Evaluating multi-season DESIS-like data in combination with Landsat time series for forest alliance mapping

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Forest Alliances

- Effective forest management requires detailed information on forest type and function.
- Forest alliances group ecologically related vegetation based on the dominant species in the sub-regional environment.

Ground view (left) and false color aerial composite (right) of a Coastal Redwood Alliance

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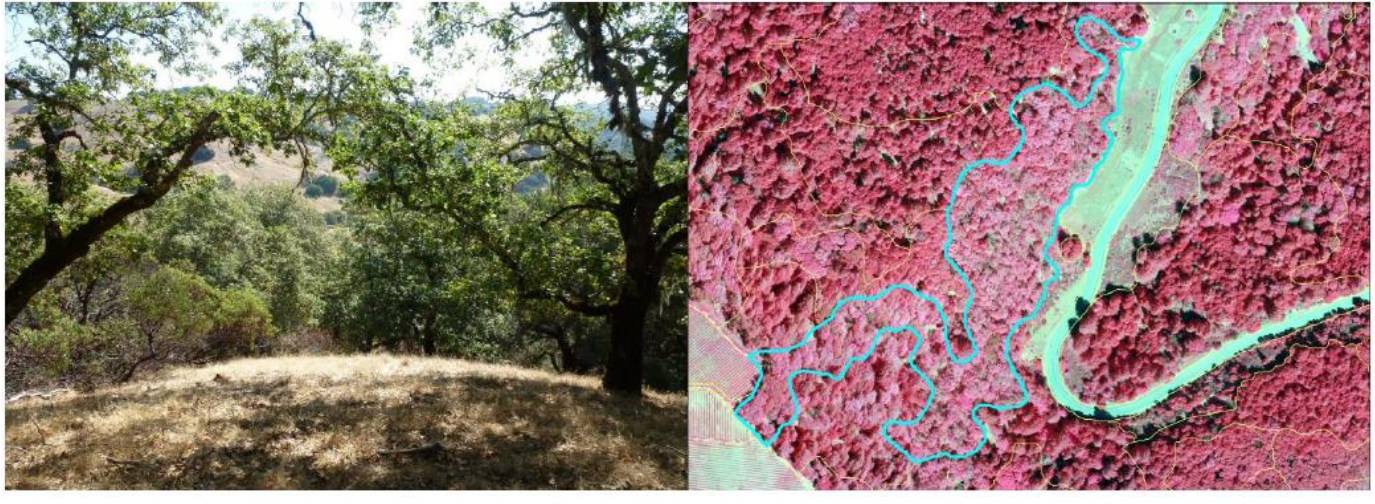


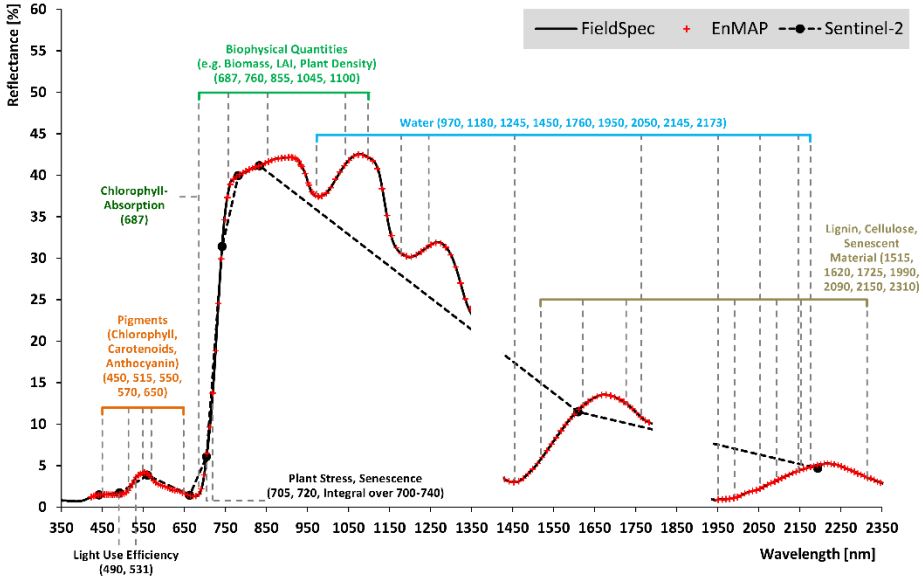
Ground view (left) and false color aerial composite (right) of a California Black Oak Alliance

Remote sensing for forest type mapping

- Optical remote sensing is well suited for forest type mapping
- Imaging Spectroscopy (IS) in particular of use for mapping biophysical & chemical traits relating to different species.
  - Often spatially and temporally limited
- Multispectral provides dense temporal time series which can incorporate phenological information relating to different species
  - Limitation in distinguishing spectrally similar species with similar phenologies or species with small phenological cycles

DESIS

- DESIS data is interesting for forest applications
- The missing SWIR, which contains absorption features relevant to vegetation, can be necessary for differentiation
- Multi-season mapping possible – though not dense time series



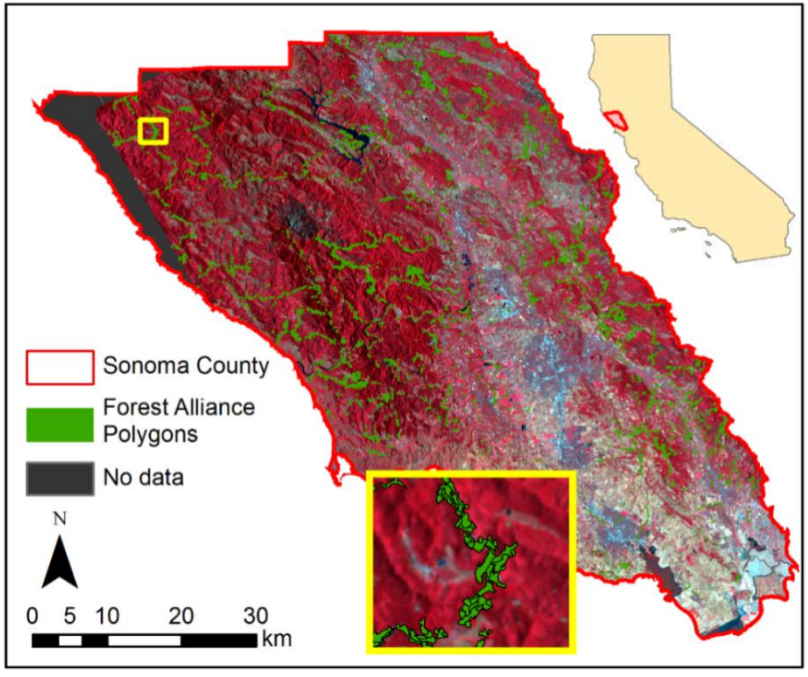
Various absorption features in a vegetation spectrum. Figure courtesy of Tobias Hank.

Research Objectives

- Explore the utility of multi-season DESIS-like imagery for mapping forest alliances.
- Explore to what extent the missing SWIR information impacts forest alliance mapping accuracies.
- Explore the benefits of combining DESIS imagery with Landsat time-series for forest alliance mapping.

Study site & materials

- AVIRIS data from spring, summer and fall 2013 was simulated to EnMAP (195 bands; 420-2450 nm), further reduced to DESIS spectral range (93 bands; 420-1000 nm)
- Landsat 7/8 16-day time series (6 spectral bands) using all available data for 2013.
- Forest alliance polygons obtained from the Sonoma County Vegetation Mapping Program



False color composite of EnMAP imagery for Sonoma County, CA and field-referenced forest alliance polygons.

Methods

- Reference polygons divided 50/50 into training and validation, excluding small polygons (<1000m^2) and those with fires between 2000-2016.
- 100 random pixel spectra drawn per class for training, 400 per class for validation with at least 100m between training and validation pixels.
- Gaussian Process Classification for alliance mapping.

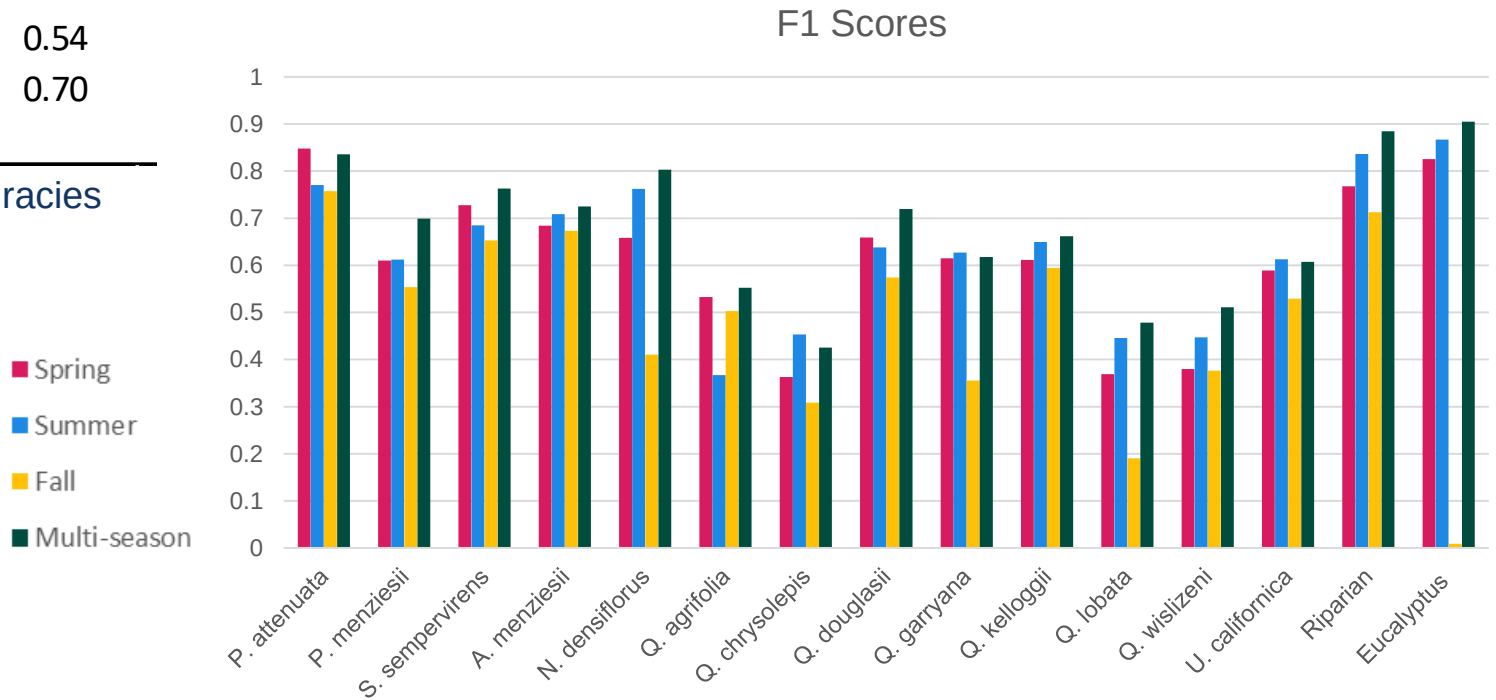
Alliance Name	Common Name	n-pixels	n-polygons
Pinus attenuata	Knobcone pine	1143	48
Pseudotsuga menziesii	Douglas fir	17054	1151
Sequoia sempervirens	Coast redwood	18071	1108
Arbutus menziesii	Madrone	3565	220
Notholithocarpus densiflorus	Tanoak	1989	121
Umbellularia californica	California bay laurel	6406	457
Quercus agrifolia	Coast live oak	6601	460
Quercus chrysolepis	Canyon oak	408	27
Quercus wislizeni	Interior live oak	1139	52
Quercus douglasii	Blue oak	2409	120
Quercus garryana	Oregon white oak	11053	445
Quercus kelloggii	Black oak	1505	104
Quercus lobata	Valley oak	2525	216
Eucalyptus	Eucalyptus	780	58
Riparian	Riparian	1254	288

Forest alliances considered in this study

Utility of multi-season DESIS-like data

	DESIS
Spring	0.64
Summer	0.65
Fall	0.54
Multi-season	0.70

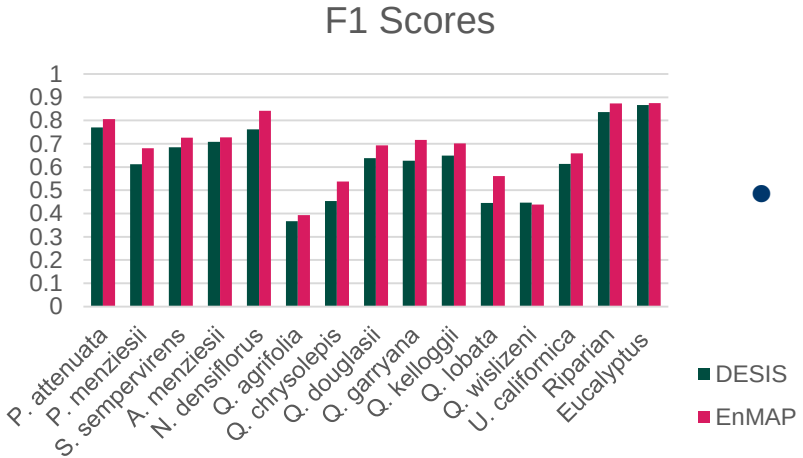
Overall Accuracies



Comparing DESIS (VNIR) and EnMAP (VNIR+SWIR)

	DESIS	EnMAP
Spring	0.64	0.68
Summer	0.65	0.70
Fall	0.54	0.58
Multi-season	0.70	0.71

Overall Accuracies

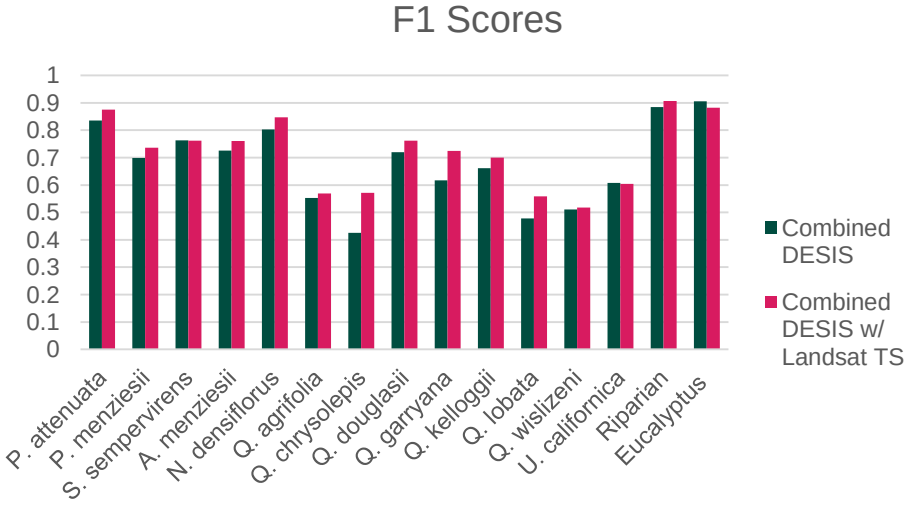


- EnMAP outperforms DESIS for single season models, however the improvement is less pronounced with multi-season
- Class-wise, EnMAP generally had higher accuracies, with greatest improvements amongst different oak alliances
- Little improvement with Eucalyptus, some decline with Q. wislizeni

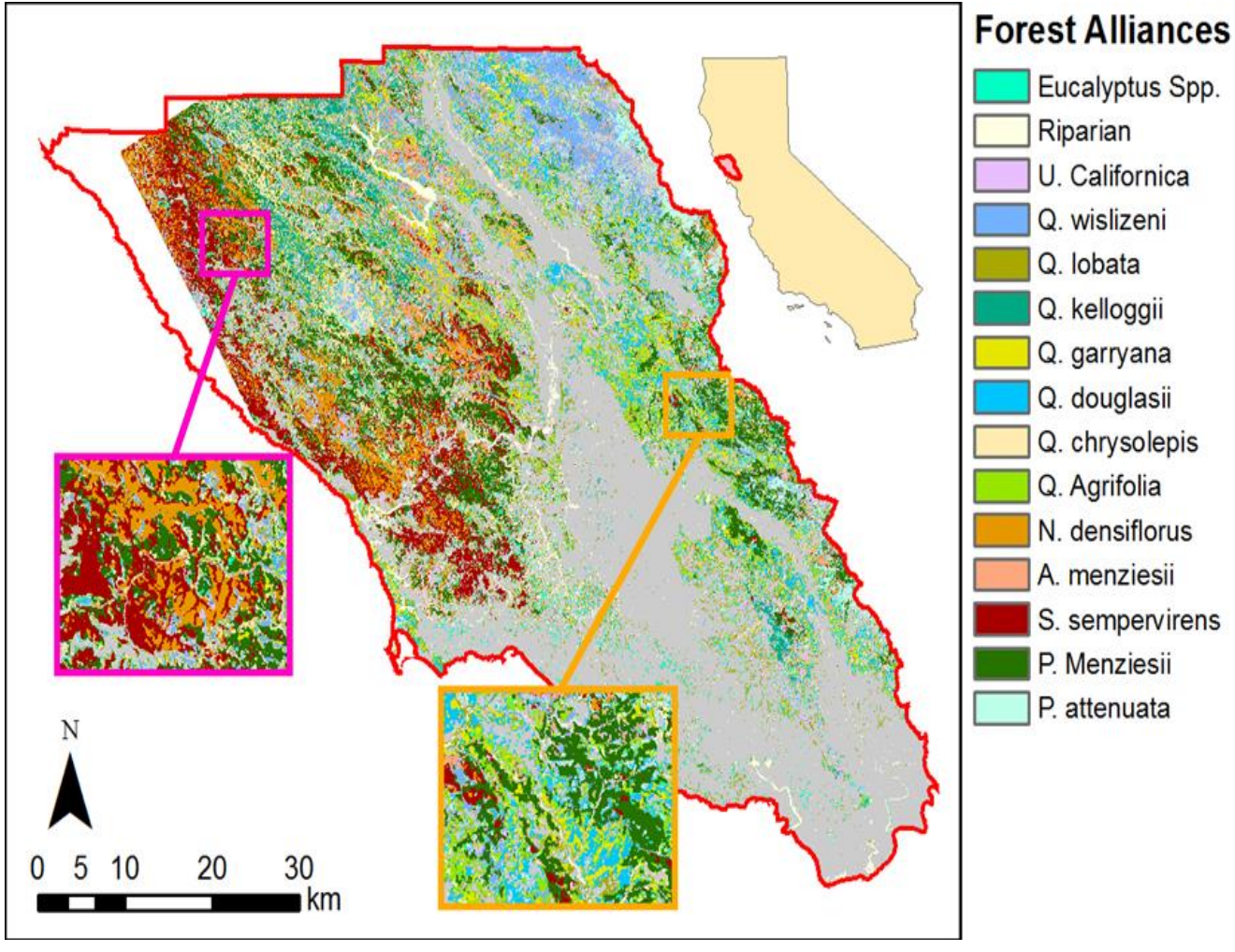
Combining DESIS with Landsat time series

	DESIS	Landsat	DESIS - Landsat
Spring	0.64	0.43	0.73
Summer	0.65	0.50	0.72
Fall	0.54	0.33	0.71
Multi-season	0.70	0.50	0.57
Time Series	-	0.56	-

Overall Accuracies



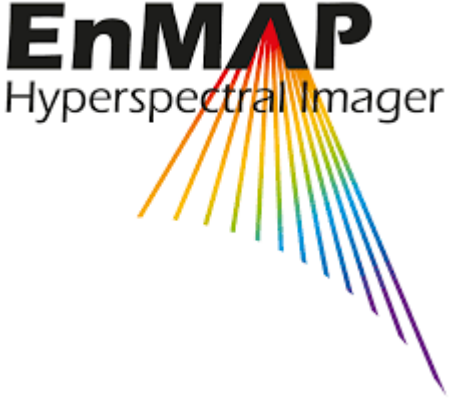
- IS generally outperforms Landsat-based mapping
- Adding Landsat Time Series data improves single season models, but again less improvement is seen when using multi-seasonal DESIS
- Class-wise, greatest improvements were seen in deciduous oak alliances


Forest Alliances
Eucalyptus Spp.
Riparian
U. Californica
Q. wislizeni
Q. lobata
Q. kelloggii
Q. garryana
Q. douglasii
Q. chrysolepis
Q. Agrifolia
N. densiflorus
A. menziesii
S. sempervirens
P. Menziesii
P. attenuata
N
0 5 10 20 30
km

Conclusions

- While this study is based on simulated EnMAP data, it demonstrates the utility of DESIS-like imagery for mapping forest alliances.
- Multi-season IS data acquired across different phenological phases was found to be beneficial
- The SWIR is an important component for forest alliance mapping and a general drawback of DESIS imagery
- Improvements through combining VNIR DESIS with multispectral time-series indicates potential to compensate for missing SWIR information

Thank you!


EnMAP
Hyperspectral Imager


DLR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