BULLETIN OF THE IRAQ NATURAL HISTORY MUSEUM
Iraq Natural History Research Center & Museum, University of Baghdad
https://jnhm.uobaghdad.edu.iq/index.php/BINHM/Home

Online ISSN: 2311-9799-Print ISSN: 1017-8678

Bull. Iraq nat. Hist. Mus.
(2023) 17 (3): 481-498. https://doi.org/10.26842/binhm.7.2023.17.3.0481

ARTICLE REVIEW

IMPACT OF LINEAR INFRASTRUCTURE INTRUSIONS ON AVIFAUNA: A REVIEW

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Recived Date: 08 December 2022, Accepted Date 26 April 2023, Published Date:20 June 2023

ABSTRACT

This review examines the reported impacts of three major linear infrastructure developments, namely railways, roads and power lines on avifauna. These infrastructures are proliferating worldwide posing serious threats to wildlife including avifauna. The major impacts involved with linear infrastructures are habitat degradation, fragmentation, direct mortality by collision and electrocution. The factors affecting collision mortality can be divided into intrinsic and extrinsic factors. The intrinsic factors include species morphology and species behavior whereas the extrinsic factors are the external factors such as weather, landscape features and the technical aspects of the infrastructure. Power lines affect a large number of birds, killing more than one billion birds globally each year. Studies suggest the implementation of anti-collision devices such as wire markers; flight diverters and physical barriers like trees, diversion poles or noise barriers are effective mitigation measures to reduce bird mortality due to the linear infrastructures. Therefore, understanding the overall impact of linear infrastructures is crucial for effectively managing their impacts on avifauna and helping make future developments less destructive and more sustainable.

Keywords: Avifauna, Collision, Impact, Linear infrastructures, Mitigation.

INTRODUCTION

Major linear infrastructure intrusions such as roadways, railways, canals, pipelines and power lines are the common human-made features in the globe and all are essential lifelines of urban infrastructure and serve to maintain effective connectivity between places through transporting people, energy, fuel, water and facilitate economic development of the country. Power lines, roads or railways, are among the most ubiquitous man-made features worldwide and are known to have negative impacts on natural habitats and ecosystems. Such linear intrusions into natural areas cause habitat loss and fragmentation causing barrier effects, which in turn result in connectivity loss between habitat patches and populations, also will cause the spread of invasive alien species and direct wildlife mortality by collision and electrocution (Raman, 2011; Loss *et al*., 2014; Santos *et al*., 2016). Many large terrestrial and wetland birds and some smaller, fast-flying species are prone to colliding with power lines and other man-made structures. A high proportion of threatened species are directly affected by these linear infrastructures.

The wildlife mortality rate caused by linear infrastructures can vary widely and depends on several factors, such as environmental factors, both spatial and temporal including topography and habitat features and light levels, weather conditions, season, and phenology and the infrastructure specifications such as design, thickness, arrangement and distance between the wires, (Scott *et al.*, 1972, Anderson, 1978; Henderson *et al.*, 1996; Savereno *et al.*, 1996, Shaw, 2009; Jenkins *et al.*, 2010; Shobrak, 2012). Though the power lines and associated structures can cause a significant threat to avifauna, it is becoming increasingly evident that these infrastructures can also have positive effects on biodiversity, especially on birds. Birds such as raptors and storks also make use of these infrastructures for their daily activities such as roosting, nesting, perching and hunting (Tryjanowski *et al*., 2014; Mainwaring, 2015). Altogether it is essential to understand the both positive as well as negative impacts of these linear infrastructures for any developing country to effectively manage those impacts and help make future developments less destructive and more sustainable.

The study's primary goal is to: i) draw conclusions about the impact of linear infrastructures on avifauna from the available scientific evidence, ii) identify obvious gaps in our knowledge about the possible impacts, and iii) propose effective management plans for the impact of linear infrastructures.

MATERIALS AND METHODS

We collected data on studies associated with power lines, roads and railways by searching the databases such as J store, Google Scholar, Bio One, and google web search, google scholar with the broad search terms ‘‘linear infrastructure, impact on biodiversity, birds, or mammals combined with specific terms such as ecology, avoidance, collision, electrocution, fragmentation, degradation, edge effect, disturbance, clearing, mitigations, and management. All the peer-reviewed articles related to the impact of linear infrastructures on avifauna were selected for the review. More emphasis was given to power lines and bird-power line collisions because they represent one of the major threats to avifauna among the other linear infrastructures.

RESULTS AND DISCUSSION

Linear infrastructure and avifauna: The major impacts of these infrastructures on avifauna include mortality due to direct collision, habitat loss and fragmentation, vehicular noise and emissions and radiations from power lines. The impacts of linear infrastructures on avifauna can broadly be classified into these major types: 1) Direct physical impacts and electrocution, 2) Impacts from emissions and radiations, and 3) Impacts from changes in the habitat (Wylie and Bell, 1973; Murcia, 1995; Goosem, 2007; Jenkins *et al*., 2010, Moroń *et al*., 2014, D’Amico *et al*., 2018).

Direct physical impacts: Direct physical impacts on the avifauna from linear infrastructures are primarily resultant of collisions with vehicles, railways and power lines. Carcasses attract predators and scavengers to roads and railway sites consequently increasing mortality risk by being exposed to traffic. Bertwistle (2001) observed that the seasonal migration of animals to winter refugia in Canada is one of the factors which significantly increased the chance of collision on roads and railways. Similarly, birds perching on the poles and train catenaries and those perch and inhabit the vicinity of roads increase the chances of bird mortality due to collision (Van Rooyen and Ledger, 1999; Anderson, 2002). Godinho *et al*. (2017) documented bird mortality due to railways and their associated structures in Portugal and they surveyed 16.3 km of railway and found 5.8 dead birds/km. Most birds recorded belonged to the order Passeriformes, while were only a small number of aquatic birds. Power lines also affect a large number of birds, killing more than one billion birds globally each year (McNeil *et al.*, 1985; Bevanger, 1994; Loss *et al*., 2014). Birds with poor flying adaptations, young or inexperienced birds and birds flying in large flocks, heavy birds such as Swans, Cranes, Bustards, Raptors, Storks and Ravens are at a higher risk of collision with objects including vehicles (Bevanger, 1994; Janss, 2000). Bird species, especially those under the threatened categories are at high risk from tower line collision and risking the loss of small populations (McNeil *et al*., 1985; Bevanger, 1998; Janss, 2000; Janss and Ferrer, 2000; Real *et al*., 2001; Sundar and Choudhury, 2005). Worldwide, studies have shown high mortality rates of several bustard species because of power-line collisions, for example, 30% of Denham's Bustard *Neotis denhami* (Children & Vigors, 1826) die annually from power-line collisions in South Africa (Shaw, 2009; Jenkins *et al*., 2010). In Spain, Janss recorded higher casualties of Great Bustard *Otis tarda* Linnaeus, 1758, Little Bustard *Tetrax tetrax* (Linnaeus, 1758) and Common Crane *Grus grus* (Linnaeus, 1758) due to power line collisions (Janss, 2000). The mortality of the Sarus Crane *Grus antigone* (Linnaeus, 1758) due to rural power lines in Uttar Pradesh, India was studied by Sundar and Choudhury. Breeding and nonbreeding Sarus Cranes were assessed during the time and they found that, Similar proportions of non-breeding and breeding Sarus Crane were killed, together accounting for nearly 1% of the total Sarus Crane population annually (Sundar and Choudhury, 2005).

McNeil *et al*. (1985) conducted a study on avian mortality with power lines in the Chacopata lagoon in North-eastern Venezuela and observed more casualties in Brown Pelican *Pelicanus occidentalis* Linnaeus, 1766, which cause a drastic population decline in the species. Brown *et al*. (1987) observed power lines were the major cause of mortality for Whooping Crane *Grus americana* (Linnaeus, 1758) and Mallard *Anas platyrhynchos* Linnaeus, 1758 in south-central Colorado and concluded that power line collisions cause a large number of mortalities in cranes and waterfowl (Brown *et al*., 1987). A study on waterfowl collisions with power lines in Lake Sangchris done by Anderson (1978) reported that Mallard *Anas platyrhynchos*, Blue-Winged Teal *Spatula discors* Linnaeus, 1766 and American Coot *Fulica Americana* Gmelin, 1789 are the major victims of power line mortality (Anderson, 1978; Jenkins *et al*., 2010). Mortality of birds due to electrocution with power lines mostly affects raptors, storks, ravens and thermal soarers; thermal soarers are a type of bird that uses rising columns of warm air (thermals) to gain altitude and maintain flight without flapping their wings e.g., eagles, vultures, pelicans etc. (Infante and Peris, 2003; Janss, 2000). Among the other linear infrastructures power lines affect a large number of birds, majority of the bird species use electricity infrastructures for perching, nesting, roosting and hunting. For example, White Stork *Ciconia ciconia* (Linnaeus, 1758) in Poland and Eurasian Kestrel *Falco tinnunculus* Linnaeus, 1758 in Spain (Fargallo *et al*., 2001, Tryjanowski *et al*., 2009), have an increased risk of electrocution. In short, Anseriformes, Podicipediformes, Charadriiformes, Falconiformes and Gruiformes are orders more susceptible to power line collision (Brown and Drewien, 1995).

Linear infrastructures and several associated structures, commonly related to the decline of biodiversity, but several researchers also mentioned the positive impact of roads, railways, power lines and associated structures on certain bird species or communities. For example, it provides alternate foraging habitat, and through providing a warm surface that assists in conserving metabolic energy during cold weather (Delgado *et al*., 2007; Morelli *et al*., 2014; Moroń *et al*., 2014; Wiącek *et al*., 2015). Railways surfaces provide a source of sand, employed by several bird species to make the sand bathing, useful to clean the feathers and good foraging ground (Devictor *et al*., 2007: Morelli *et al*., 2014; Wiącek *et al*., 2015). They are also seen to be using power lines and related structures for perching and hunting (mainly for insectivorous species and raptors) (Prather and Messmer, 2010; Morelli *et al*., 2014; D'Amico *et al*., 2018). Many raptors use electricity poles and towers for perching as it gives a wide view of a large area for hunting, thus enhancing the efficiency of the predator (Boeker and Nickerson, 1975; Lehman *et al*., 2007; Prather and Messmer, 2010).

Similarly, raptors and corvids also make use of electrical infrastructures associated with roads and railways as perches from which to scavenge road-killed animals more effectively (Dean *et al*., 2006; D'Amico *et al*., 2018). They also provide song posts and roosting/nesting platforms for several species (Møller *et al*., 2006; Prather and Messmer, 2010; D'Amico *et al*., 2018). For example, the Pied Crow *Corvus albus* Statius Muller, 1776 was found to be making use of electricity structures for nesting in treeless, but potentially suitable habitats in arid shrub lands of South African Karoo (Cunningham *et al*., 2016). Many bird species from small passerines to storks make use of electricity infrastructures for communal roosting (Prather and Messmer, 2010) and as an anti-predator behavior (Blumstein *et al*., 2004, Møller *et al*., 2006).

Factors affecting collision mortality: The factors affecting collision mortality can be divided into intrinsic and extrinsic factors. The intrinsic factors include species morphology and species behavior (Bevanger, 1998; Janss, 2000; Rubolini *et al*., 2001; Jenkins *et al*., 2010) whereas the extrinsic factors are the external factors such as weather, landscape features and technical aspects of the infrastructure viz. design, arrangement of wires, the distance between the wires, and thickness of the wires (Scott *et al*., 1972; Anderson, 1978; Henderson *et al*., 1996; Savereno *et al*., 1996; Jenkins *et al*., 2010; Shobrak, 2012). Though birds of varying sizes and taxonomic groups collide with power lines, the frequency of casualties is more related to species morphology, behaviour and flight performance (McNeil *et al*., 1985; Savereno *et al*., 1996). The collision of most species with power lines is due to the overhead ground wire (earth wire) as the bird suddenly changes the flight altitude to avoid collision with the conductor wires (McNeil *et al*., 1985; Bevanger, 1994). This may be because of poor visibility when the flying birds cannot see the wires from a reasonable distance (Morkill and Anderson, 1991; Alonso *et al*., 1994). Some species of ducks and bustards are also prone to power line collision due to poor vision as they have a very narrow range of visual field in the direction of travel due to differences in beak arrangement and morphology (Silva *et al*., 2023). Nocturnal bird species are more vulnerable to power line collision than others, especially; the migratory species are at high risk as they cross numerous power lines and other human artefacts on the way to and from their breeding grounds (Martin, 1990; Bevanger, 1994; Dixon *et al*., 2020; Hamer *et al*., 2021). Young and immature birds are more susceptible to power line mortality due to a lack of awareness of the environment or a lack of previous experience with such utility structures (Savereno *et al*., 1996). Species spending more time in the air face higher threats from power lines compared to ground-dwelling species (Bevanger, 1994) and species with high wing loading and low aspect are also highly susceptible to collision (Rayner, 1988; Janss, 2000; Norberg, 2012). Most birds collide with obstacles during flight as they have no prior knowledge of human artefacts such as power lines, vehicles, railway infrastructures or wind turbines.

Bird collision and mortality with power lines will also depend on the weather conditions to a great extent (Scott *et al*., 1972; Anderson, 1978; McNeil *et al*., 1985). Thick fog and wind impair bird flight; mist, snow and rainfall reduce the visibility of flying birds and make it difficult to see the power lines (Avery *et al*., 1977; Kerlinger and Moore, 1989; Bevanger, 1994; Jenkins *et al*., 2010). Landscape characteristics such as topography and habitats are key factors for bird collision and electrocution with power lines (Bevanger, 1994; D'Amico *et al*., 2018). Increased risk of collision was observed in areas where power lines are crossing varying altitudes with rise and depressions. Birds use coasts and valleys as directional cues during migratory and local movements and are at high risk if these areas are traversed with power lines (Bevanger, 1994, D'Amico *et al*., 2018, Travers *et al*., 2023).

Impacts from radiation and emissions: Birds are negatively affected due to noise, light, vibrations, emission of harmful gases, particulate matter and electromagnetic radiation from linear infrastructures. There is a less recognized impact of electromagnetic radiation produced by the power lines. Electromagnetic radiation from power lines was found to reduce breeding performance in birds nesting in these structures. Tree Swallow *Tachycineta bicolor* (Vieillot, 1808) nesting under power lines has been observed to have reduced fledgling and reproductive success compared to that in the reference site in Delaware County, Ohio (Doherty and Grubb, 1998). This study monitored the breeding biology of birds using nest boxes placed under transmission lines and in reference areas. Similar observations were made in Canada. American Kestrel *Falco sparverius* Linnaeus, 1758 exposed to the electromagnetic field (EMF) were found to be more active during courtship and incubation which increases the chances of egg breakage. They conclude that electromagnetic field (EMF) exposure affected the reproductive success of kestrels, increasing fertility, egg size, embryonic development, and fledging success but reducing hatching success (Fernie *et al*., 2000).

Numerous chemical and physical pollutants are used during road construction and maintenance which affect the surrounding environment in various ways and varying degrees. Atmospheric pollution from vehicle emissions contains carbon monoxide, atmospheric lead, hydrocarbons, oxides of nitrogen and sulphur, particulate matter, and sometimes nickel (Lagerwerff and Specht, 1970) which cause serious impacts on various species of flora and fauna. The concentration of lead in soil and plants are found to be higher near roads and it affects the level of lead in small mammals, bats, birds and larger herbivorous species, as animals primarily accumulate lead through their dietary intake (Chow, 1970; Wylie and Bell, 1973; Goldsmith *et al*., 1976; Fakayode and Olu-Owolabi, 2003; Sharma and Prasad, 2010). Lead concentrations in carcasses and stomach contents of adult and nestling Barn Swallow (*Hirundo rustica*) in the right-of-way of a major Maryland highway were found greater than Barn Swallows nesting within a rural area (Grue *et al*., 1984). Lead contamination in bird's results in loss of weight and vision, wing and leg paralysis, altered nerve function, behavioural alterations, different immune responses, and altered levels of brain enzymes (Grue *et al*., 1984). A similar process is also observed from emissions of oxides of nitrogen from vehicle exhausts, cadmium and zinc from engine oils and tyres, and nickel from gasoline, in roadside soil and vegetation and causing serious impacts on associated avifauna by Lagerwerff and Specht (1970).

Researchers also reported that some species (especially nocturnal birds) get disturbed and disoriented because of the light, noise and vibrations from trains and vehicle traffic (Santos *et al*., 2017), and it may also disrupt the activities of birds and other fauna inhabiting the vicinity of roads and railway lines (Reijnen and Foppen, 2006; van Rooyen, 2009; Polak *et al*., 2013). The virtually continuous flow of traffic on busy roads constitutes a linear source of noise which eventually ended up disrupting birds' vocal activities (Wiącek *et al*., 2015). Railways are generally believed to produce an eco-friendlier mode of transport than roads (Borken-Kleefeld *et al*., 2010), vehicle-related mortality, fuel consumption and air emissions were much lesser. Most studies suggested that wildlife can ignore or adapt to disturbances due to rail transport to a certain extent (Waterman *et al*., 2002; Ghosh *et al*., 2010; Mundahl *et al*., 2013; Wiącek *et al*., 2015).

Impacts from habitat loss, degradation and fragmentation: Habitat degradation due to linear infrastructures such as roads, railways and power lines always has a negative effect on its surroundings; it alters the microclimate, soil, vegetation and hydrological properties (Forman and Alexander, 1998; Eigenbrod *et al*., 2009). Different infrastructures may have different impacts on the environment, e.g., even paved and unpaved roads can have different impacts on wildlife; because the paved roads are much wider and intensively used (van der Ree *et al*., 2015). Similarly, power lines may cause a minor fragmentation impact compared to roads and railways (Girvetz *et al*., 2008; Bruschi *et al*., 2015). The intrusion of linear infrastructures leads reduction in habitat area and increased habitat isolation, which in turn affects biodiversity and wildlife movement across the natural habitat (Goosem, 2007; Karlson and Mörtberg, 2015). Habitat loss takes place when infrastructure construction leads to the reduction of the available habitat for several species. Habitat fragmentation involves the splitting of natural habitats and ecosystems into smaller and more isolated patches, which fail to maintain viable populations and genetic diversity in the long run because of the limited gene flow (Fahrig, 2003). Whereas general information on habitat fragmentation is abundant, studies exclusively focused on railway-related fragmentation are non-existent because researchers did not differentiate between railway- and road-related fragmentation, assessing these two different infrastructures as a whole (Jaeger *et al*., 2007; Girvetz *et al*., 2008; Bruschi *et al*., 2015).

The linear infrastructure disrupts the movement and creates barrier/edge effects; which reduces the availability and suitability of adjacent areas. Edges (boundaries of linear infrastructure systems between different habitats) can act as barriers for birds, affecting their genetic diversity, abundance, distribution, and nest survival, which ultimately leads to their local extinctions (Newmark and Stanley, 2011; Mammides *et al*., 2015). The edges caused by linear infrastructures, alter the physical and chemical properties of the environment and increases sunlight penetration, temperature and wind exposure, especially in forested habitats. This will directly influence the vegetation structure and bird community because the vegetation structure had a compelling effect on species richness (Murcia, 1995; Khamcha *et al*., 2018). The response of avian guilds to edge effects varies across regions and species with specific or specialized diets or foraging behaviors that may affect more. Species richness and abundance of most of the avian guilds were reduced close to the edge and the birds with the nectarivore-insectivore guild, such as sunbirds were the only ones to show a positive response to the edge (Khamcha *et al*., 2018). On other hand, a comprehensive study from eastern Poland shows that the abundance of bird species especially the insectivores was reported to be the highest near the railway line. The mean number of species near the line was 10.2 ± 3.2 species and differed significantly (Wiącek *et al*., 2015). The high diversity of plants and invertebrates on railway embankments ultimately attracts insectivorous birds, thus acting as a potential habitat for these species (Moroń *et al*., 2014). This concludes that the transportation corridors, running through different habitats, can also create edge effects, thereby increasing biodiversity around.

Management of impacts: The reduction in mortality due to railways, road and power lines are one of the most important aims of the mitigation and management measures to be taken and it is handy to have a more robust understanding about the important areas of mortality. The mitigation measures for railway lines are more complicated compared to the other linear transportation structures as the speed and trajectory of a train cannot be changed easily to avoid collisions; therefore, mitigation measures must almost entirely rely on preventing the animals from crossing the train tracks (Santos *et al*., 2017). Special crossing structures should be designed specifically for comfortable wildlife passing such as pipe culverts, box culverts, amphibian tunnels, wildlife underpasses and overpasses and exclusion fences (van Rooyen, 2009; van der Grift *et al*., 2015; Carvalho *et al*., 2017). But it is less effective in the case of flying mammals and birds because they do not use such physical structures and fly over trains and overhead wires (Van der Grift, 1999; Glista *et al*., 2009; Dorsey *et al*., 2015). Physical barriers like trees, diversion poles, flight diverters, or noise barriers can be used in such situations to minimize the collision, especially for birds (Jacobson, 2005; Kociolek *et al*., 2015; Zuberogoitia *et al*., 2015) and bats (Ward *et al*., 2015). The pole barriers employed by

Zuberogoitia (2015) consisted of (1) gray PVC poles of 2 m in height and 8 cm in width, regularly separated by 1–2 m, with shredded pieces of colored paper (white or orange) attached to the highest part of the pole, or (2) tree trunks (20–26 cm diameter and 350 cm height) separated by 1 m. Trees can be a better barrier, especially to large animals, and forcing birds and bats to fly high above the trains. Lighting and reflectors can act as wildlife deterrents for nocturnal species (Carvalho *et al*., 2017). Since the chances of collision and mortality are likely to be more during breeding and migration time, minimizing the maintenance during those times can make a positive reduction in the mortality rate of birds (WII, 2016).

Several studies suggested that the implementation of anti–collision devices such as wire markers can be an effective mitigation measure to reduce power line collision (Morkill and Anderson, 1991; Alonso *et al*., 1994; Janss, 2000; Janss and Ferrer, 2000). Beaulaurier (1981) observed a 45% reduction (range 28–60%) in bird mortality in marked wires. Alonso *et al.* (1994) observed a 60% decrease in bird mortality at marked spans of line with respect to the same span of unmarked line in south–western Spain. A study by Brown and Drewien (1995) found that wire marking is effective in reducing avian mortality by 61% with dampers and 63% with plates used as markers in south-central Colorado. Power line electrocutions not only affect bird populations but also create significant economic loss to electricity companies as it causes breaks in the energy supply (Bevanger, 1994). Minimizing collision and electrocution can be achieved by making changes in the design of electricity infrastructures. Removal of earth wire (ground wire) can be effective to reduce both collision and electrocution and maintain a gap between the wires will further reduce electrocution (Bevanger, 1994; Lehman *et al*., 1999). The best way to reduce power line collision and mortality is by avoiding power lines in sensitive areas (Brown and Drewien, 1995).

Power line planning and routing should be made very carefully to minimize the impacts and intensive studies must be conducted to enumerate the effects of these lines, especially in hotspots (McNeil *et al*., 1985, Morkill and Anderson, 1991; Bagli *et al*., 2011). Routing of power lines along existing linear infrastructures is also effective and the same has been effectively implemented in some areas (Bagli *et al*., 2011). Replacing the aerial wires with underground cabling can also be seriously considered in potential habitats, where endangered species may otherwise get seriously affected (Jenkins *et al*., 2010). Also, the installation of safe perches and nesting platforms along power line routes may generate benefits for bird species to be more co-existing with this infrastructure (D'Amico *et al*., 2018). Such artificial structures can also be used successfully to enhance the biodiversity of urban environments. So, the intelligent use of such structure by managing agencies can reduce the direct and indirect impacts of linear infrastructure intrusions and support and sustain the biodiversity of the area (Bissonette, 2002; Benítez-López *et al*., 2010). Environmental impact assessment studies that are currently not mandatory in some countries (e.g., India) should be made mandatory to facilitate such planning along the potential habitats of sensitive faunal groups before implementation of the projects and the effects should be regularly monitored during the operation phase.

CONCLUSIONS

According to the extensive literature review, we find that the rate of mortality, factors affecting mortality and population effects in relation to infrastructures are poorly investigated. The major impacts of linear infrastructures are habitat degradation, fragmentation, and direct mortality by collision and electrocution. Research and careful planning have led to solutions that begin mitigating the negative effects of these infrastructures all over the world. But there are very few attempts to be made to understand the impact of linear infrastructure on avifauna in Asian countries, even for the endangered species. Systematic research and collaborative efforts should be made by the scientific community, government and power line companies to integrate biodiversity conservation and infrastructure development. But in practice, planning and routing of linear infrastructures are primarily based on economic feasibility only rather than environmental considerations. This needs to change for a better sustainable development paradigm with ecological concerns given equal or more weightage than purely economic considerations.

CONFLICT OF INTEREST STATEMENT

"The authors have no conflicts of interest to declare ".

ACKNOWLEDGEMENTS

We thank Director, SACON for his guidance and valuable support. We would like to thank Mr Alby J Mattathil (Research Fellow) and Arjun Suresh (Research Fellow) of the Sálim Ali Centre for their continued support.

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تأثير تدخلات البنية التحتية الخطية على فونا الطيور Avifauna : مراجعة

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تأريخ الاستلام: 2022/12/8، تأريخ القبول: 2023/4/26، تأريخ النشر: 2023/6/20

الخلاصة

تتناول هذه المراجعة التأثيرات المشار عنها للتطورات الثلاثة للبنية التحتية الخطية ، السكك الحديدية والطرق وخطوط الكهرباء على Avifauna طيور الافيفونا . تنتشر هذه البنى التحتية في جميع أنحاء العالم مما يشكل تهديدات خطيرة للحياة البرية بما في ذلك طيور الافيفونا . و التاثيرات الرئيسية التي تنطوي عليها البنى التحتية الخطية تدهور الموائل، التجزئة، و الهلاكات المباشرة عن طريق الاصطدام والصعق بالكهرباء. يمكن تقسيم العوامل التي تؤثر على هلاكات التصادم إلى عوامل داخلية وخارجية. تتضمن العوامل الداخلية مورفولوجيا الأنواع وسلوك الأنواع، في حين ان العوامل الخارجية تتمثل بالطقس وخصائص المناظر الطبيعية والجوانب التقنية للبنية التحتية. تؤثر خطوط الكهرباء على عدد كبير من الطيور ، و تقتل أكثر من مليار طائر على مستوى العالم كل عام. تشير الدراسات إلى تنفيذ أجهزة مضادة للتصادم مثل علامات الأسلاك؛ تعد محولات الطيران والحواجز المادية مثل الأشجار أو أعمدة التحويل أو حواجز الضوضاء تدابير فعالة للتخفيف من موت الطيور. لذلك، فإن فهم التأثير الكلي للبنى التحتية الخطية أمر بالغ الأهمية لإدارة تاثيرها على الطيور بشكل فعال والمساعدة في جعل التطورات المستقبلية أقل خطورة وأكثر استدامة.