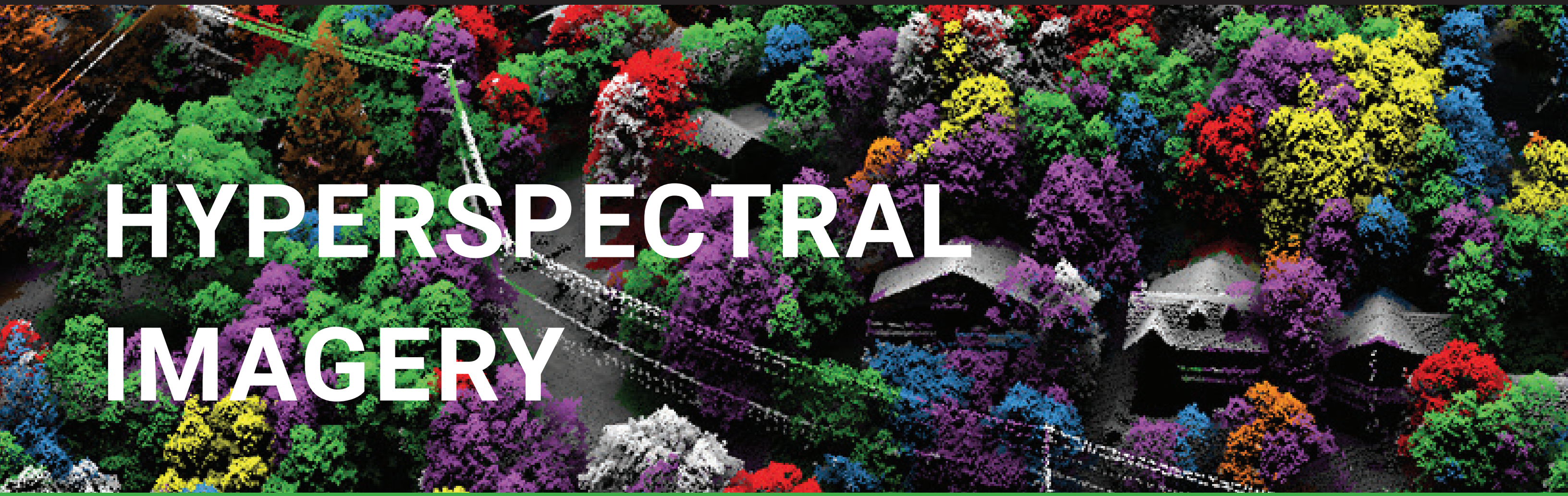
NV5 GEOSPATIAL

HYPERSPECTRAL IMAGERY



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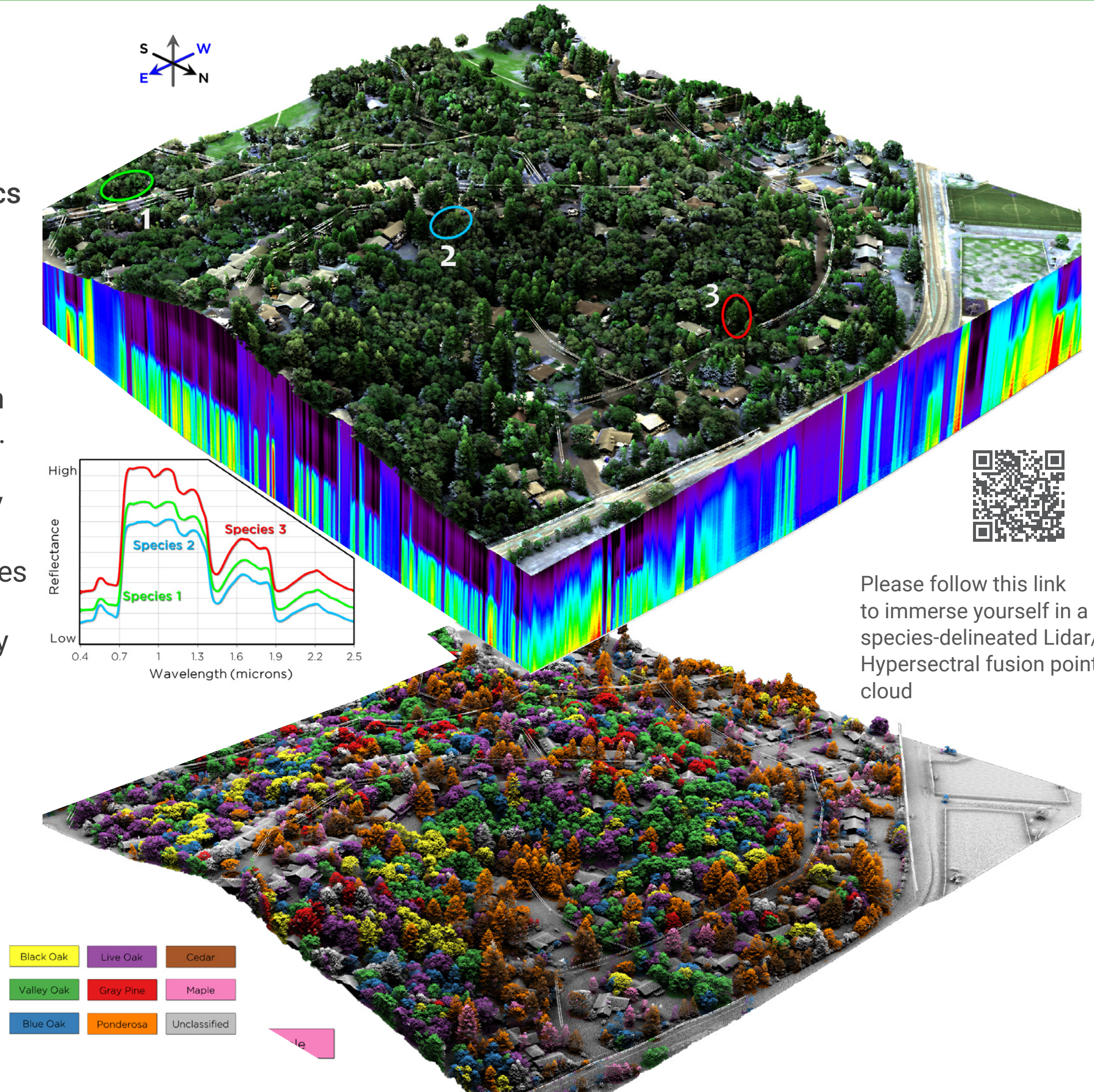
NV5G EDGE

NV5 Geospatial is the industry leader for acquisition and analysis of high density lidar. And with the addition of spectral anlaytics, and entirely new view of the world is possible.

SEEING THE TREE & THE FOREST

Tree species and forest health derived from combined hyperspectral and lidar analytics

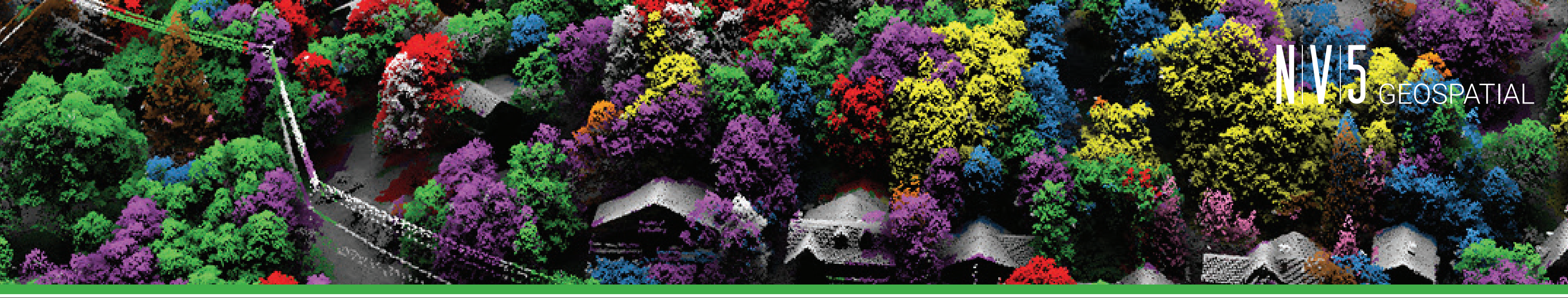
From the urban landscape to dense natural forests, the identification of individual tree species is a powerful tool for vegetation management, carbon accounting, and forest inventory. NV5 Geospatial has developed a production-scale methodology for delineating tree crowns and quantitatively determining species using a combination of high resolution hyperspectral imagery and high density lidar data.



Please follow this link to immerse yourself in a species-delineated Lidar/ Hypersectral fusion point cloud

A hyperspectral imagery cube (shown in the upper scene) can be viewed as a true-color image, any combination of spectral bands, or as distinct spectra for individual pixels representing specific tree species. The lidar point cloud classified by species (shown in lower scene) emphasizes the detail that is possible to derive with meter-scale hyperspectral imagery.

For more information or to schedule a meeting contact nv5g-srsales@nv5.com



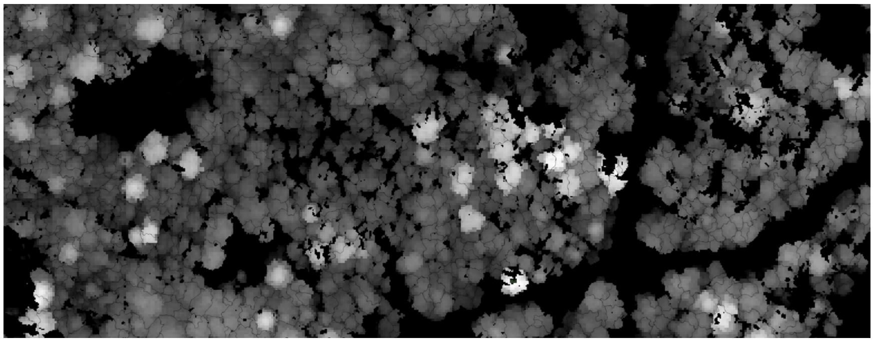
A MULTI-FACETED APPROACH

TRUE-COLOR

The NV5G hyperspectral sensor collects reflected solar energy from 400 to 2500 nanometers (nm). These data are visualized here as a true-color image that can be used to interpret the characteristics of natural, urban, and infrastructure features in the scene.

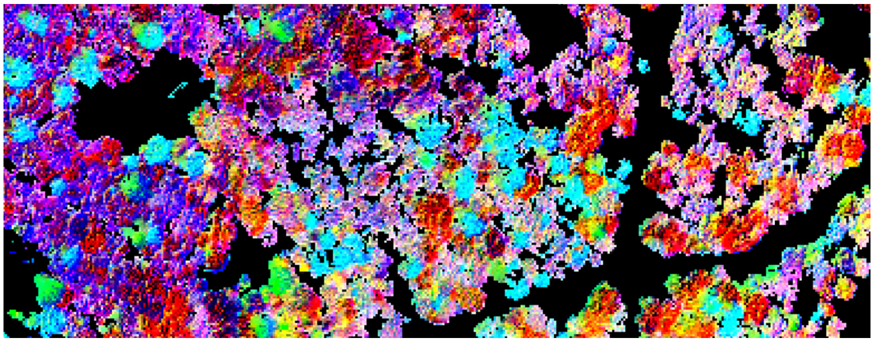
VEGETATION HEIGHT MODEL

Vegetation height is generated by segmenting returns from the lidar point cloud that occur above the bare-earth ground model. This information is used to mask low shrub and grass pixels from the dataset when performing spectral analysis. Tree crowns are often discernible for individual trees and lidar metrics, like height, can be compared per species.



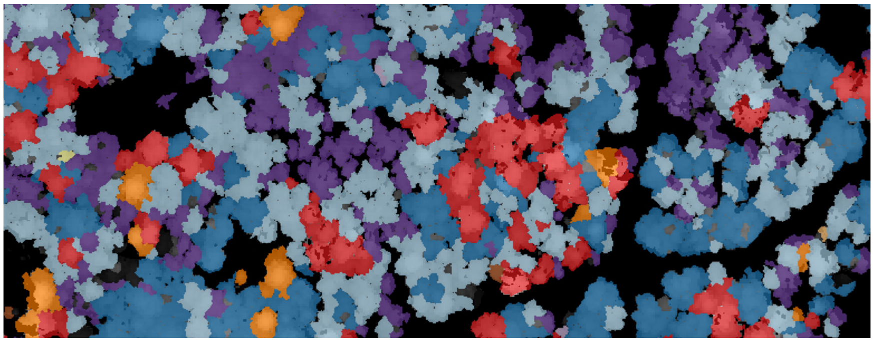
PRINCIPAL COMPONENT ANALYSIS

The raw spectral variability of a dataset can be visualized with a principal component RGB image that is used to isolate individual tree species. The colors correspond to spectral features that are consistent across crowns and variable between species.



CLASSIFICATION MAP

The colors displayed in this image are the final product of the hyperspectral tree classification. Each pixel is classified to a species' spectral signature using a machine learning routine and training data defined by field-based tree identification. The lidar derived tree crown polygons are then assigned a class based on pixels that fall within each feature.



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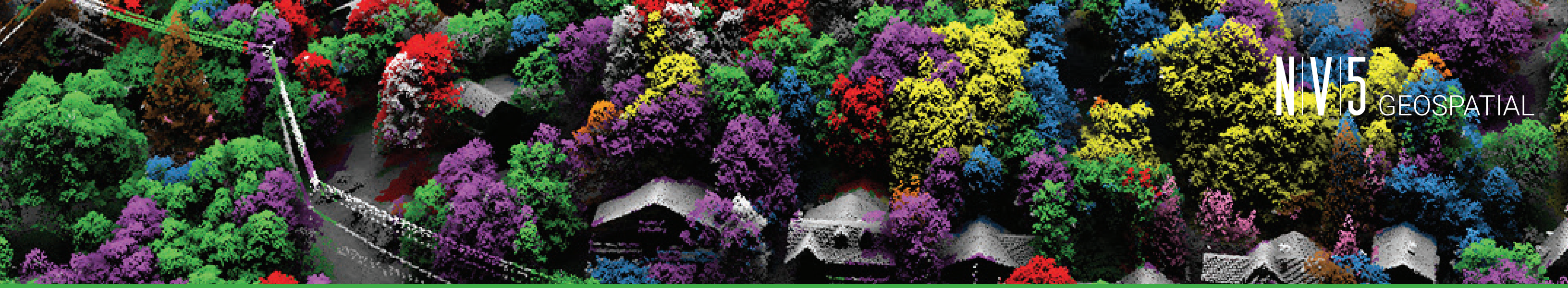
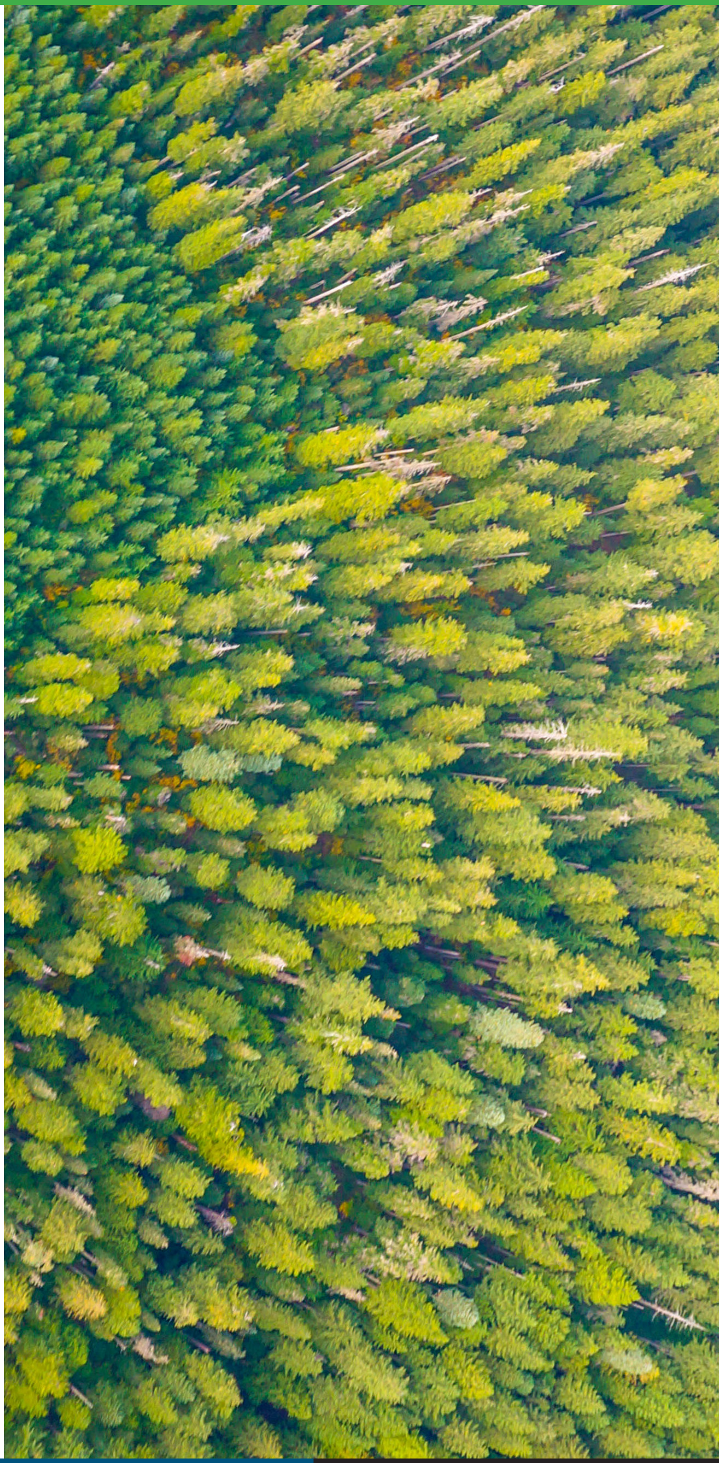
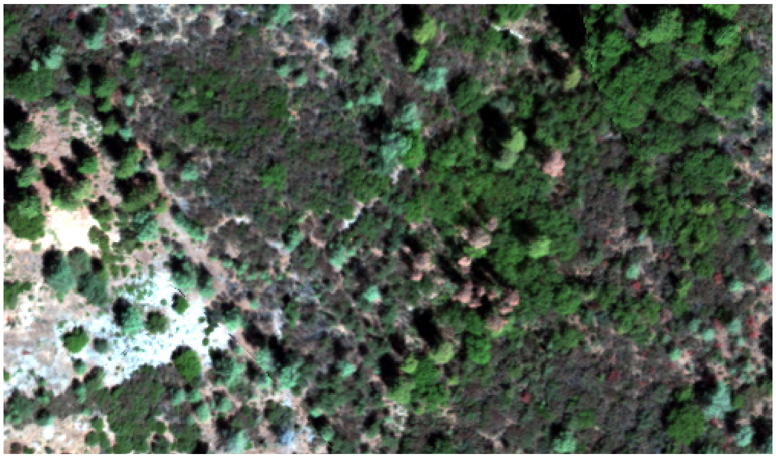


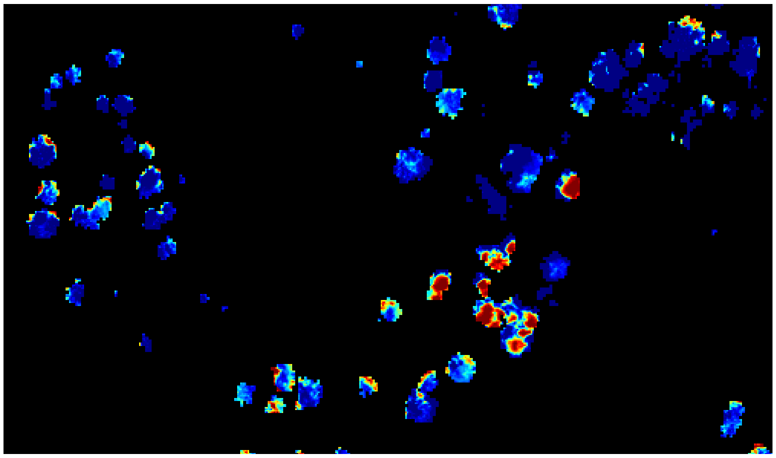
VEGETATION HEALTH

IDENTIFYING DYING OR DISEASED VEGETATION

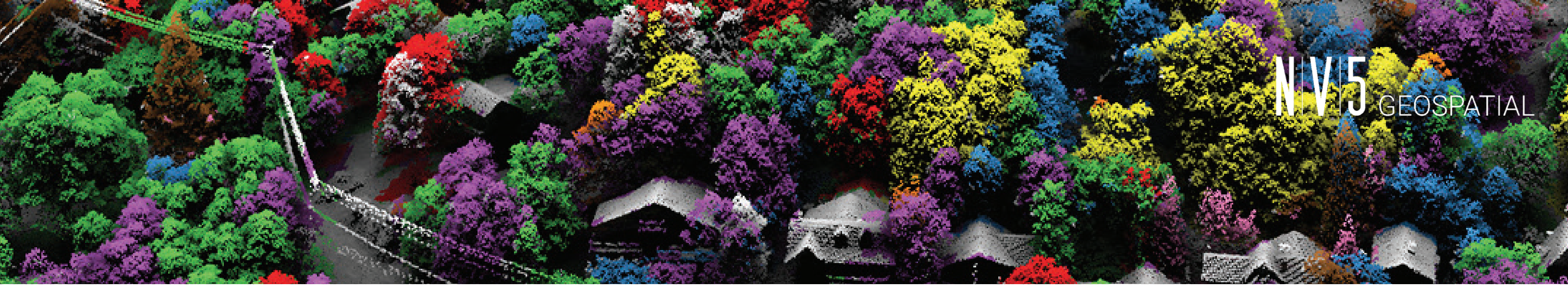


Ultra-high resolution imagery and the lidar point cloud provide a stand-alone set of analytics that allow each tree crown to be mapped using spectral vegetation health metrics. The same information used to classify the species can be used to detect trees that are completely dead, canopies that show signs of stress, and potentially even identify the presence of specific diseases or infestation. Biomass calculation and carbon accounting can also be reliably generated with the best possible results from NV5 Geospatial's stacked lidar and spectral analyses.





The true-color image on the top can be used to visually identify the most apparent dead trees that show brown canopies, but the bottom image displays a combination of spectral health and tree height to easily detect and highlight the presence of dead or stressed trees.



VALIDATION AND ACCURACY

Understanding Hyperspectral Classification Accuracy
Assessing the confidence of the results is an important component in any forest analysis. A robust set of field observations allows us to calculate an accuracy matrix for every project, which displays the accuracy of each species in the classification. Accuracy values tend to vary depending on species distribution, region, and time of year, allowing the end user to be confident in key species and determine which suites of trees should be combined for the best analytics. A representative Accuracy Table from a 20 km2 mapping project in the Sierra Nevada foothills is shown below. User's (commission errors) and producer's (omission) accuracies are displayed in the end columns and rows. The overall accuracy (excluding unclassified trees which accounted for 8% of predicted species) was 83.9% with a kappa statistic of 81.4%.

		Observed												
		Pine	Amer Sweet	Man-zanita	Gray Pine	Ever-green Oak	Decid. Oak	Plum	Cyp-ress	Deo. Cedar	Inc. Cedar	Un-class	Row Total	User's Accuracy (%)
Predicted	Ponderosa Pine	51	2	0	0	2	0	0	1	5	21	--	82	62
	American Sweetgum	0	11	0	0	0	0	0	0	0	0	--	11	100
	Whiteleaf Manzanita	2	0	71	0	1	1	2	1	0	0	--	78	91
	Gray Pine	3	0	1	94	0	0	0	1	1	0	--	100	94
	Evergreen Oak	0	0	0	0	35	4	0	0	0	0	--	39	90
	Deciduous Oak	1	0	0	0	6	48	0	1	2	1	--	59	81
	Thundercloud Plum	0	0	0	0	0	0	52	0	0	0	--	52	100
	Leyland Cypress	2	2	0	0	0	2	0	11	2	7	--	26	42
	Deodara Cedar	1	1	0	0	1	0	0	1	21	2	--	27	78
	Incense Cedar	1	0	0	0	0	0	0	1	0	32	--	34	94
	Unclassified	15	4	2	1	1	6	5	1	5	5	--	45	--
	Column Total	76	20	74	95	46	61	59	18	36	68	--		
	Producer's Accuracy (%)	67	55	96	99	76	79	88	61	58	47	--		

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