# Integrating Lidar in Modeling GAP Habitats

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One of the cornerstones of the Gap Analysis Program (GAP) is modeling species-habitat associations and mapping species distributions. Species-habitat modeling has become more widespread in theoretical and applied conservation ecology in recent years. A foundation for spatial modeling of species distributions is the relationship between species occurrence or abundance and habitat characteristics which we can map. The objective of this project is to investigate the potential of lidar data – with its ability to quantify landscapes in three dimensions – as well as additional land-cover data to enhance the quality of geospatial information on habitat characteristics for species-habitat modeling.

## Description of Project

Our study incorporates previous GAP data from Idaho and Puerto Rico and spans coniferous and broadleaf, evergreen and seasonal forests and rangelands. We are identifying variables of habitat structure that are suitable for refining GAP predictions of species distributions, assessing the relationships between lidar derived data and key habitat variables such as the presence and abundance of snags and understory shrubs, and exploring the capabilities of lidar in assessing canopy height and cover in subtropical dry forests.

## Status

We are in the third and final year of the project and expect to complete it in 2010.

## Results and Goals

Martinuzzi et al. (2009a) have identified eleven variables of habitat structure potentially suitable for refining GAP species distribution. For forests these include percent tree canopy cover, measures of forest stand biomass, diameter and density of snags, height of overstory trees, diversity of the tree canopy (i.e. number of canopy strata), tree density and percentage of understory shrub cover. For rangelands, the important variables were the height and percentage of shrub cover, as well as the height of the grasses. In terms of topography, important variables included rock outcrops, and morphological measures of streams, creeks and canyons.

We evaluated some of these key variables by incorporating tree-canopy information into broad-scale models of wildlife-habitat distributions. Martinuzzi et al. (in review) determined that improvements in the characterization of forested land cover by the degree of canopy closure can significantly alter predicted species distribution patterns, estimates of biodiversity and estimates of the level of protection of particular habitats – ultimately leading to better information for land management and planning.

We reviewed the use of lidar as a tool in habitat mapping (Vierling et al. 2008). We developed a map of forest successional status using a combination of lidar and field data (Falkowski et al. 2009) that was then used to improve the mapping of snags and forest understory as a component of bird habitat in Idaho. Martinuzzi et al. (2009b and in press) find that the value of lidar resides in the ability to quantify 1) ecological variables that are known to influence the distribution of understory vegetation and snags, such as canopy cover, topography and forest succession, and 2) direct structural metrics that indicate or suggest the presence of shrubs and snags, such as the percentage of vegetation returns in the lower strata of the canopy (for the shrubs) and the vertical heterogeneity of the forest canopy (for the snags).

Vierling et al. (2009) organized a special session on lidar habitat mapping at the 94th Ecological Society of America annual meeting. We are continuing our evaluation of lidar in subtropical dry forests in Puerto Rico.

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## Literature Cited

Falkowski M.J., J.S. Evans, S. Martinuzzi, P.E. Gessler, and A.T. Hudak. 2009. Characterizing Forest Succession with Lidar Data: an Evaluation for the Inland Northwest USA. *Remote Sensing of Environment,* 113: 946–956.

Martinuzzi S., L.A. Vierling, W.A. Gould, and K.T. Vierling. 2009a. Improving the characterization and mapping of wildlife habitats with LiDAR data: measurement priorities for the Inland Northwest, USA. *Gap Analysis Bulletin 16*. USGS/BRD/Gap Analysis Program, Moscow, ID, USA.

Martinuzzi S., L.A. Vierling, W.A. Gould, J. Evans, M. Falkowski, A. Hudak, and K.T. Vierling. 2009b. *Using discrete return lidar data to map the distribution of snags, understory shrubs, and avian habitat suitability in a mixed conifer forest*. 00S-36-5, ESA Annual Meeting, Albuquerque, NM, August 2-7, 2009.

Martinuzzi S., L.A. Vierling, W.A. Gould, K.T. Vierling, and A.T. Hudak. In review. Refining GAP predictions of species distribution with novel biophysical data: consequences for biodiversity and conservation assessments. *Journal of Applied Remote Sensing.*

Martinuzzi S., L.A. Vierling, W.A. Gould, J. Evans, M. Falkowski, A. J.S. Evans, Hudak, and K.T. Vierling. In press. Mapping snags and understory shrubs for a LiDAR-based assessment of wildlife habitat suitability. *Remote Sensing of Environment*.

Vierling L.A., K.T. Vierling, and S. Martinuzzi. 2009. Special Session *Lidar Measures of Ecosystem Structure: Implications for Biodiversity and Wildlife Habitat Modeling.* 00S-36, ESA Annual Meeting, Albuquerque, New Mexico, August 2-7, 2009.

Vierling K.T., L.A. Vierling, W.A. Gould, S. Martinuzzi, and R. Clawges. 2008. Lidar: Shedding new light on habitat characterization and modeling. *Frontiers in Ecology and the Environment, 6*, 90–98. doi: 10.1890/070001.