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Remote Sensing: Way to watch the bird's habitat

Payal Jain, Rakhi Vaish, Nidhi Gupta, Shashi Tekam and Priyansh Washnik

Department of Veterinary Anatomy, College of Veterinary Science and A.H., NDVSU, Jabalpur, Madhya Pradesh, India

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Corresponding Author: Payal Jain

Abstract

Changes due to anthropogenic pressure and climate pose significant threat to avian ecosystem and lead to the habitat degradation and biodiversity losses. Since the bird plays important role of seed disperser, scavengers and pest controller in ecosystem require a complex habitat for survival and reproduction. For preservation of bird's habitat, information about their distribution, locality and pattern is very much required. Remote sensing has emerged as a valuable non-invasive approach to mapping and monitoring bird habitats across vast landscapes and timeframes. This paper explores the potential of remote sensing in identification of bird's habitat. Various remote sensing techniques—including optical remote sensing (panchromatic, multispectral, hyper spectral), radar, and LiDAR—offer complementary capabilities in capturing spatial, spectral, and structural data relevant to bird habitats.

Keywords: Bird, ecosystem, habitat, optical remote sensing, radar and remote sensing

Introduction

Habitat loss and degradation along with the invasion by other species may affect the biodiversity of any ecological niche. Ecosystems such as forests and grasslands provide us with food, medicines and important raw materials, oxygenate the air and remove pollutants from water. Birds play an important role in the effective functioning of these systems. Exaggerated human activities like change in land utilization, release of harmful gases in the environment, excessive fresh water extraction leads the earth towards climate change results in to change in the habitat pattern of different species (Nathalie *et al*., 2014). Birds are important for the ecosystem as they work as pollinator, scavengers, seed disperser and pests predators. Bird's habitats are critical for the survival and reproduction of avian species. So, the primary task of the present is to protect the ecological environment and provide sustainability, however, the lack of information about three-dimensional structure in forests limits our ability to monitor and manage bird species in these ecosystems and to conserve scarce habitat.

To accomplish this goal, it is essential to recognize the significance of monitoring the environment and gaining real time insight in to the state of the ecosystem (Jiao, 2024) [2]. Traditional methods of habitat identification, such as ground surveys, are often time-consuming and labor-intensive, however, remote sensing offers a non-invasive, efficient alternative for mapping and monitoring bird habitats over large areas and extended periods. Other than this remote sensing can be helpful for population monitoring, assessment of impact of climate change and conservation planning. Remote sensing (RS) is defined as the science of collecting, extracting, and analyzing information about objects, on images obtained without having physical contact with the objects. Wide spatial coverage from space or airborne remote sensors complements the information obtained from extensive field-based inventories of urban landscapes (Wong, *et al*., 2021) [6]. Collaborative approach between the remote sensing area and biodiversity study may increases our ability effectively to anticipate and mitigate adverse consequences to bird's well being. The review of remote sensing for bird habitat is important because it enhances habitat evaluation, modeling, and monitoring programs, which are crucial for effective wildlife conservation and management. These technologies enable studies in remote regions that are otherwise difficult to access, addressing urgent needs for habitat assessments. By analyzing satellite imagery and GIS applications, researchers can improve the quality of inferences and comparative analyses, ultimately leading to better-informed conservation strategies for avian species (Beijing, 2010) [10].

So, looking in to the importance of present topic this article will discuss about different remote sensing technologies used by different researchers to monitor the bird's habitat and their pros and cons.

Role of Remote Sensing in Avian Ecology

1. **Habitat Mapping:** Remote sensing allows for the creation of detailed habitat maps by analyzing land cover and vegetation types. This is essential for identifying suitable habitats for different bird species.
2. **Population Monitoring:** Satellite imagery and aerial surveys help track changes in bird populations and habitat use over time, providing valuable data for conservation planning.
3. **Climate Change Impact Assessment:** Remote sensing data can be used to study the effects of climate change on bird habitats, such as shifts in vegetation patterns and habitat fragmentation.

4. **Conservation Planning:** By identifying critical habitats and areas of habitat loss, remote sensing aids in the development of effective conservation strategies and management plans.

Different remote sensing technique used for avian habitat survey

Bird's habitat include various component as vegetation cover, land use, variable structural arrangement species composition etc., so to explore it variable types of remote sensing techniques can be used. Use of multiple types of technique usually provides good results than the single one. All of the sensors have different spatial, spectral, radiometric, and temporal resolutions. Spatial resolution can be defined as the smallest detectable detail in an image that can be stated as the measure of the smallest entity in an image which can be discriminated as an independent entity in the image. Spectral resolution can be defined as the range of the electromagnetic spectrum and the number of spectral bands measured by the sensor. Temporal resolution is defined as the time required by the sensor to revisit and obtain data from the same location (Bhargava *et al*., 2024) [1].

Various techniques and their uses are listed as

1. **Optical Remote Sensing:** in this technique visible, near infrared and short wave infrared sensor are used to form image from the solar radiation reflected by the target from the ground. Since the absorption and reflection ability of different material varied it help to generate the spectra reflectance signature and results in to identification of object. On the number of spectral band this system is further divided in to:

- **Panchromatic imaging system:** this system utilizes a single channel detector and provides black and white images. Quantity is measured on the basis of brightness. Examples of sensor are IKONOS PAN and SPOT HRV-PAN.
- **Multispectral imaging system:** this system uses spectral band more than one and result in to generation of multilayer image contain brightness and colour (spectra). Examples of multispectral systems are: LANDSAT MSS, LANDSAT TM, SPOT HRV-XS and IKONOS MS.
- **Hyperspectral Imaging Systems:** Hyperspectral imaging is a technique that facilitates the spectrum acquisition in an image for every pixel value. HSI sensors (spectrometers imaging) usually capture near-infrared, visible, and short-wavelength infrared spectra in the range of 0.4-2.5 μm region. Also, HSI with narrow band systems are agile to produce spectral spectrum at hundreds of distinct wavelengths. A few examples of HSI data acquired techniques are point scanning (whiskbroom), line scanning (push broom) imagers staring, and imager snapshots (Bhargava *et al*., 2024) [1].

Multispectral and hyperspectral data help to identify the spatial distribution of vegetation across landscapes. These vegetation characteristics have commonly included land cover, phenology, patch size, fragmentation, mostly related to vegetation class (e.g. deciduous and conifer) and their spatial attributes, however vertical dimension is difficult to obtain from these sensor such as Landsat or MODIS (Swatantran *et al*., 2012) [5].

2. **Radar:** Radar system uses the electromagnetic energy transmitted towards the object and records the echoes returned from them. Target can be variable such as aircraft, ships, space craft or birds. Radar signals included echo intensity, ground speed and wing flapping pattern help to differentiate between bird or any other object as insect movement. It allows a precise estimation of target distance and depending on the type of radar and the operational mode also of flight altitude. Thus, the information available from radar is in the best case the position in time and space, and the amount of energy reflected. Radar has been used: (i) in studies of bird migration (ii) in studies of population dynamics of breeding seabirds or roosting land birds (iii) monitoring of bird traffic at prospective locations of power lines, wind farms or bridges (Zaugg *et al*., 2008) [7]. Different types of radar sensor work on the principle of Millimeter-Wave Radar Sensor Continuous WaveRadar Sensor and Frequency Modulated Continuous Wave Radar Sensor.
3. **LiDAR (Light Detection and Ranging):** Light detection and ranging (Lidar) is based on the use of laser light emitted from a source and reflected back to a sensor as it intercepts objects in its path. As the reflected light is detected at the sensor it is digitized, creating a record of returns that are a function of the distance between the sensor and the intercepted object. This entire stream of reflected laser returns is referred to as a waveform. Subcanopy topography, canopy height, basal area, stem diameter, canopy height profiles, canopy cover and biomass have all been successfully derived from large-footprint lidar waveform data in a variety of forest types. Melin *et al*., 2018 [3] utilises the LiDAr data to access the importance of vegetation structure and found that bird diversity and abundance were found to be positively affected by vegetation density. They found that by combining lidar data with spot-mapped bird data, allowed the examination of the spatial relationships between bird distributions and vegetation structure across the whole woods and in relation to the full vegetation height profile. They suggest that planning habitat management, special care should be taken to first identify and then to preserve the features of habitat that act as determinants for diversity. LiDAR data, combined with GPS tracking, can help in understanding bird migration patterns and habitat use across different landscapes. The detailed habitat maps generated using LiDAR are valuable for designing effective conservation strategies and managing forest ecosystems for bird conservation.

Combining use of these technology can give enhanced result as study performed by Richter *et al.* (2019) [8] stated that By integrating bird survey data with land cover variables from the remote sensing product, the researchers were able to model population density based on environmental factors. They found that even small-scale land cover characteristics could be predicted accurately using remote sensing data. The overall classification accuracy with pansharpened

SPOT 6 data was 71.3%, which improved to 73.21% with the addition of SWIR bands, especially for complex land cover types like shrubby areas. This high accuracy contributed to robust habitat models**.**

Rhodes *et al*. (2015) [9] compare the field survey and remote sensing data collection method and found that the Collection of field data is typically costly in time, labour and resources, making use of remote-sensing more feasible for assessment at larger spatial extents if data of equivalent value are produced, but the cost-benefit threshold between the two is likely to be context-specific. However, integration of field survey with remote-sensed data provides accurate predictions of bird distributions, which suggests that both forms of data should be considered for future biodiversity surveys.

Conclusion

Remote sensing is a powerful tool for identifying and monitoring bird habitats, offering significant benefits for avian ecology and conservation. Techniques such as optical remote sensing, radar, and LiDAR complement each other in capturing land cover, vegetation structure, and movement dynamics are crucial to bird survival. As advancements in sensor resolution, data analysis and integration with biodiversity databases, remote sensing will play an increasingly central role in shaping conservation strategies. Interdisciplinary approach between ecologists, conservationists, and remote sensing experts may become a key to safeguarding avian habitats in the face of environmental change.

References

1. Bhargava A, Sachdeva A, Sharma K, Alsharif MH, Uthansakul P, Uthansakul M. Hyperspectral imaging and its applications: A review. Heliyon. 2024;10(12):1-10.
2. Jiao Z. The application of remote sensing techniques in ecological environment monitoring. Highlights Sci Eng Technol. 2024;81:449-55. https://doi.org/10.54097/7dqegz64
3. Melin M, Hinsley SA, Broughton RK, Bellamy P, Hill RA. Living on the edge: utilising lidar data to assess the importance of vegetation structure for avian diversity in fragmented woodlands and their edges. Landscape Ecol. 2018;33:895-910. https://doi.org/10.1007/s10980-018-0639-7
4. Pettorelli N, Safi K, Turner W. Satellite remote sensing, biodiversity research and conservation of the future. Philos Trans R Soc Lond B Biol Sci. 2014;369(1643):20130190.
5. Swatantran A, Dubayah R, Goetz S, Hofton M, Betts MG, Sun M, *et al*. Mapping migratory bird prevalence using remote sensing data fusion. PLoS One. 2012;7(1):e28922. https://doi.org/10.1371/journal.pone.0028922
6. Wong MS, Zhu X, Abbas S, Kwok CYT, Wang M. Optical remote sensing. In: Shi W, Goodchild MF, Batty M, Kwan MP, Zhang A, editors. Urban Informatics. Singapore: Springer; 2021. p. 689-706. https://doi.org/10.1007/978-981-15-8983-6_20
7. Zaugg S, Saporta G, van Loon E, Schmaljohann H, Liechti F. Automatic identification of bird targets with radar via patterns produced by wing flapping. J R Soc Interface. 2008;5(26):1041-53.
8. Richter R, Heim A, Heim W, Kamp J, Vohland M. Combining multiband remote sensing and hierarchical distance sampling to establish drivers of bird abundance. Remote Sens. 2019;12(1):38. https://doi.org/10.3390/rs12010038
9. Rhodes CJ, Henrys P, Siriwardena GM, Whittingham MJ, Norton LR. The relative value of field survey and remote sensing for biodiversity assessment. Methods Ecol Evol. 2015;6(7):772-81.
10. Beijing C. Application of RS, GIS and GPS techniques in study of avian habitat. For Sci Technol. 2010;7:146-50. https://en.cnki.com.cn/Article_en/CJFDTOTAL-LYKE201007024.htm