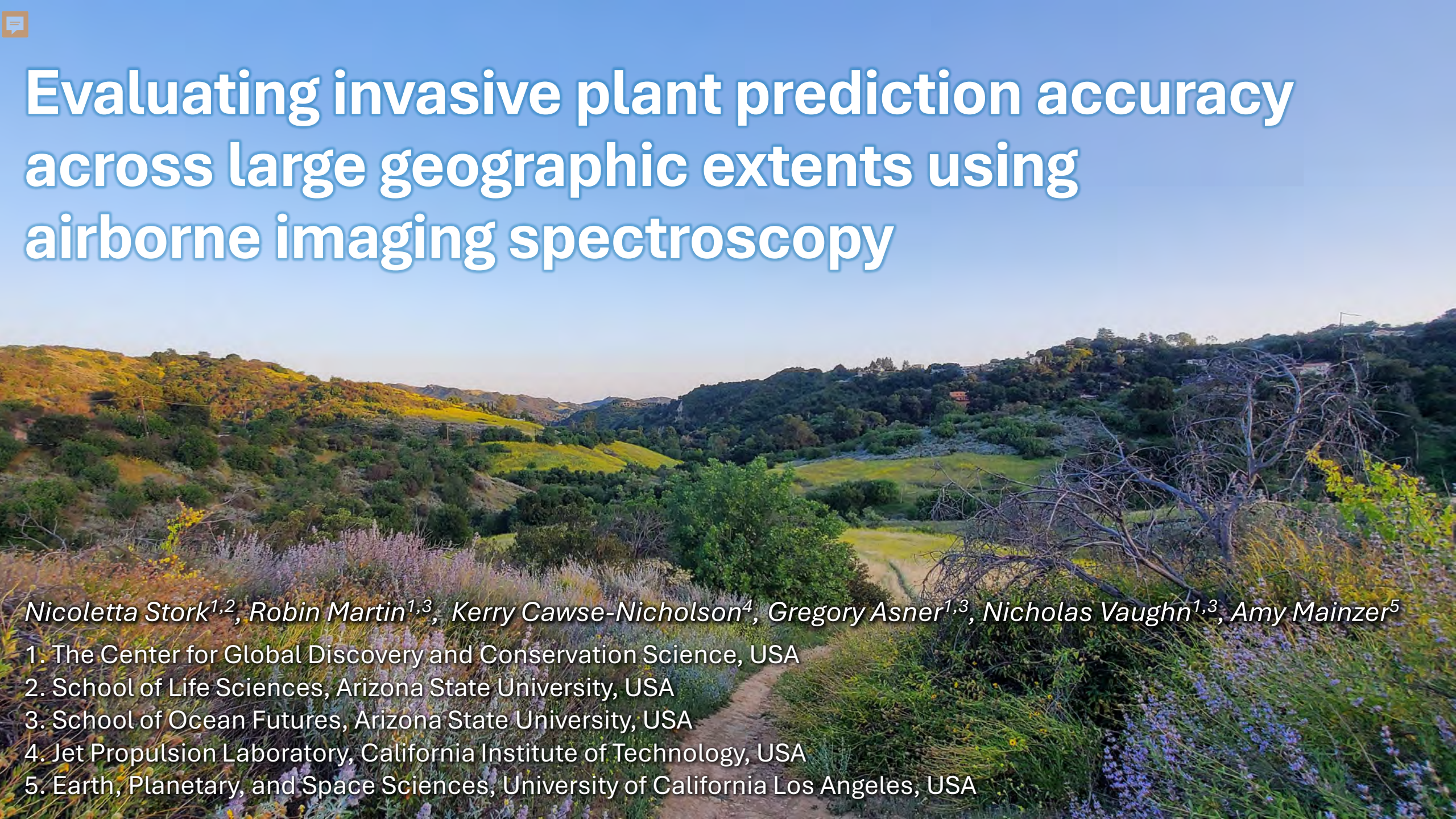
Evaluating invasive plant prediction accuracy across large geographic extents using airborne imaging spectroscopy



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1. The Center for Global Discovery and Conservation Science, USA
2. School of Life Sciences, Arizona State University, USA
3. School of Ocean Futures, Arizona State University, USA
4. Jet Propulsion Laboratory, California Institute of Technology, USA
5. Earth, Planetary, and Space Sciences, University of California Los Angeles, USA

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Project objectives

Examine the intra- and interspecific spectral variation of native and invasive plants across ecoregions in Southern California

Generate a species distribution map of native and invasive plants

Examine the environmental factors that influence prediction performance

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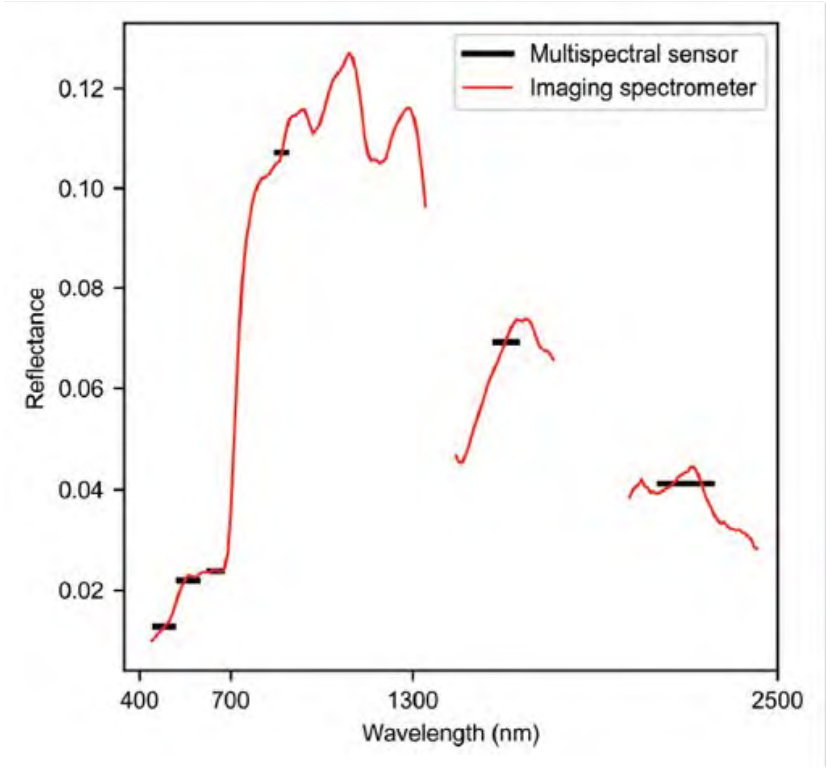
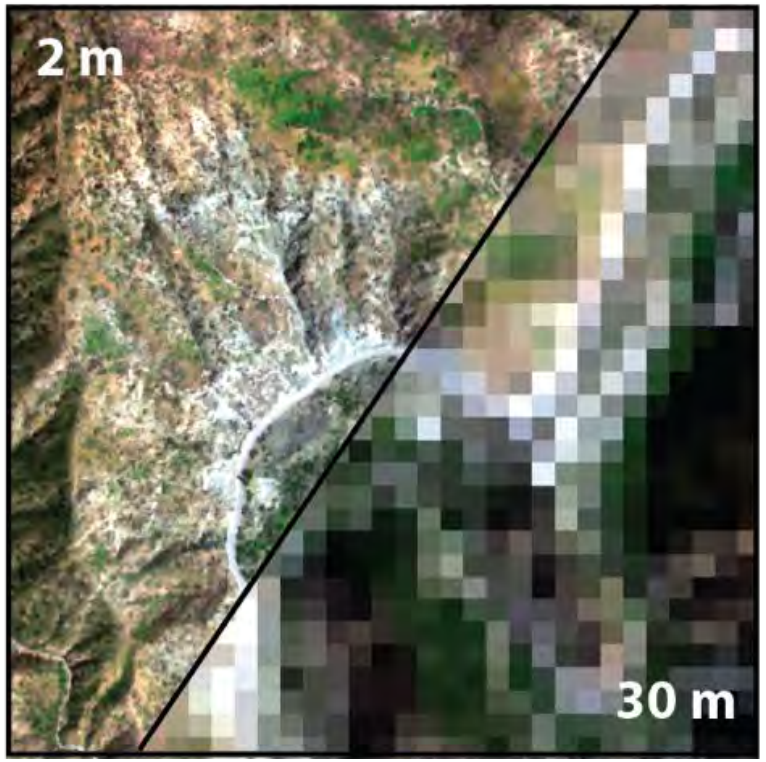
Background: Remote sensing

Spectral resolution



How finely a sensor divides the electromagnetic spectrum

Spatial resolution



Total area a single pixel represents

Temporal resolution

Frequency of data acquisition over the same region

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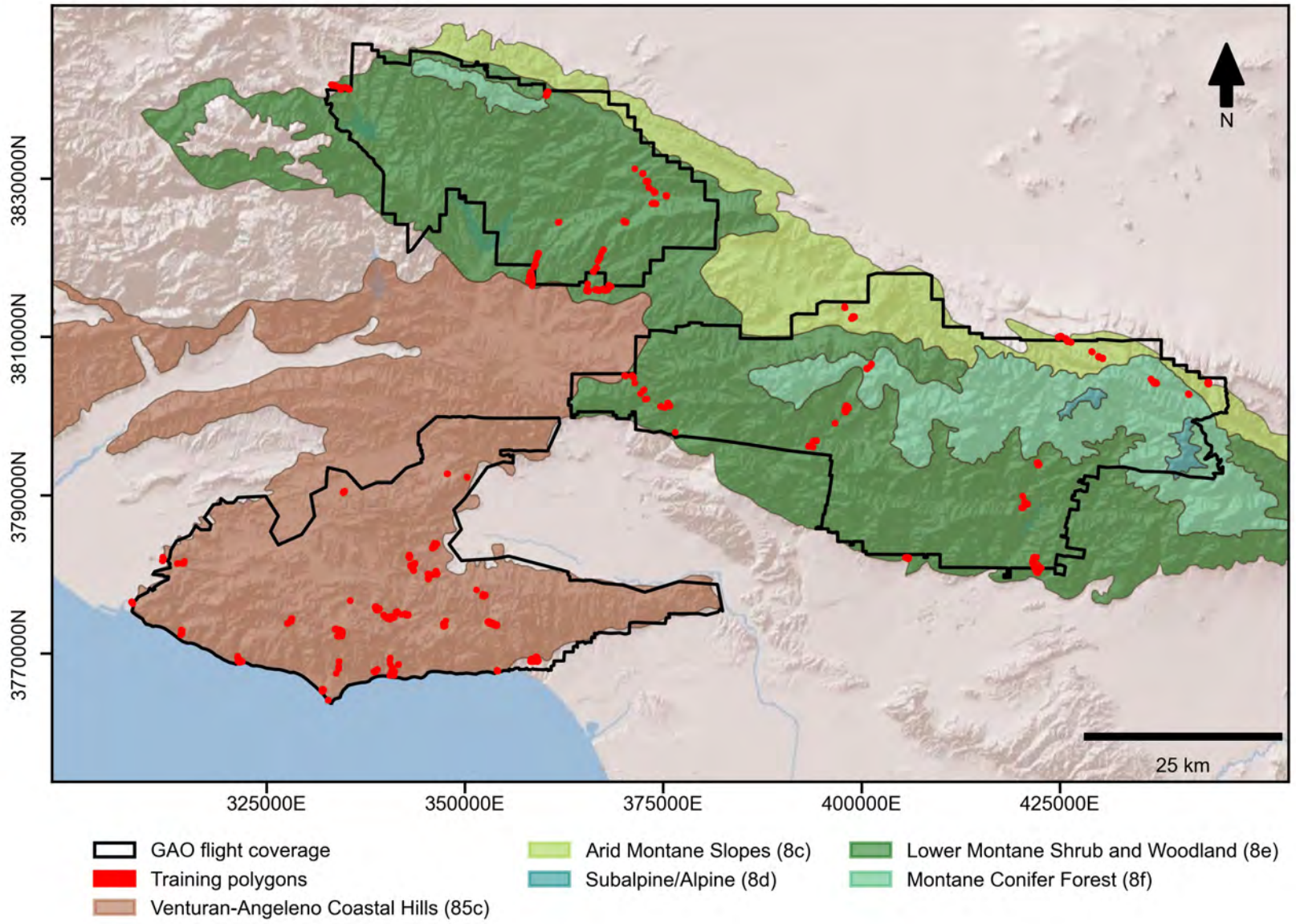
Data

Global airborne observatory

- Spectral range: 400-2500 nm
- Channel width: 10 nm
- Spatial resolution: 2 m
- LiDAR: 4 points/meter

Flights took place in April 2021

- Santa Monica Mountains & Angeles National Forest



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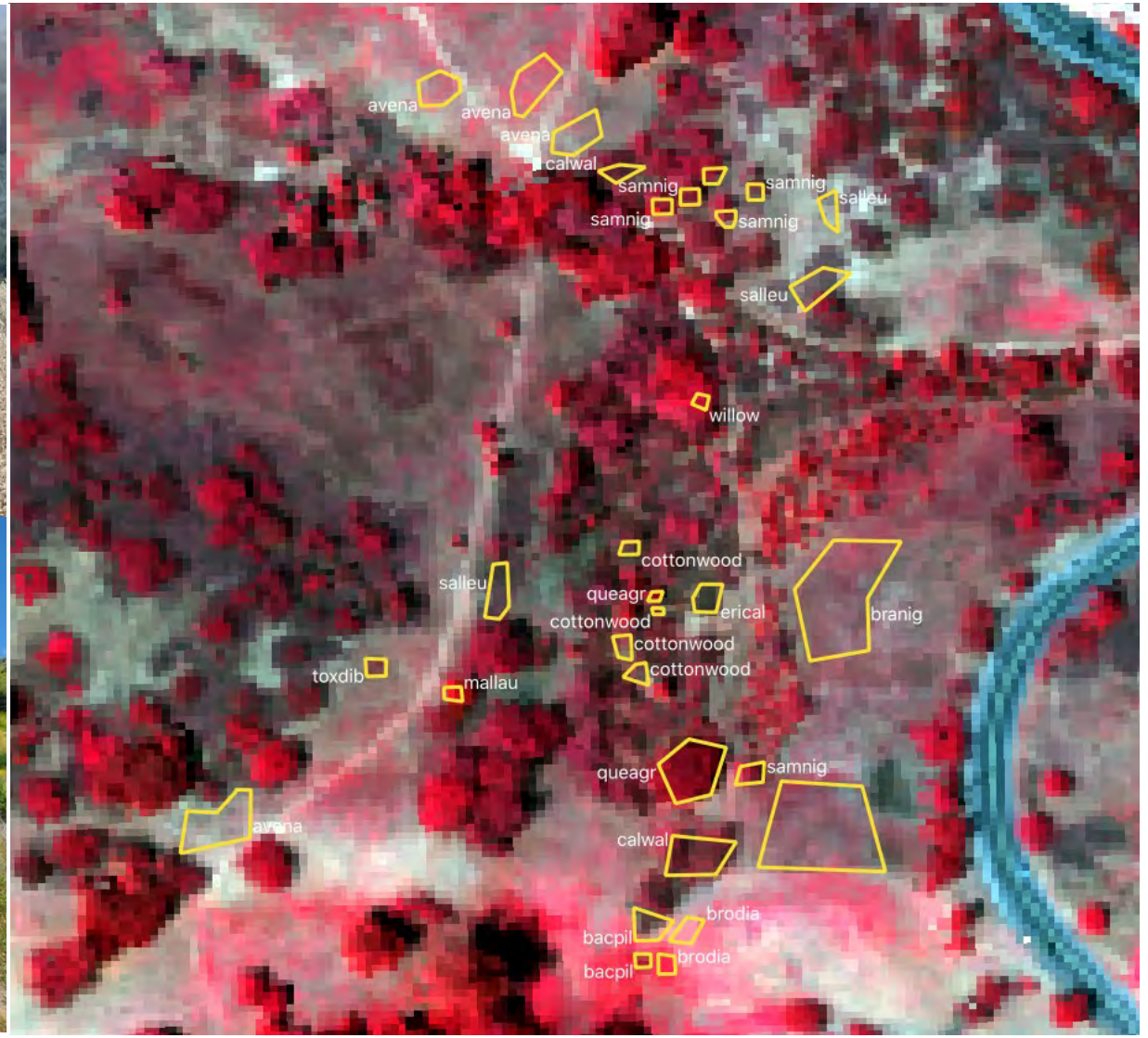
Field data collection



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Field data collection

Collected spectral data for ~90 species-level and ~10 genus-level classes

Data reduction:

- <20 crowns set to “others”
- Aggregated some classes to genus-level
- Removed native classes with low performance

In total: 13 native, 13 invasive, 1 “others” class

Class Name	Class Code	Group	Polygons	Pixels	Pixel/Crown Ratio
Brassica nigra	BRANIG	Invasive Forb	560	3436	6.14
Hirschfeldia incana	HIRINC	Invasive Forb	289	1836	6.35
Sisymbrium altissimum	SISALT	Invasive Forb	237	1136	4.79
Centaurea solstitialis	CENSOL	Invasive Forb	112	552	4.93
Annual grass	ANNGRA	Invasive Grass	982	6089	6.2
Arundo donax	ARUDON	Invasive Grass	41	1012	24.68
Cynodon dactylon	CYNDAC	Invasive Grass	40	1138	28.45
Spartium junceum	SPAJUN	Invasive Shrub	60	693	11.55
Tamarix ramosissima	TAMRAM	Invasive Shrub	24	293	12.21
Nicotiana glauca	NICGLA	Invasive Shrub	22	144	6.55
Eucalyptus spp.	EUCSPP	Invasive Tree	39	1353	34.69
Robinia pseudoacacia	ROBPSE	Invasive Tree	25	249	9.96
Ailanthus altissima	AILALT	Invasive Tree	24	509	21.21
Juglans californica	JUGCAL	Native Shrub	101	2678	26.51
Malosma laurina	MALLAU	Native Shrub	99	1206	12.18
Quercus spp.	QUESPP	Native Shrub	92	1198	13.02
Adenostoma fasciculatum	ADEFAS	Native Shrub	73	4958	67.92
Heteromeles arbutifolia	HETARB	Native Shrub	72	668	9.28
Eriogonum fasciculatum	ERIFAS	Native Shrub	43	4530	105.35
Eriodictyon crassifolium	ERICRA	Native Shrub	20	156	7.8
Pinus spp.	PINSPP	Native Tree	105	2385	22.71
Quercus agrifolia	QUEAGR	Native Tree	73	3710	50.82
Platanus racemosa	PLARAC	Native Tree	59	1523	25.81
Populus spp.	POPSPP	Native Tree	37	663	17.92
Quercus chrysolepis	QUECHR	Native Tree	30	2089	69.63
Quercus lobata	QUELOB	Native Tree	20	484	24.2
Others	OTHERS		396	8535	21.55

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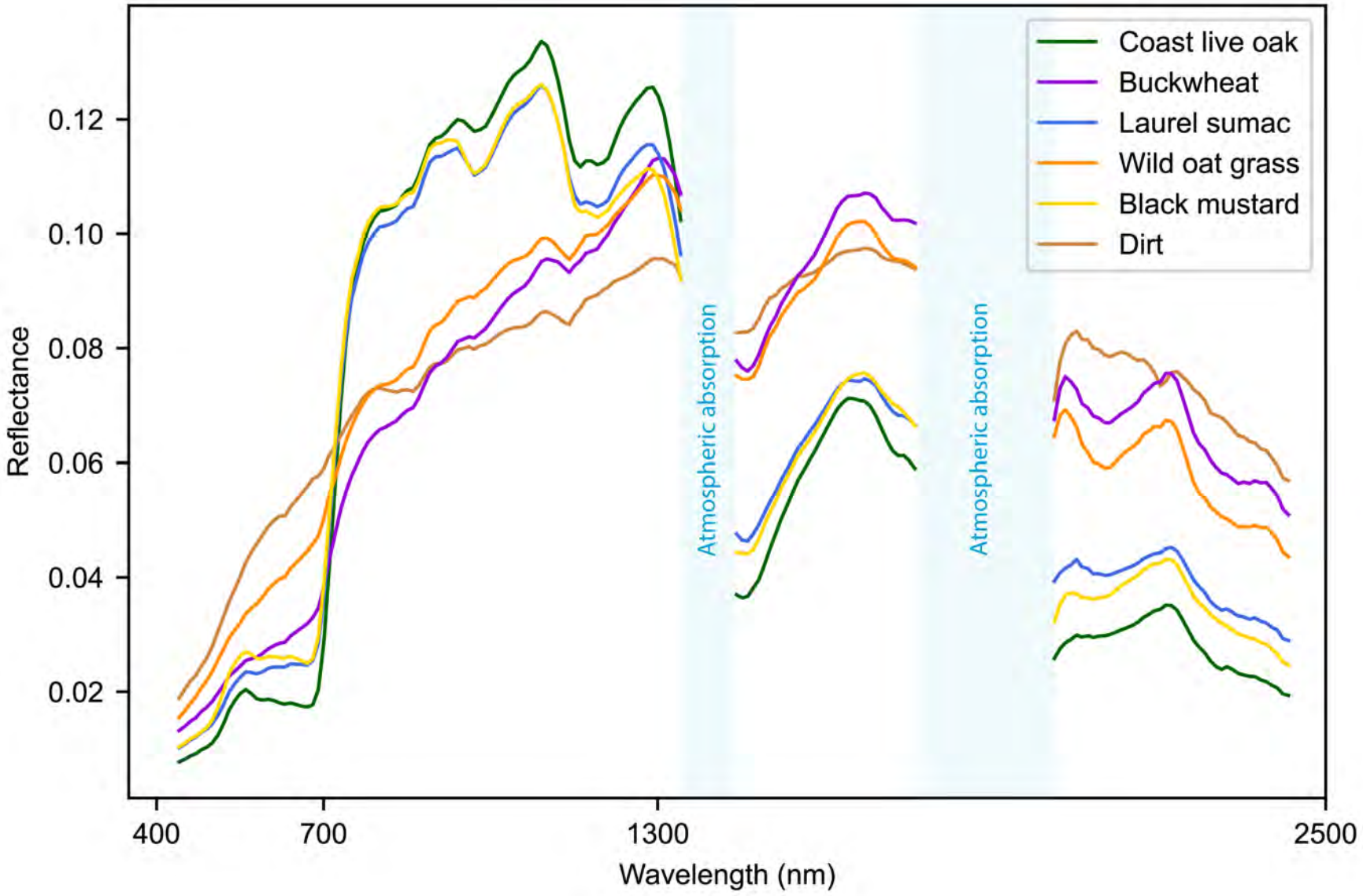
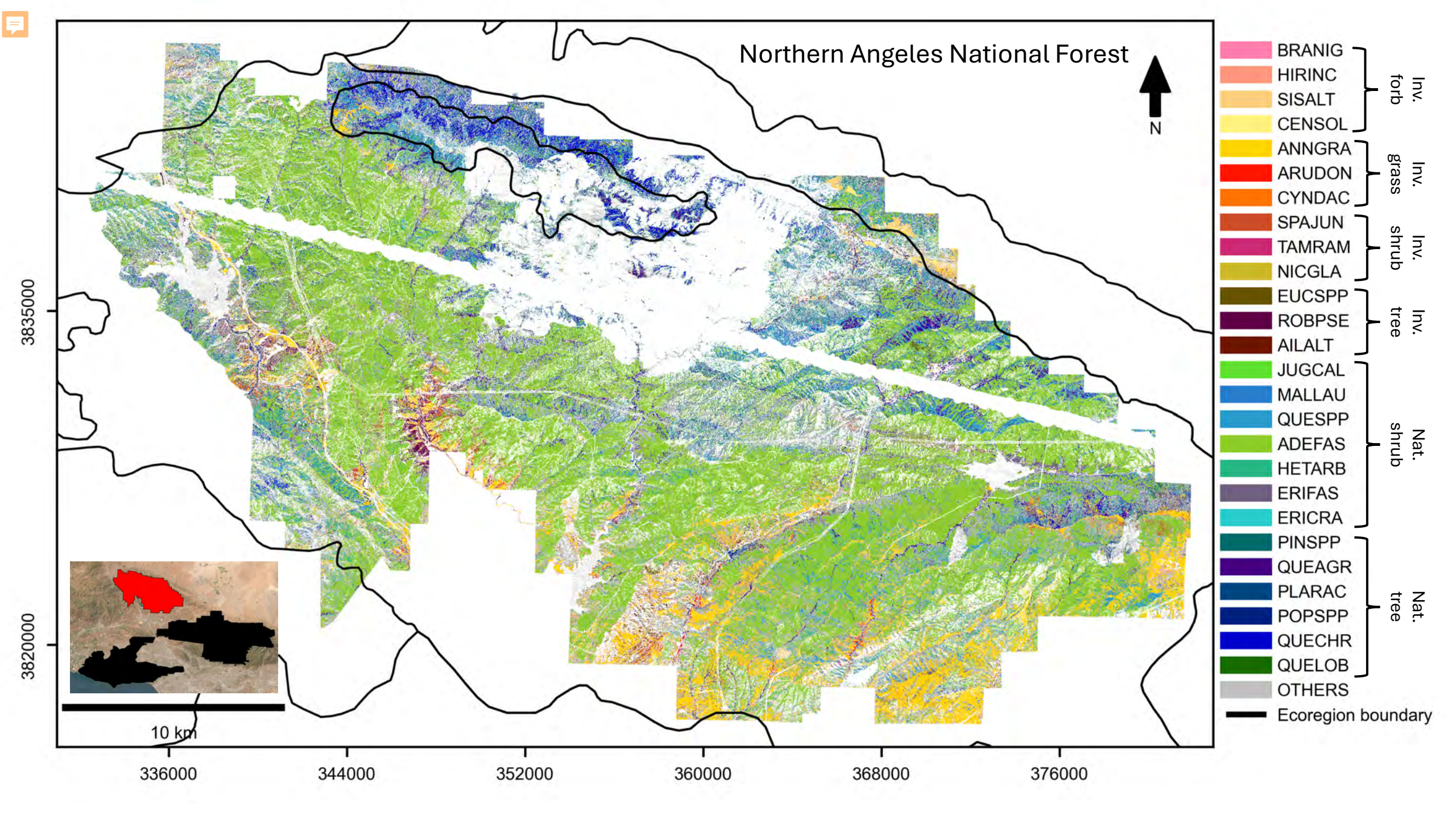
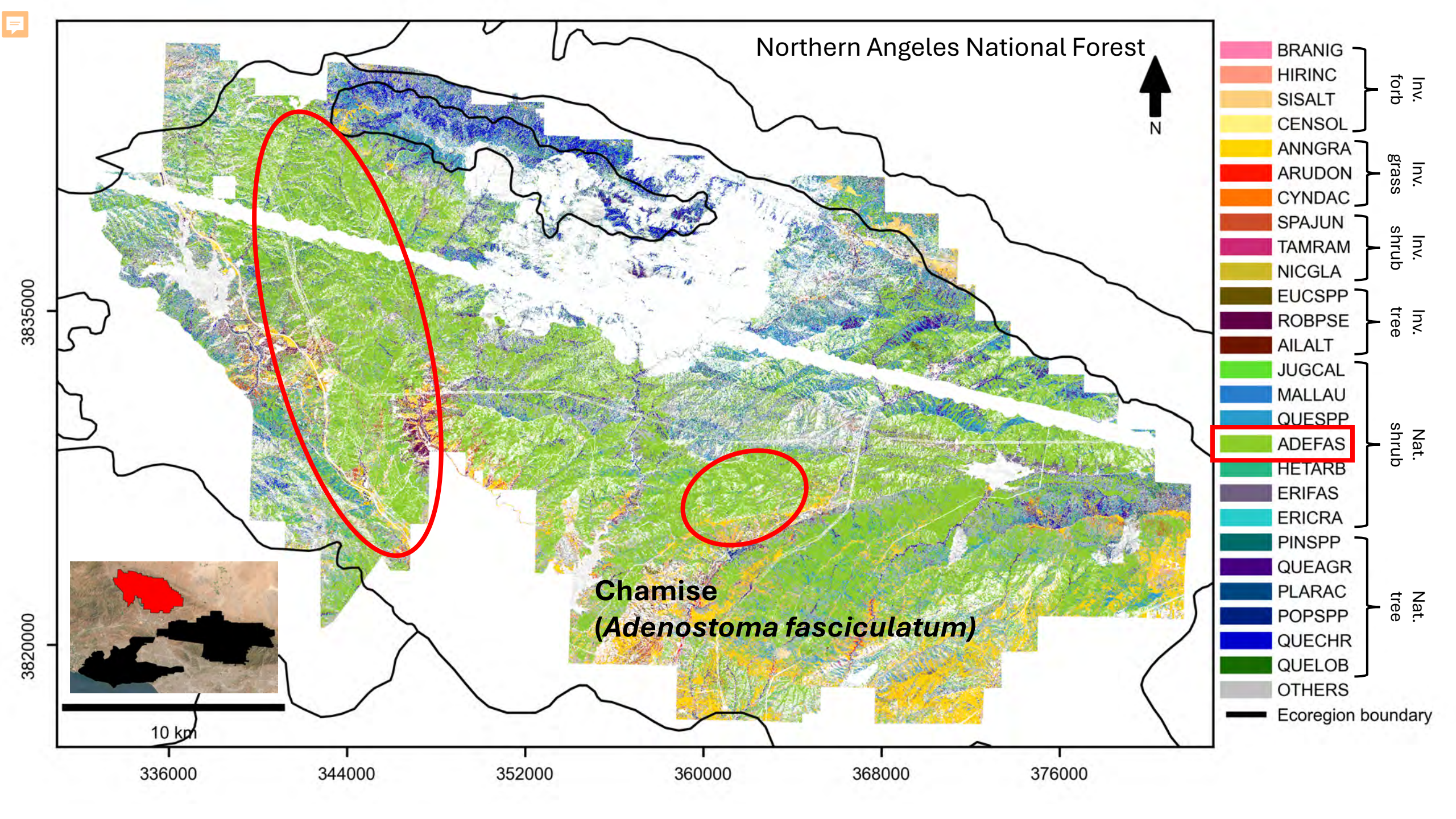
Background: Imaging spectroscopy

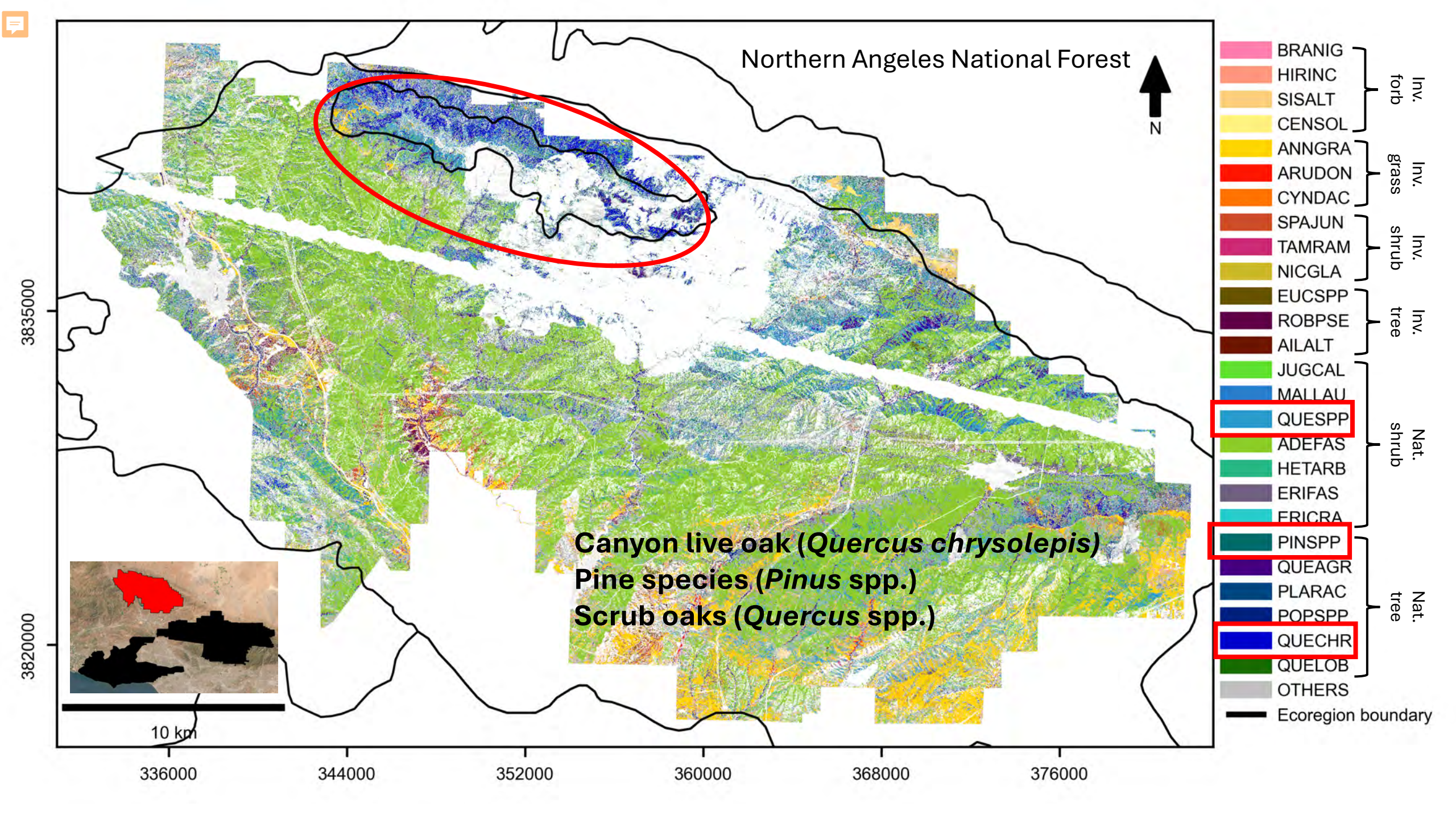


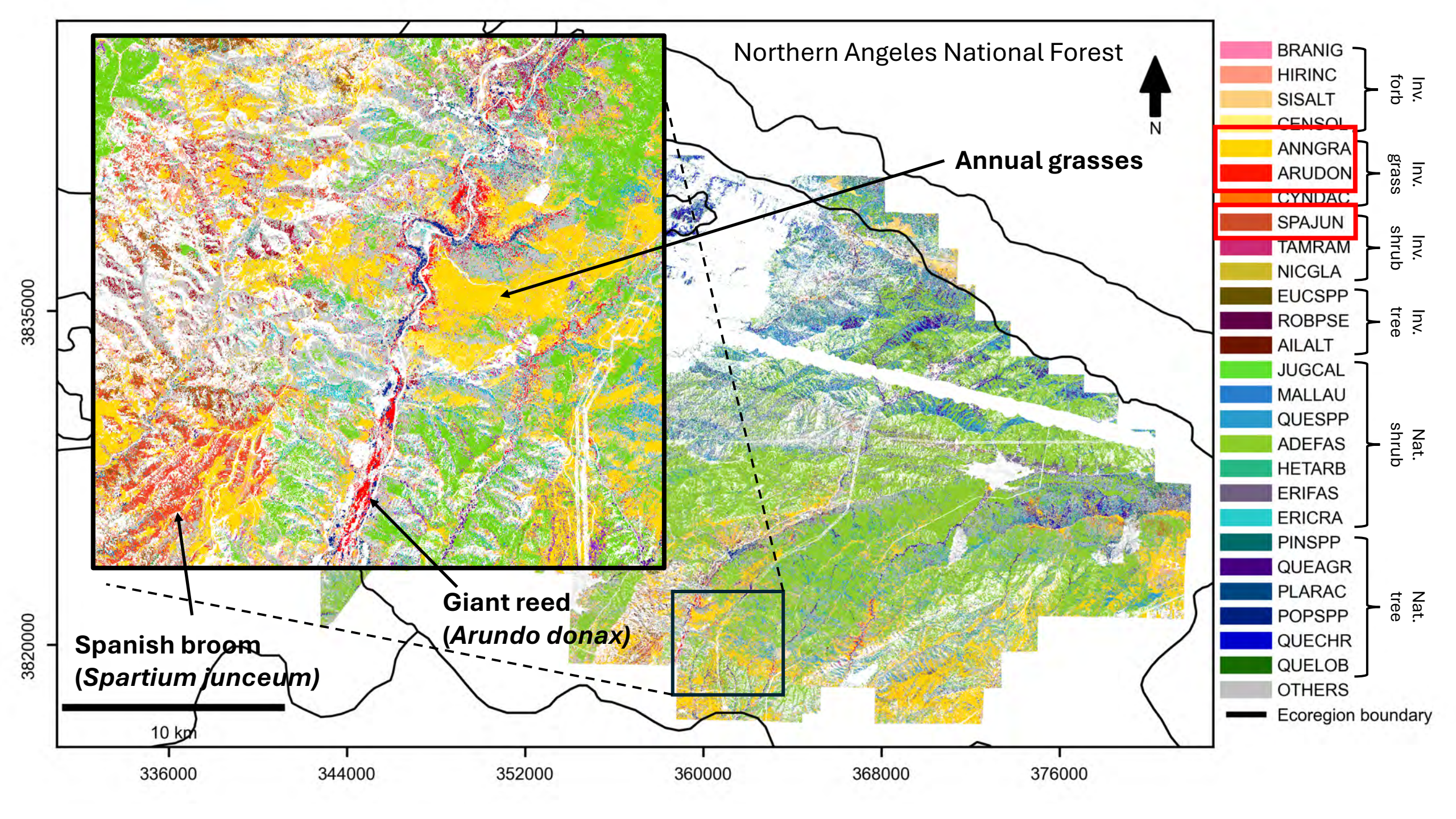
Imaging spectroscopy

- Species level detection
- Biogeochemical concentrations
- Canopy architecture

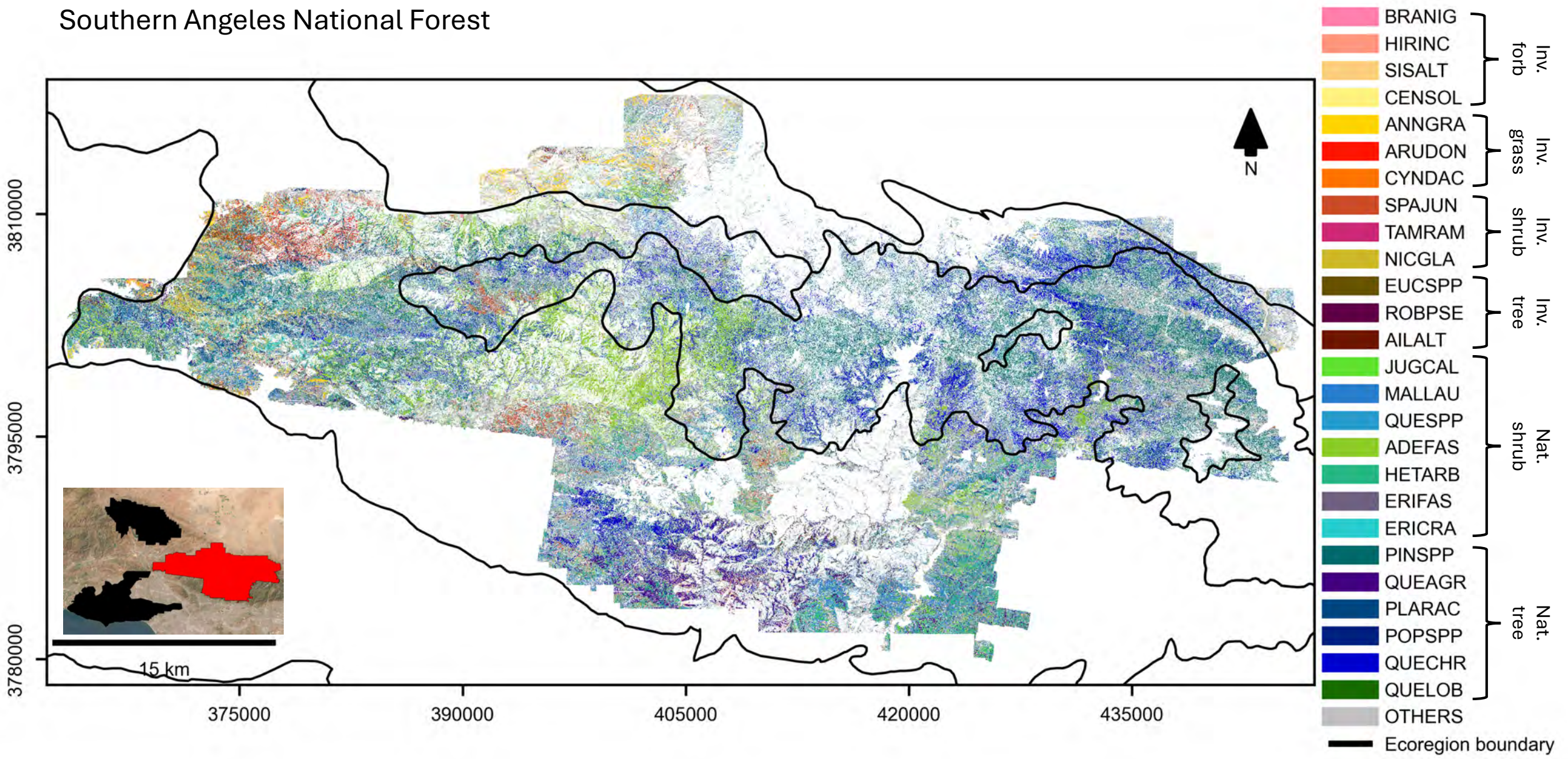

Northern Angeles National Forest
N
BRANIG
HIRINC
SISALT
CENSOL
Inv. forb
ANNGRA
ARUDON
CYNDAC
Inv. grass
SPAJUN
TAMRAM
NICGLA
Inv. shrub
EUCSPP
ROBPSE
AILALT
Inv. tree
JUGCAL
MALLAU
QUESPP
ADEFAS
HETARB
ERIFAS
ERICRA
Nat. shrub
PINSPP
QUEAGR
PLARAC
POPSPP
QUECHR
QUELOB
Nat. tree
OTHERS
Ecoregion boundary
3835000
3820000
336000
344000
352000
360000
368000
376000
10 km


Northern Angeles National Forest
N
BRANIG
HIRINC
SISALT
CENSOL
Inv. forb
ANNGRA
ARUDON
CYNDAC
Inv. grass
SPAJUN
TAMRAM
NICGLA
Inv. shrub
EUCSPP
ROBPSE
AILALT
Inv. tree
JUGCAL
MALLAU
QUESPP
ADEFAS
HETARB
ERIFAS
ERICRA
Nat. shrub
PINSPP
QUEAGR
PLARAC
POPSPP
QUECHR
QUELOB
Nat. tree
OTHERS
Ecoregion boundary
Chamise
(Adenostoma fasciculatum)
10 km
3835000
3820000
336000
344000
352000
360000
368000
376000

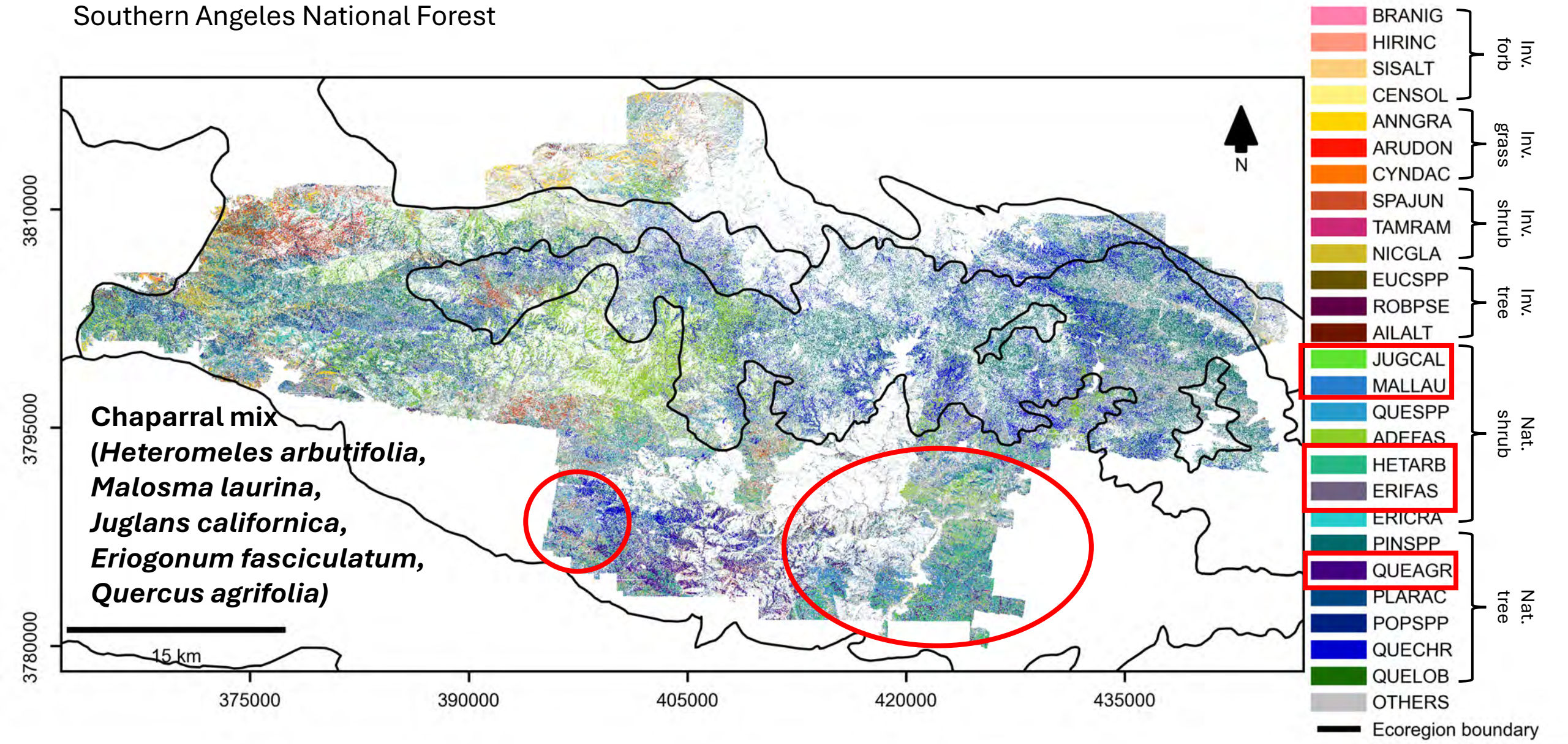

Northern Angeles National Forest
N
Canyon live oak (*Quercus chrysolepis*)
Pine species (*Pinus* spp.)
Scrub oaks (*Quercus* spp.)
10 km
3835000
3820000
336000
344000
352000
360000
368000
376000
BRANIG
HIRINC
SISALT
CENSOL
ANNGRA
ARUDON
CYNDAC
SPAJUN
TAMRAM
NICGLA
EUCSPP
ROBPSE
AILALT
JUGCAL
MALLAU
QUESPP
ADEFAS
HETARB
ERIFAS
ERICRA
PINSPP
QUEAGR
PLARAC
POPSPP
QUECHR
QUELOB
OTHERS
Ecoregion boundary
Inv. forb
Inv. grass
Inv. shrub
Inv. tree
Nat. shrub
Nat. tree


Northern Angeles National Forest
N
Annual grasses
Giant reed
(Arundo donax)
Spanish broom
(Spartium junceum)
10 km
3835000
3820000
336000
344000
352000
360000
368000
376000
BRANIG
HIRINC
SISALT
CENSOL
ANNGRA
ARUDON
CYNDAC
SPAJUN
TAMRAM
NICGLA
EUCSPP
ROBPSE
AILALT
JUGCAL
MALLAU
QUESPP
ADEFAS
HETARB
ERIFAS
ERICRA
PINSPP
QUEAGR
PLARAC
POPSPP
QUECHR
QUELOB
OTHERS
Ecoregion boundary
Inv. forb
Inv. grass
Inv. shrub
Inv. tree
Nat. shrub
Nat. tree

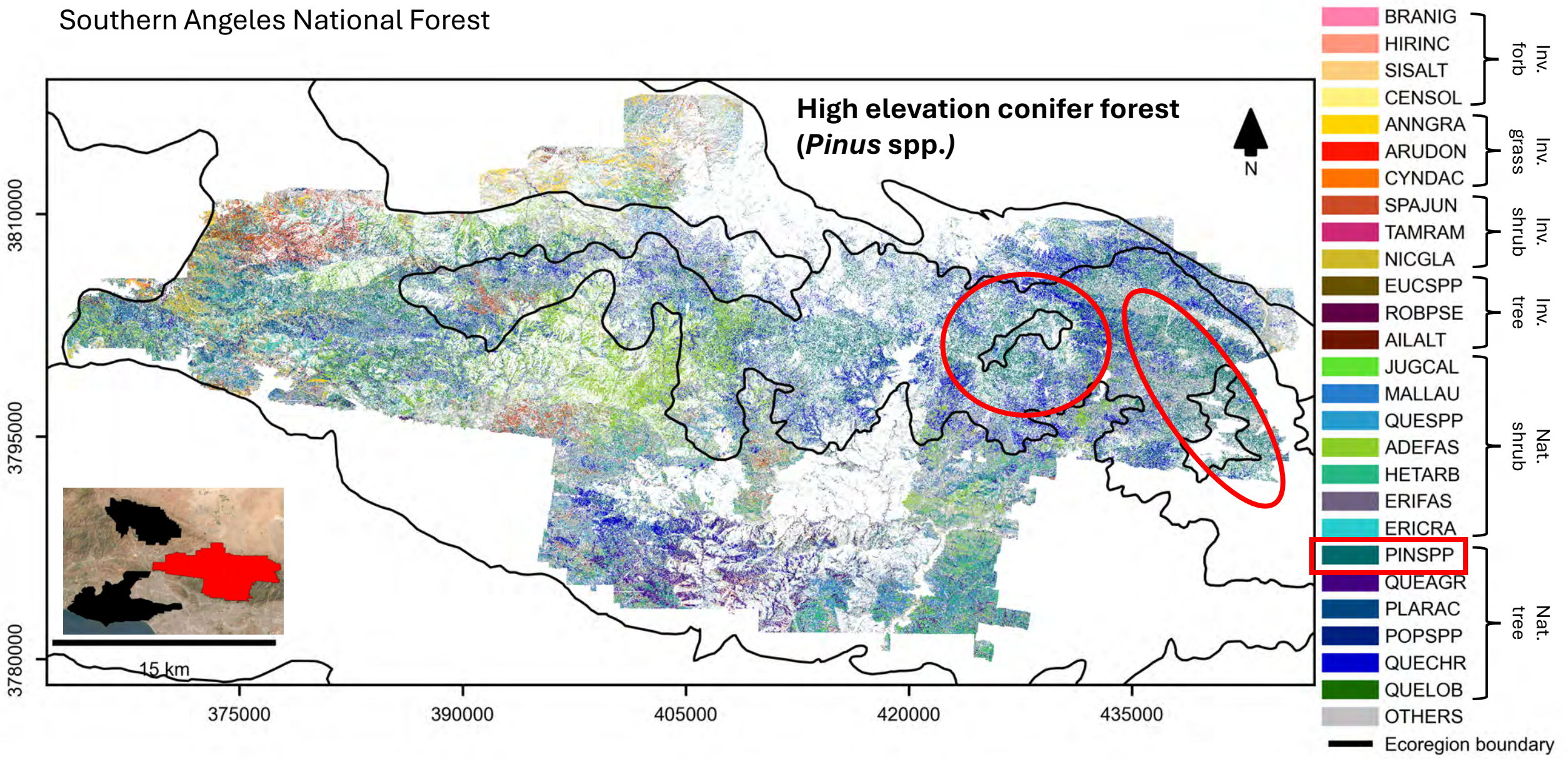
Southern Angeles National Forest

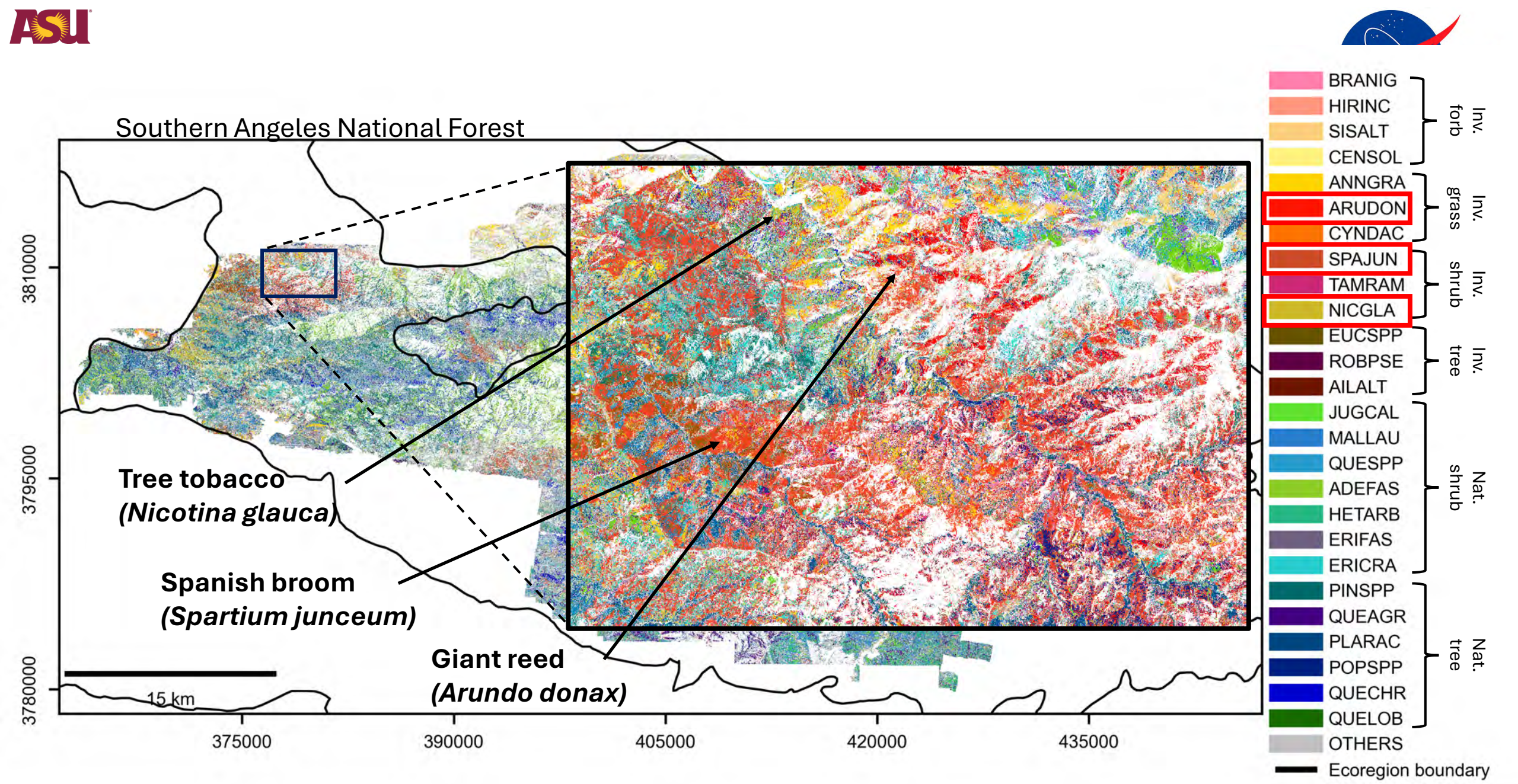


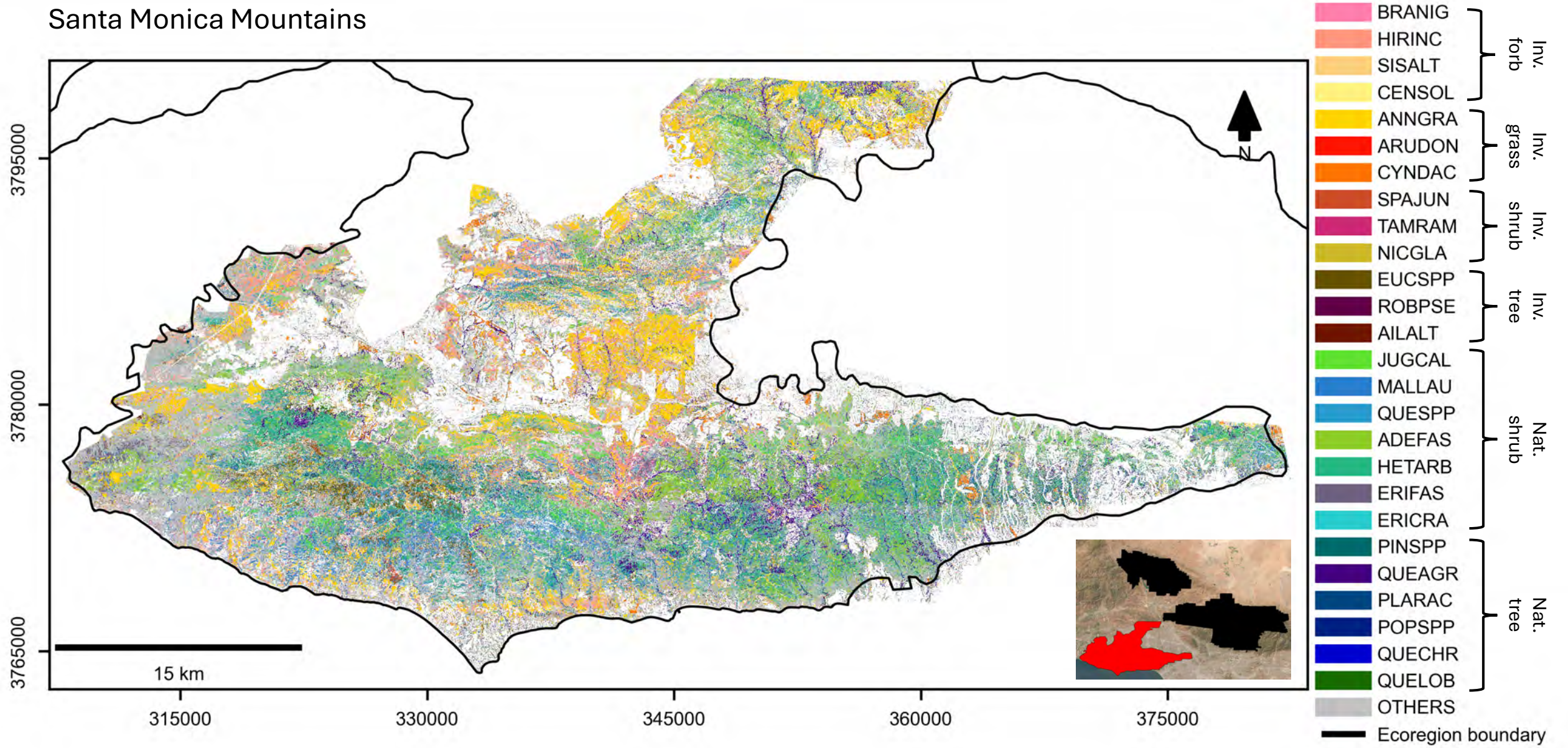
Southern Angeles National Forest



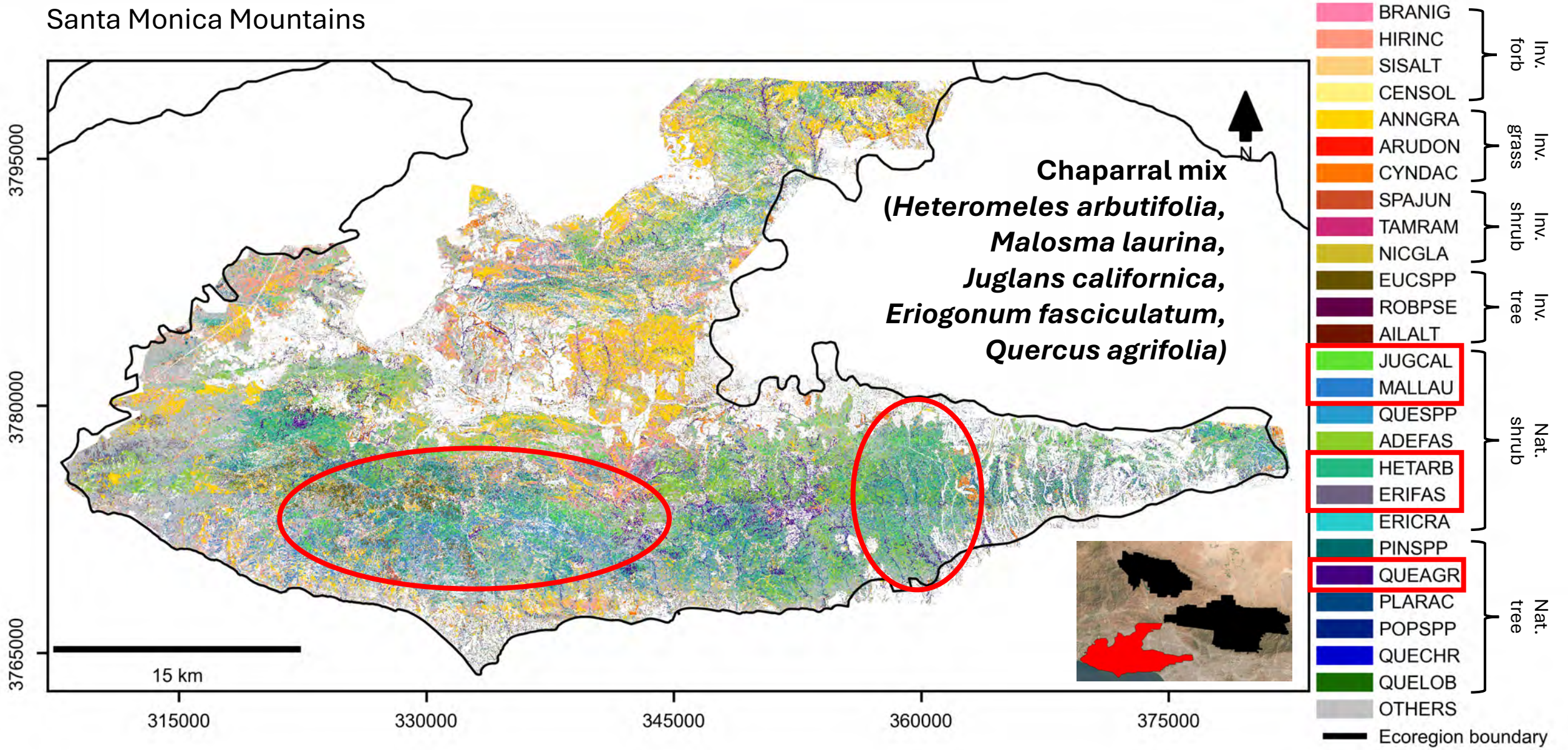
Southern Angeles National Forest



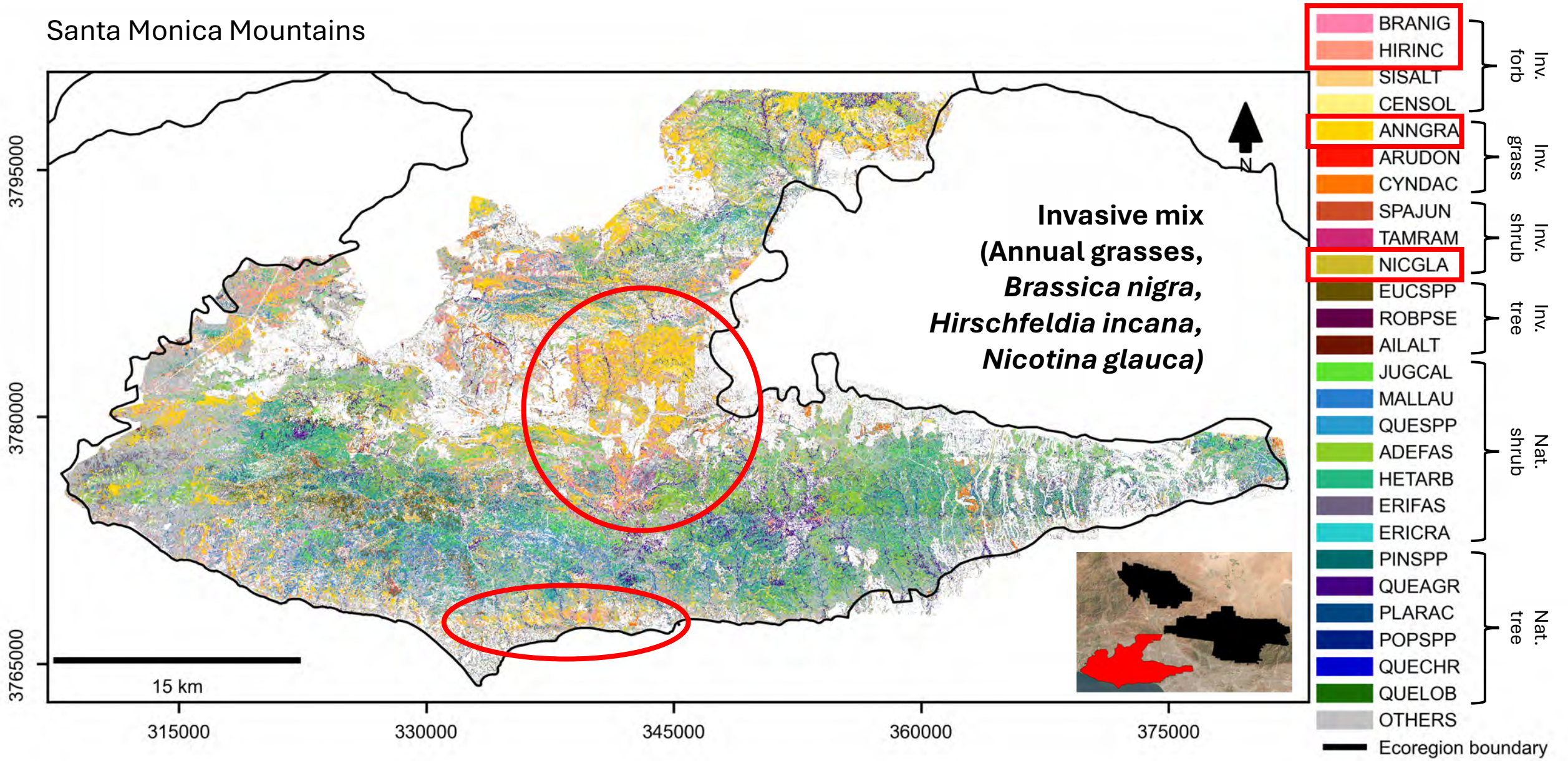

Southern Angeles National Forest
Tree tobacco
(Nicotina glauca)
Spanish broom
(Spartium junceum)
Giant reed
(Arundo donax)
15 km
3810000
3795000
3780000
375000
390000
405000
420000
435000
BRANIG
HIRINC
SISALT
CENSOL
ANNGRA
ARUDON
CYNDAC
SPAJUN
TAMRAM
NICGLA
EUCSPP
ROBPSE
AILALT
JUGCAL
MALLAU
QUESPP
ADEFAS
HETARB
ERIFAS
ERICRA
PINSPP
QUEAGR
PLARAC
POPSPP
QUECHR
QUELOB
OTHERS
Ecoregion boundary
Inv. forb
Inv. grass
Inv. shrub
Inv. tree
Nat. shrub
Nat. tree


Santa Monica Mountains
3795000
3780000
3765000
315000
330000
345000
360000
375000
15 km
N
BRANIG
HIRINC
SISALT
CENSOL
ANNGRA
ARUDON
CYNDAC
SPAJUN
TAMRAM
NICGLA
EUCSPP
ROBPSE
AILALT
JUGCAL
MALLAU
QUESPP
ADEFAS
HETARB
ERIFAS
ERICRA
PINSPP
QUEAGR
PLARAC
POPSPP
QUECHR
QUELOB
OTHERS
Ecoregion boundary
Inv. forb
Inv. grass
Inv. shrub
Inv. tree
Nat. shrub
Nat. tree

Santa Monica Mountains



Santa Monica Mountains



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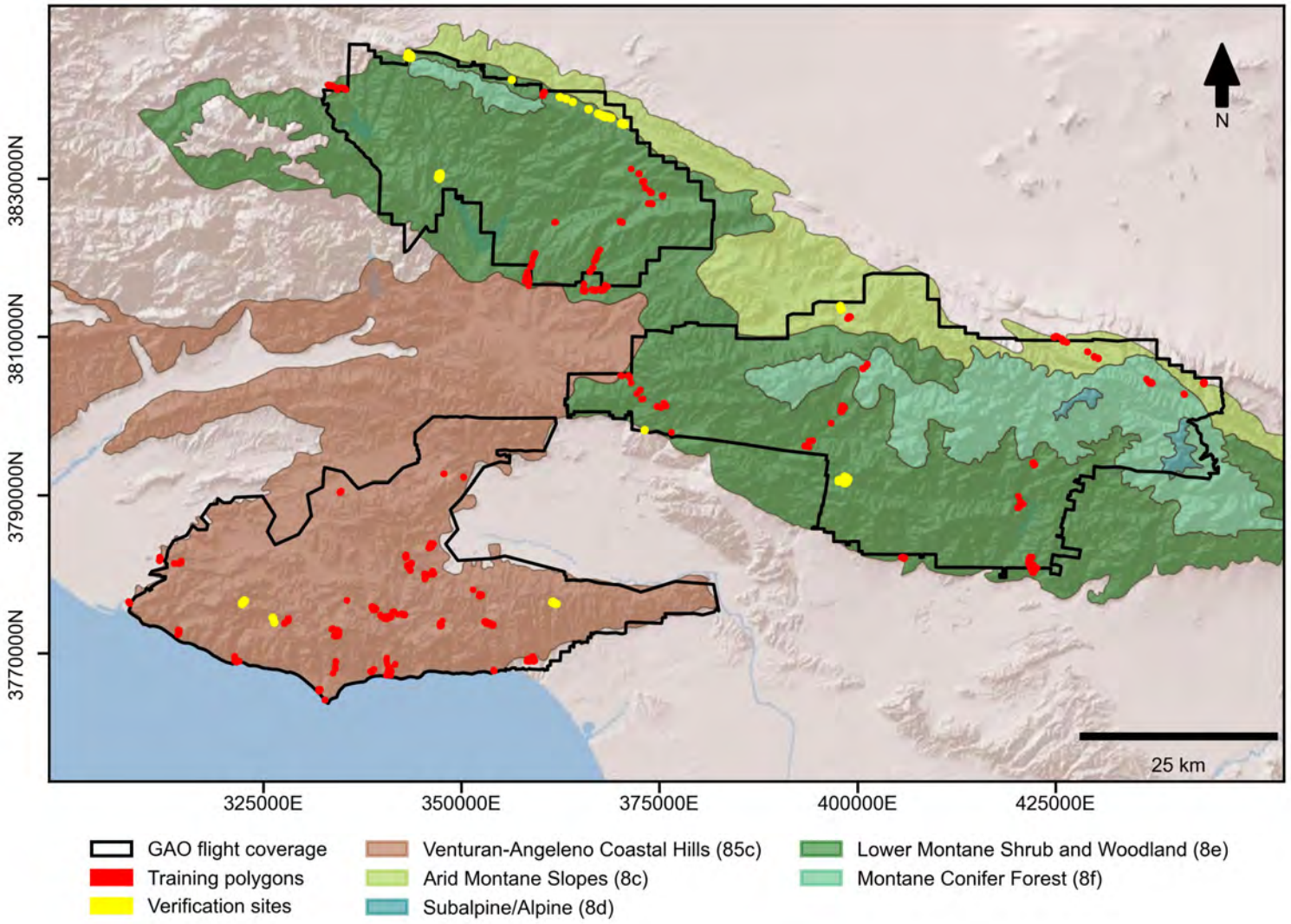
Verification



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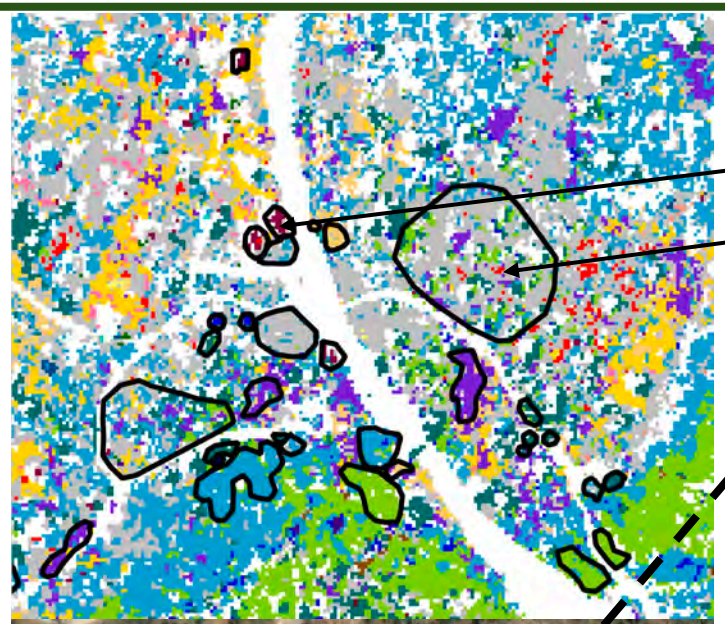
Verification



Predicted

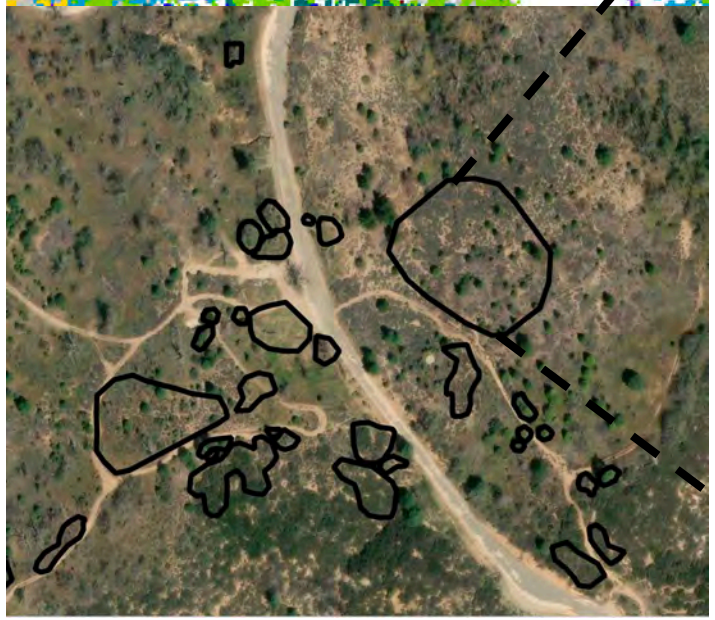
ROBPSE

ARUDON

Observed

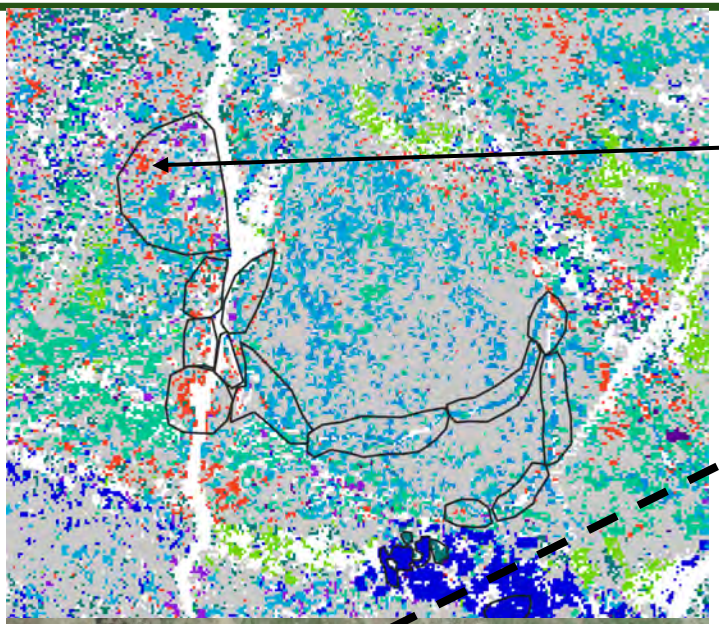
QUELOB

Mixed: OTHERS, PINSPP, ANNGRA, QUESPP, ERIFAS



Center for Global Discovery and Conservation Science

Verification

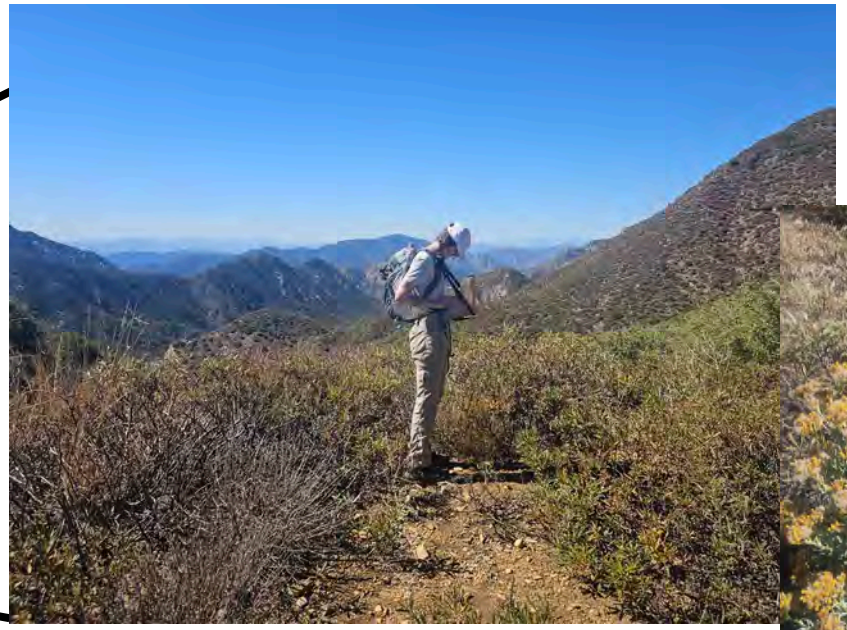


Predicted

SPAJUN

Observed

Mixed: OTHERS, QUESPP, ERIFAS



Spartium junceum

Ericameria spp.

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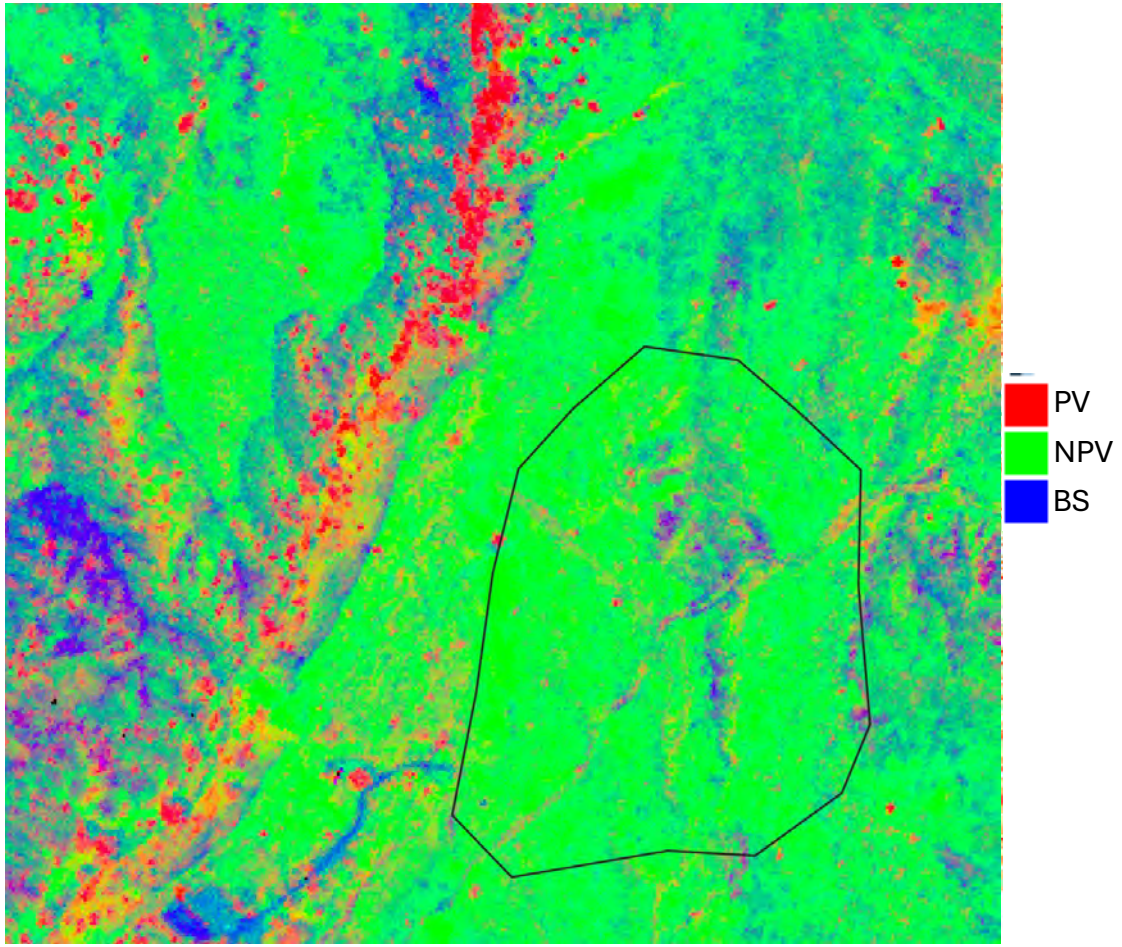
Verification

Automated Monte Carlo Unmixing (AutoMCU)

- Calculates the fractional cover of
  - photosynthetic vegetation (PV)
  - non-photosynthetic vegetation (NPV)
  - bare soil (BS)

Fractional cover of PV, NPV, and BS



Environmental influence on classification performance

True and False predictions plotted across PV, NPV, and BS cover fractions

Pixel-level predictions

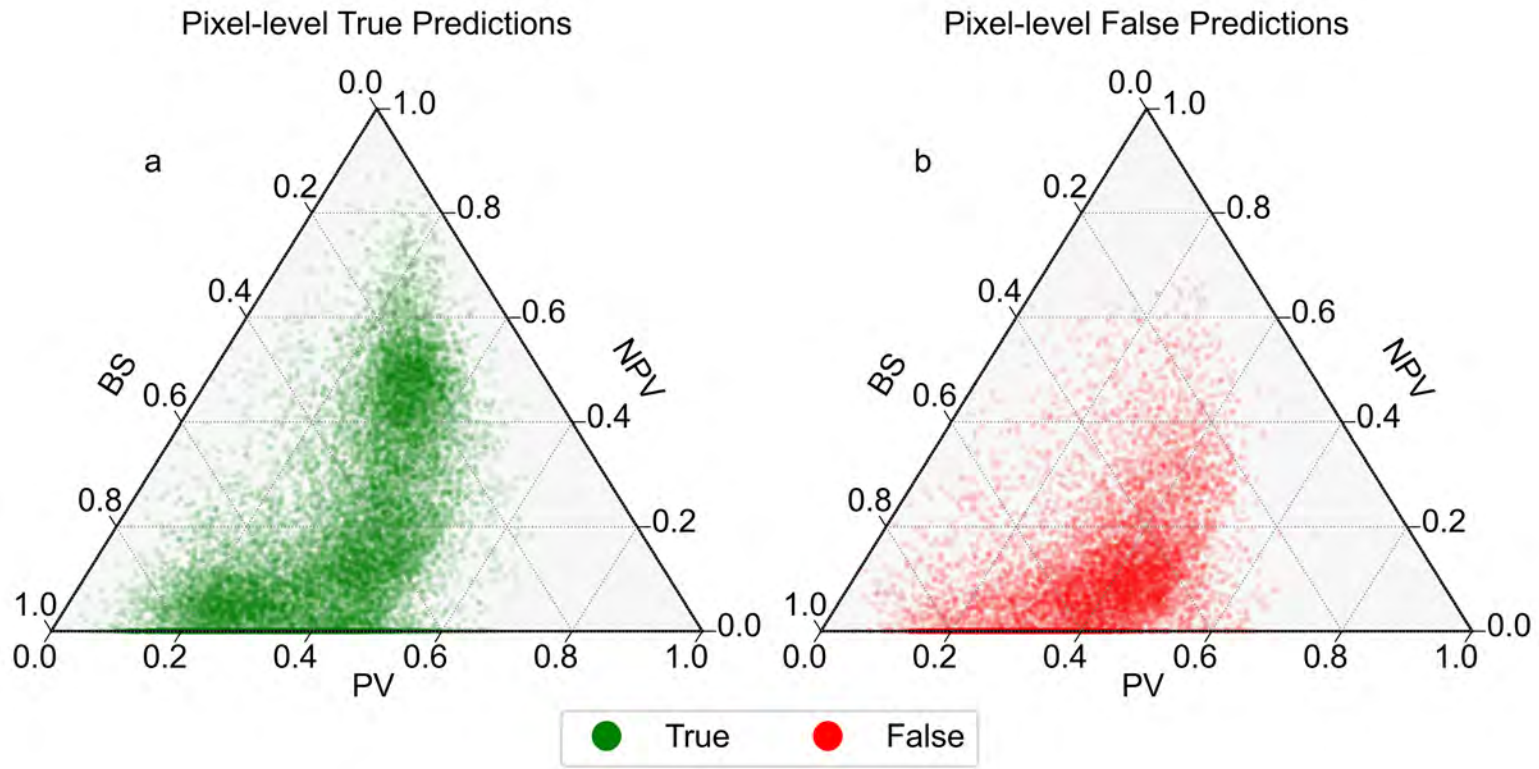
- All pixels were plotted

True predictions

- Distributed around areas with high PV or high NPV

False predictions

- Cluster around ~50% NPV, ~50% BS, and <20% PV



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Verification

True and False predictions plotted across PV, NPV, and BS cover fractions

Crown-level predictions

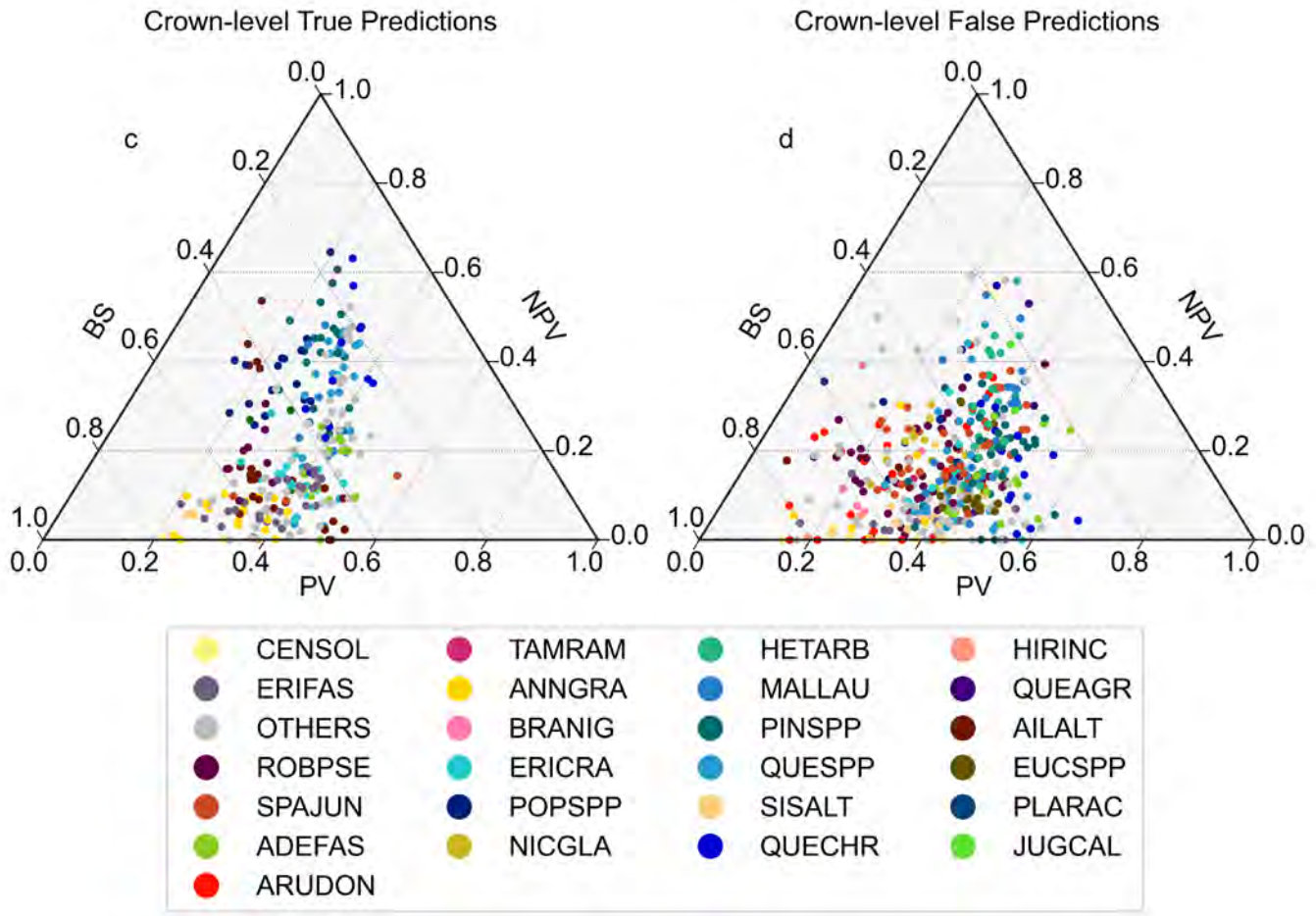
- For each species class within a single crown, PV, NPV, and BS was averaged

True predictions

- Species cluster in areas with similar cover proportions

False predictions

- Less clustering at the species level



Future work

Immediate future

- Examine the species level clustering of true and false predictions across PV, NPV, and BS
- Create uncertainty maps to help identify areas where predictions are most confident

Future project

- The maps I produce now will be the foundation for my next project - determine the fractional proportion invasive species can be detected at satellite resolution

Acknowledgements

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