Mapping Habitat for the Ivory Billed Woodpecker and the California Spotted Owl: A Multisensor Fusion Approach

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INTRODUCTION

Most passive optical sensors provide horizontal vegetation structure but do not provide vertical structure for habitat characterization. Lidar remote sensing has emerged as an important technique for quantifying forest vertical and spatial structure at both local and landscape scales.

Fusion of sparse but accurate lidar data with commercially available remote sensing data is a promising approach towards obtaining seamless forest structure at various scales for forest inventory, wildlife habitat mapping, fire risk monitoring, biodiversity conservation and other applications.

OBJECTIVES

1. To explore the potential of lidar and satellite data fusion for predicting vegetation structure at various scales.

2. To study the efficacy of lidar fusion for large area mapping in support of ecological modeling and monitoring, focusing on two dissimilar bird habitats:

   (a) The California spotted owl habitat in Sierra National Forest, CA.
   (b) The ivory-billed woodpecker in the Big Woods region of Arkansas.
The Laser Vegetation Imaging Sensor (LVIS) is an airborne, scanning laser altimeter designed and developed at NASA’s Goddard Flight Space Center. It operates at an altitude of up to 10 km from ground and produces 10-20 m footprints. The shape of the returning laser pulse of each footprint is digitally recorded and analyzed to provide canopy height, ground elevation and vegetation vertical structure.
Statistical and spatial modeling techniques are being used to fuse lidar derived metrics (canopy height, canopy cover, biomass) with spectral metrics derived from multiangle, multispectral and hyperspectral data for fine and broad scale habitat mapping for the ivory-billed woodpecker and the California spotted owl. This poster mainly discusses forest metrics derived from LVIS and Hyperspectral data for the two study sites.
Rediscovery of the long-thought extinct ivory-billed woodpecker in the Big Woods region of Arkansas (figure to right) triggered extensive search and planning efforts. LVIS was flown in June 2006 and mapped over 1,000,000 acres of woodpecker habitat as a part of the US Fish and Wildlife Service recovery plan.

The data were processed by NASA GSFC and the University of Maryland to produce various data products that were delivered to the US Fish and Wildlife Service in November 2006.

For the ivory-billed woodpecker, important primary and secondary management factors are derivable from lidar, while others (e.g. cavity trees, stress) may be derived from multi- and hyperspectral instruments. Lidar was used to directly retrieve canopy height and cover, and to statistically retrieve (using field plot data) basal area and tree density.

Hyperspectral AVIRIS data will be analyzed to obtain plant functional type and non photosynthetic vegetation. Lidar and hyperspectral data will be fused to obtain biomass, vegetation stress etc. for habitat suitability analysis.
Figures show three primary lidar products: height, canopy cover and basal area. Long rectangles are the entire Big Woods region mapped by LVIS, with detail for inset shown. Basal area is calculated by statistical relationship with multiple waveform variables.
In July of 1998 LVIS flew large portions of the Sierra Nevada in California, including Sierra National Forest, in part to support habitat characterization and conservation for the California spotted owl. Previous studies have shown strong relationships between forest vertical structure (biomass, canopy height, canopy cover) and spotted owl nesting patterns. (Hyde et al, 2006)

This study includes hyperspectral data and aims at improving biomass prediction at functional type and species level. Hyperspectral indices including the normalized difference water index (NDWI), red edge derivatives as well as fractions of green vegetation, soil, non-photosynthetic vegetation and shade were calculated from AVIRIS data over the Sierra Nevada study site using spectral mixture analysis.

Fusion of LVIS and hyperspectral indices and fractions is expected to enhance biomass and vegetation mapping for the spotted owl habitat.
Canopy height map from LVIS

Spectral end-members from AVIRIS

Fractions of vegetation, soil and non-photosynthetic vegetation
1. Forest structure maps derived from LVIS are expected to further recovery efforts for the ivory billed woodpecker and aid conservation efforts in the Big Woods region of Arkansas.

2. LVIS metrics and field plot data were found to improve hyperspectral analysis which in turn is expected to improve biomass prediction from LVIS.

3. Lidar fusion with multispectral, multiangle, radar and hyperspectral data holds great promise for comprehensive habitat mapping and should be pursued further.
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