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Study Material

Application of Remote Sensing in Conservation Planning

Scientists from the WCS (Wildlife Conservation Society), NASA, and other organizations have partnered to focus global attention on the contribution of satellites to biodiversity conservation. Addressing global questions requires global datasets that are enabled by satellite remote sensing. Continuous observations of the Earth's surface and atmosphere can advance our understanding of how and why the Earth is changing and inform actions that can be taken to halt the degradation of planet's natural systems.

Remote sensing data from orbiting satellites have been used to measure, understand, and predict environmental changes since the 1970s, but technology that subsequently became available can now be applied much more widely on a whole range of conservation issues.

1. **Species Distributions and Abundances**
   Remote sensing observations often used to predict species distributions globally have spatial resolutions of approximately 0.5–1.0 km, which are coarser than the resolutions at which many taxa interact with the environment. Finer spatial and temporal resolution are vital to understanding the distributions and abundances of certain species. Such data are needed to estimate values of variables including fractional land cover (i.e., proportion of area covered by different types of land cover), density of human-made structures, habitat quality for given species, land and sea surface temperature, coastal and open ocean chlorophyll-a, dates of soil freeze and thaw, fire dynamics, phenology, topography, and vertical vegetation structure.

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 as ecological phenomena that are extremely difficult to conserve because, for instance, their role in maintaining local and global patterns of species distributions and ecosystem function is not well understood) and little is known about how climate change may affect species' movements. Additionally, it is unknown how spatial and temporal environmental variability (e.g., the phenology of primary productivity, water availability, topography, fruiting patterns in tropical forests, weather, and climate) affect long-distance animal movements. Most long-distance movements are a response to seasonal resource variation in which species exploit resource peaks in geographically distant seasonal habitats. 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.

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. 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.

4. **Climate Change**
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.

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 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. One such example is the Fire Information Resource Management System, which provides near-real time global fire alerts on the basis of active fire-detection data. Another example is the coral reef bleaching alert system, which is based on sea surface temperature anomalies.

6. **Protected Areas**
Remote sensing data can help 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. **Agricultural and Aquacultural Expansion and Changes in Land Use and Land Cover**
It is a great challenge to meet society's growing food needs while mitigating the undesirable effects of agricultural expansion. Agriculture covers about 38% of Earth's land surface and is the most extensive land use on the planet. To accommodate this expansion, 70% of Earth's grassland, 50% of savanna, 45% of temperate deciduous forest, and 27% of tropical forest has been cleared or converted. Agricultural expansion affects both species and ecosystem functions, such as carbon storage and maintenance of soil nutrients. Similarly, aquacultural expansion alters ecosystem functions and can introduce non-native species to aquatic and terrestrial systems. A major step in understanding the potential effects of agriculture or aquaculture on species and ecosystem functions is to systematically assess the rates and locations of expansion and intensification. The global coverage and the spatial and temporal resolution from satellite observations allow mapping of these small- to large-scale changes.

8. **Conservation Effectiveness**
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.

9. **Degradation and Disturbance Regimes**
Although satellite remote sensing can detect many types of disturbance that manifest in changes in land cover, ecosystems also can be disturbed without a corresponding change in land cover, making such disturbances more challenging to detect. For example, detectable landcover conversion may not accompany changes in composition, structure, and function, including 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.