**Subject: Environmental Science (Hons.)**

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**Name of Topic: Use of remote sensing in conservational planning**

# Use of remote sensing in conservational planning

## 1. Species Distributions and Abundances

Development and validation of accurate, spatially explicit predictions of species distributions and abundances across a range of spatial and temporal scales requires integrating data on intrinsic biological factors, extrinsic environmental drivers, and historical and current species distributions and abundances. Remote sensing provides data on extrinsic environmental drivers such as land cover, primary productivity (e.g., the normalized difference vegetation index [NDVI], chlorophyll concentration [ocean colour or productivity]), and elevation and bathymetry.

## 2. Species Movements and Life Stages

Long-distance movements, such as the migrations of the monarch butterfly (*Danaus plexippus*), common wildebeest (*Connochaetes taurinus*), humpback whale (*Megaptera novaengliae*) and many other species are well recognized ecological phenomena that are extremely difficult to conserve, because for their role in maintaining local and global patterns of species distributions, ill-understood ecosystem functioning and little known effect of climate change on their movements.

Remote sensing can provide information about spatial and temporal environmental variation that affects animal movement and about land-cover changes that remove or reduce the quality of migration corridors. Movements of relatively large animals have been linked to remotely sensed observations. However, data on variables correlated with animal movements, such as phenology climate, and food and water availability, are needed at finer spatial, thematic, and temporal resolution, particularly to model small-scale and high-frequency movement.

## 3. Ecosystem Processes

Ecosystems and ecosystem processes are constantly changing in response to natural and anthropogenic disturbances, but it is not always clear how ecosystems will respond to single or multiple disturbances. For example, there is no clear understanding of the capacity of terrestrial, freshwater, and marine ecosystems to absorb nitrogen from human activities or how nitrogen facilitates the development of unproductive aquatic zones and changes in terrestrial ecosystem productivity. Remote sensing offers cost-effective information on ecosystem extent, status, trends, and responses to stressors over large areas. For example, remote sensing can contribute to quantifying agricultural and atmospheric nitrogen inputs and associations between outbreaks of insects and forest productivity and nutrient retention. Similarly, Landsat-derived maps of coral bleaching are an indicator of substantial stress and a potential loss of ecosystem function.

## 4. Climate Change

Changes in climate can alter ecosystem state and functions. Greater integration of paleoecological and paleoclimatological data, contemporary observations of ecosystem status and trend and environmental models can help researchers estimate the ecological and economic effects of climate change and thus allow societies to develop and assess adaptation and mitigation plans. Remote sensing can detect environmental changes that potentially reflect climate change at multiple spatial scales, from local patterns of disturbance, to regional changes in snow depth, to global changes in ice cover. In addition, some satellite remote sensing missions provide long-term records of land and sea surface temperature and of vegetation, from which indices useful for understanding the dynamics of climate change can be derived. As climate forcing strengthen over time, long-term satellite data records will help inform and improve projections of the effects of climate change on biological diversity.

**5. Rapid Response**

Accurate and timely information is key to making effective conservation decisions. Some decisions, such as responses to wildfires, droughts, oil spills, and illegal resource extraction activities (e.g., fishing and logging) require information within hours or days. Near real-time ecosystem monitoring based on remote sensing can make the detection of ecosystem threats more accurate and catalyze rapid response.

**6. Protected Areas**

Remote sensing data can help to define the extent and configuration of potential protected areas to meet the needs of the species and ecosystem processes they were designed to protect. Additionally, remote sensing can contribute to monitoring the status of protected areas by providing information on vegetation condition, areas of human disturbance, and the location and spread of non-native invasive species.

**7. Conservation Effectiveness**

For over a decade the conservation community has advocated for quantitative evaluation of conservation effectiveness to adapt strategies for law enforcement, governance, and conservation of both livelihoods and species and their habitats. Monitoring conservation effectiveness is intended to provide evidence whether the money spent on conservation initiatives and actions met benchmarks of success. Remotely sensed information can play a substantial role in determining whether investment in protected areas, ranger patrols, conditional payment schemes and governance training is correlated with status and trend of natural resources. Multiple sources of remotely sensed data such as multispectral satellite sensors, aerial videography, acoustic ground stations and imaging surveys contribute to assessment of the effectiveness of conservation actions. These actions may include the creation of protected areas, reduction of anthropogenic levels of light or sustainable management of ecosystems and the services they provide.

**8. Degradation and Disturbance Regimes**

Although satellite remote sensing can detect many types of disturbance that manifest in changes in land cover and ecosystems. For example, changes in vegetation and soils caused by varying levels of livestock grazing, changes in species composition and vegetation structure caused by non-native invasive species, increased tree mortality caused by insect outbreaks and air pollution, and myriad effects of global climate change can be detected using remote sensing technology.