levels of 5–7 mg/kg (5–7 ppm) have been shown to be lethal for marine animals.

Zook *et al*., 1972 [99] diagnosed post-mortem in 34 simian primates, 11 parrots, and 3 Australian fruit bats at the National Zoological Park found presence of acid-fast intranuclear inclusion bodies in renal epithelia or hepatocytes in most of the cases, there was more accumulation of lead in samples of liver, the main source of poisoning was lead paint used for painting the zoo captives. Miller, 2011 reported the lead poisoning in endangered California condors, vultures and other wildlife is due to scavenging animals ingesting fragments of spent lead hunting ammunition. Accumulation of lead in the leopard cat and civet cat was higher (Dey *et al*., 1998) [19] compare to leopard (*Panthera pardus*) due to their characteristic behaviour pattern and frequent movements to human territory. Generally, soil in the home range contains more Pb concentration (1.4-14.5 µg/g) results in low soil pH and high humus content, during rainy season the Pb concentration (1.5 µg/g) was also higher in water (Dey *et al*., 1998) [19] thus, wild animals having more prey activity around the human population are more susceptible to Pb toxicity. The visible toxic effect of lead in *Felis bengalensis* and *Petaurista magnificus* includes lesions in epidermis of skin, constipation, loss of appetite (Dey *et al*., 1998) [19], besides these, the metal is known to affect the central nervous system, reproductive system, blood, kidney and liver. In fish lead deposits in active calcification areas such as scales, fin rays, vertebrae, and opercula (Mouwerik *et al.,* 1997) [59]. Mateo *et al*., 1998 considered lead poisoning was the second most common cause of mortality (20% of deaths) in waterfowl species in Spain including Greylag Goose (*Anser anser*), Northern Shoveler (*Anas clypeata*), Mallard (*Anas platy-rhynchos*), Northern Pintail (*Anas acuta*) and others; shooting-related injuries were the number one cause of mortality. Rodrı´guez *et al*., 2010 [75] studied the toxic effect of Pb in 135 wild Mallards (*Anas Platyrhynchos*) treated with different doses of Pb, maximum level observed after 10 days in 90% of the birds and 34% of the birds died and those survived were suffering from anorexia, lethargy and decrease response to external stimulus. Out of 135 tested wild mallards, 41% had a blood lead concentration higher than 0.200 mg/g. Lead shot was found embedded in 3.6% of the wild birds and 1.2% had a lead shot pellet in their gizzard. American robins (*Turdus migratorius*), northern cardinals (*Cardinalis cardinalis*), and waterfowl found increase lead tissue concentrations ($p < 0.05$) compared with lead tissue concentrations from reference birds, and the exposure of songbirds to lead was comparable with that of birds observed at other sites severely contaminated with lead (Beyer *et al.*, 2004) [7]. The increased environmental concentrations of Zn associated with mining in the District accounted for the pancreatitis and significantly higher ($p < 0.05$) zinc concentrations in liver and kidney of waterfowl has been observed. The Chromium concentration in the hair is regarded as a useful indicator for diagnosing the status of the element in the body (Kirchgebner *et al.,* 1983) [46]. Uptake of chromium is inhibited by vanadium (Hill, 1976) [35], which was found to have a higher concentration than chromium in the soil of the home range of the animals. NRSMRP (2004) [64] analyzed the 96-hour LC_{50} value of chromium-VI in marine species ranges from 445 to 2,000 parts per billion (ppb). Arsenic toxicity on estuarine and marine organisms has been reported at water concentration levels of 100 micrograms per liter (µg/l) and above (NRSMRP, 2004) [64]. Clark (2001) [15] reported Arsenic toxicity in marine benthos in heavily contaminated areas of San Francisco Bay where sediment concentrations were measured at 50–60 mg/kg (dry weight). Clark (2001) [15] analysed the Nickel toxicity ranges for the 96-hour LC_{50} include 17-50 ppm for polychaetes, 0.115 to 47 ppm for crustaceans, 60–320 ppm for mollusks, 30–70 ppm for estuarine fish, and 8–350 ppm for marine fish, also found that there is no evidence of bioaccumulation of Nickel in marine food chains. Female birds may in order to get rid of toxic heavy metals, deposit them into the eggs, thus making the eggs suitable bioindicators of pollution (Ruuskanen *et al*., 2014) [78].

Acid Rain

Term "Acid Rain", was first used by Robert Angus Smith who measured high levels of acidity in rain water in industrial areas of England and compared it with the much lower levels of acidity in less polluted areas near the coast. Combustion of oil and coal by power plants and automobiles release huge amount of sulfur and nitrogen into the atmosphere are the primary cause of Acid Rains. When these gases are discharged into the atmosphere they react with the water, oxygen, and other gases already present there to form sulfuric acid, ammonium nitrate, and nitric acid. These acids with wind patterns disperse over large areas and fall back to the ground as acid rain. Atmospheric deposition of acidic ions negatively affects the biota in forest. These negative effects range from loss of leaves to complete destruction of tree in the forest (Brotons *et al.*, 1998) [9]. Acid rains causes leaching of many minerals like Ca, Mg and K from the top soil due to which plant is unable to uptake the nutrient further growth rate is affected as Ca is utilized by tree for cell formation and in various processes for transport of sugars, water, and other nutrients from the roots to the leaves. Magnesium is important for photosynthesis, as a carrier of Phosphorus thus important for DNA formation. Female bird laying a clutch of eggs experiences calcium demand 10–15 times greater than that of a similar-sized mammal with developing embryos (Graveland, 1996) [28], thus depletion of calcium from soil in acid rain prone area is potentially a serious problem (Graveland, 1998) [29]. Failure to sequester sufficient calcium during laying ramified to thin, brittle eggshells in eggs that break before hatching, porous eggshells that cause the desiccation of the embryo, and complete reproductive failure (Graveland, 1997) [26]. In Ontario lakes, no existence of Mollusks was reported with pH at or below 5 and also leaching of calcium disturbed the shell formation process in mollusks (Roff and Kwiatkowski, 1977) [76]. One of the direct effects of acid rain is on lakes and its aquatic ecosystems. Several routes are there for the entrance of acidic chemicals into the lakes. In the early 1970s the term "Wet Desert" being used to describe the clear blue fishless lake due to death of large number of fishes in the lakes of Ontario (Canada) due to leaching of aluminum from the soil which causes acute toxicity in fish at the concentration of 6.2mg/L which is not harmful for humans (Thoreau, 2012) [87]. Aluminum precipitates and reduces the ion exchange through the gills and subsequently salt depletion in living system which interferes with the transport of oxygen and other ions, so that the fish literally dies of suffocation. For compensation fish will exude mucus to combat the aluminum in their gills and further this mucus builds up and clogs the gills so that oxygen and salt transportation is inhibited. Research has shown that dead fish had low levels of Na+ and Cl^- in their blood which clearly indicates that they were unable to regulate their body salts. At low pH, many species of amphibians including frogs, toads and salamander are particularly sensitive (Berlekom, 1985) [6]. Haines and Baker (1986) [32] reported loss of 98 brook trout populations and many populations of other species, including lake trout, rainbow trout, white sucker, brown bullhead, pumpkinseed sunfish, and golden shiner in Adirondack lakes, New York (US). The lower plants including algae, fungi and lichen are also negatively affected by acid rain. Nitrogen fixation performed by lichen, *Peltigera spp* was found to be sensitive at pH 2.4 (Gunther, 1988). Photosynthetic activity was also found to be decreased at pH 3.0 in *Cladina stellaris* (Lechowiez, 1982) [49]. Acid rain disturbs the immune response and decrease the plasma levels of antibodies decreased significantly at 1 week after the initiation of low pH exposure (Kawahara *et al.*, 2001) [44].

Effect of light pollution in wildlife

Verheijen (1985) [89] proposed the term "photopollution" means "artificial light having adverse effects on wildlife". Photopollution literally means "light pollution" and nowadays light pollution is so widely understood to describe the degradation of the view of the night sky and the human experience of the night and extinction of many species. Animal's navigation can be confused by the light pollution as their mobility depends on the horizon and orientation of stars, alter competitive interactions and reproduction behavior, change the normal predator-prey relationship and influence animal psychology. Artificial light induces a wide range of behavioural effects especially in birds. A study on black-tailed godwits (*Limosa limosa*) showed the preference of dark hours for breeding far away from artificial street light (Kempenaers *et al*., 2010) [45]. Various evidences have proved the widespread, negative impact of light pollution on many different species (Rich and Longcore, 2006) [73]. The evidence for the impact of light pollution in migratory birds (Gauthreaux and Besler, 2006) [25], hatchling sea turtles (Salmon, 2006) [81], and insects (Eisenbeis, 2006) [22] is striking because of the massaive mortality that has occurred as a result of artificial night lighting. Such a huge mortality makes light pollution effect more obvious and quantifiable on certain species. Wise (2012) [92] reported artificial night lighting has the potential to alter the behaviour (foraging and breeding) as well as physiological development (growth and metabolism) of frogs and salamanders. Wise (2012) [92] taken Amphibian and Salamanders as a model for examining the light pollution in wildlife in many species because most of the amphibians are nocturnally active or their biological rhythms is regulated by light, mainly reproduction in these species primarily occur during dark periods and these amphibian species are widespread, abundant, and form an important component of terrestrial and aquatic ecosystems as both predators and prey. Light pollution increases ambient illumination, disrupts photoperiod, and changes spectral properties of night light that may affect the physiology, behavior, ecology, and evolution of frog (Buchanan, 2006) [11] and salamander (Wise, 2006) [93] populations. A study on zebra finches (*Taeniopygia guttata*) suggests sleep deprivation from continuous exposure to light led to increased mortality (Snyder *et al*., 2013) [84]. Darkness during sleep is an important animal behaviour across the animal kingdom (Cirelli and Tononi, 2008; Siegel, 2008) [14, 83]. Blue tits (*Cyanistes caeruleus*) have been found to adjust their awakening time according to local light conditions in different geographical areas 30. Hence, light pollution or artificial light may cause animals to wake up earlier which further decreases the potential sleep time than actual needed and lead to cessation of normal physiological activity (Russ *et al*., 2015) [77]. Lighting also affects the egg-laying behavior of female sea turtles (Salmon, 2003) [80]. Frank (1998) [24] reported the moths attracted to street lights where they are more visible to predators like toads and bats. Some nocturnal spiders are negatively phototactic (i.e. repelled by light), whereas others exploit light for their movements and reproduction (Nakamura and Yamashita 1997) [61]. In ecosystem, adaptive behavior of some insects are always positively phototactic while others always photonegative (Summers, 1997) [86].

Nesting of black-tailed godwits *(Limosa l. limosa)* was statistically lower in 2nd year around 300m away from the street or road light, compare to 1st year. Longcore and Rich (2004) [53] noted that birds nesting earlier in the year chose sites farther away from the lighting, while those nesting later filled in sites closer to the lights. Artificial night lighting also effects visual communication within and between the species, female glow-worms attract males up to 45 m away with bioluminescent flashes away, but artificial illumination disrupt the natural phenomenon in such species (Longcore and Rich, 2004) [53]. Artificial light although increased the food concentrations of some species like bat (Frank, 1998) [24] but its consequences altered the ecology of bio-community. Steinmeyer *et al*., 2013 [85] provided the first direct experimental proof which showed that light pollution can have a significant impact on several aspects of sleeping behavior in birds and animals affecting fitness. Plants are also affected by the colour and duration of lighting. Generally, artificial lighting may change the natural growth patterns and may affect the resistance of plants to infestations and disease. By extending light past the evening, may slow the plant’s biochemistry from changing to prepare for winter (Rich and Longcore, 2006) [73].

Conclusion

Human should control its activities beyond the limits which have negative effect on other creaturea and stop disturbing other living species before their extinction so that animals can live in harmony with us without compromising their needs. Human management should be for reducing the human-wildlife conflicts in order to protect other living beings, safety and security of animal populations, habitat and general biodiversity and also to minimise damage to property.

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