A DECISION SUPPORT SYSTEM FOR MONITORING, REPORTING AND FORECASTING ECOLOGICAL CONDITIONS OF THE APPALACHIAN NATIONAL SCENIC TRAIL

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1. INTRODUCTION

This paper introduces a NASA funded collaborative multi-agency effort to improve decision-making on management of the Appalachian National Scenic Trail (A.T.) by providing a coherent framework for data integration, status report and trend analysis. The A.T. traverses most of the high elevation ridges of the eastern United States, extending about 3,676 kilometers across 14 states, from Springer Mountain in Northern Georgia to Mount Katahdin in central Maine. The A.T. and its corridor intersects 8 National Forests and 6 National Park units; crosses more than 70 State Park, Forest, and Game Management units; and passes through 287 local jurisdictions. A.T.'s gradients in elevation, latitude, and moisture sustain a rich biological assemblage of temperate zone forest species. The A.T. and its surrounding protected lands harbor forests with some of the greatest biological diversity in the U.S., including rare, threatened, and endangered species, and diverse bird and wildlife habitats; and are the headwaters of important water resources of millions of people. The Trail's north-south alignment represents a cross-section MEGA-Transect of the eastern United States forests and alpine areas, and offers a perfect setting for collecting scientifically valid and relevant data on the health of the ecosystems and the species that inhabit them. The high elevation setting of the A.T. and its protected corridor provide an ideal barometer for early detection of undesirable changes in the natural resources, from development encroachment to recreational misuse, acid precipitation, invasions of exotic species, and climate change.

The National Park Service (NPS) Inventory and Monitoring (I&M) program and A.T. MEGA-Transect partners selected a suite of reliable and representative metrics or *Vital Signs* for inventory and monitoring long-term ecosystem conditions. Vital signs are defined as a subset of physical, chemical, and biological elements and processes that represent the overall health or condition of different natural resources [1]. Based on the selected vital signs, this A.T. MEGA-Transect DSS integrates NASA multi-platform sensor data, NASA Terrestrial Observation and Prediction System (TOPS) models, and *in situ* measurements to address identified natural resource priorities and improve resource management decisions. The TOPS models allow multi-platform sensor data to be integrated, making it possible to obtain near real-time observations of current (*nowcast*) ecological conditions as well as predictions for future ecological condition over extensive areas [2]. TOPS data products alone will be a DSS tool that can provide near-real time information on ecological condition over large regions. Integrating NASA EOS data and modeling products that link climate models (e.g., through TOPS) and ecological models (e.g., habitat suitability) with *in situ* observations, the A.T. MEGA-Transect DSS provides needed geospatial information and improves the effectiveness of decision-making in management of the A.T. lands and environment for conservation of biodiversity. The objectives of this project include to:

1. Develop a comprehensive set of seamless indicator data layers consistent with selected A.T. "Vital Signs";
2. Establish a ground monitoring system to complement TOPS and integration of NASA data with *in situ* observations;
3. Assess historical and current ecosystem conditions and forecast trends by coupling TOPS with habitat models; and
4. Develop an Internet-based implementation and dissemination system for data visualization, sharing, and management to facilitate collaboration and promote public understanding of the A.T. environment.

2. METHODS

This study focuses on three selected primary vital signs including *Phenology and Climate Change; Forest Health;* and, *Landscape Dynamics* and four supplementary vital signs including habitats of *Mountain Birds; Migratory Breeding Birds; Alpine and High Elevation Vegetation*; and *Water Resources.* This study addresses decision making issues in two spatial scales, i.e., the entire A.T. corridor (regional scale) and selected sensitive segments within which more intensive monitoring studies are directed (focused scale). The sensitive segments have either experienced or are expected to experience impacts and disturbances, and may already have a quantity of monitoring data [3]. TOPS modeling is to ingest and process data from TERRA-MODIS, AQUA-MODIS, AQUA-AMSR-E, AVHRR, LANDSAT along with surface weather observations. The outputs include at 30-1000 m spatial resolution and on daily/weekly/annual temporal frequencies, such as annual 500m land cover, 250m tree cover, 8-day vegetation indices (NDVI, EVI), 8-day Leaf Area Index/Fraction of Absorbed PAR, 8-day Land Surface Temperatures (day/night), 8-day snow cover, 8-day albedo. The forecast and modeling outputs include evapotranspiration, soil moisture, freeze/thaw, soil temperature, vegetation stress, gross and net primary production, N cycling, and streamflow in daily or weekly frequencies, and climate change in decadal soil moisture, stream flows, net primary productivity, phenology.

For the regional scale analysis, monitoring, reporting and forecasting employ MODIS data (beginning with data from 2000). For focused scale analysis we develop data layers to represent three time periods: 1980s and 1990s (past); 2000s (current); and, > 2010 (future). Multiple sets of temporal data allow resource managers to build a comprehensive understanding of the current status and trends for the A.T. region in terms of driving factors (e.g., climate, land use/cover) and responsive conditions (e.g., ecosystem productivity, phenological patterns, forest health), and help characterize habitat condition (e.g., landscape configuration and composition, suitability) and primary drivers for simulation and prediction exercises.

In situ observations of forested habitats for targeted vital sign indicators are integrated with TOPS data products from remote sensing observations. The regional (or landscape) scale field data collection follows a probabilistic system design. The system establishes long-term biological monitoring plots centered along the A.T., covering a consistent portion of the trail and the corridor on each side of the trail. The sampling at landscape-scale references the USFS Forest Inventory and Analysis (FIA) monitoring protocols, which allows use of data from the current regional FIA system to be incorporated into the analyses of forests adjacent to the A.T. land. The field collected data can be used to: 1. provide status and trend information on the health of the A.T. forests and the Appalachian Trail; 2. link ground-based forest health information to remote sensing data (aerial and satellite) for TOPs analyses; and 3. monitor changes in ecotonal communities common on ridges that are indicative of early signs of climate change.

Focused scale monitoring targets mid- to high-elevation forests in mountain ecoregions. This study selects ten (10) distinct segments in which to locate ground based sampling plots. A segment is defined to be that portion of the A.T. corridor that intersects watersheds at level 10 Hydrologic Unit Codes (HUC-10). From the total list of 179 candidate segments, those HUC-10 watersheds that are smaller than 50-100 hectares and those segments with average elevation less than 450 meters are eliminated. The remaining watersheds represent the target population, each with an equal selection probability. Finally 10 segments are selected for the study. Field sampling within the selected segments will follow the long-term forest monitoring protocol that was developed and employed by the Northeast Temperate Network of the NPS I&M Program [6].

3. ANTICIPATED RESULTS

Through integration of TOPS outputs and *in situ* observations, the monitoring and evaluation of status and trend in forest condition and habitat, include tree regeneration and mortality; forest succession; incursion by invasive exotic species; net primary productivity (NPP) and biogeochemical cycling. With calculate habitat conditions of targeted vital signs through data developed, habitat modeling combines landscape-scale land use, and patch size and connectivity data with ground-based data related to vegetation (e.g., forest type and composition, structure, understory species, tree basal area and distribution, canopy density, and other factors), physical characteristics (e.g., slope, aspect, elevation, etc.), and climate. The changes of habitat conditions can then be obtained through connections with the primary vital signs. A variety of scientific research has been devoted to develop methods for integrating breeding bird survey and FIA databases with calculated landscape structure variables from NLCD data to evaluate forest bird-habitat relationship [4][5]. This study pursues habitat modeling by data integration methods under the A.T. DSS environment for monitoring, reporting and forecasting of the habitat conditions.

The Internet data and modeling system is powered by commonly adopted software systems to provide mapping and visualization services. Upon completion the database and modeling results is to be hosted by the National Biological Information Infrastructure (NBII), managed by the USGS Biological Informatics Office. This transition will benefit from both the existing infrastructure and administrative capability of the NBII, which is a broad, collaborative program to provide increased access to data and information on the nation's biological resources.

Technical details will be addressed in the full proceedings paper.

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