MAPPING OF LAND COVER IN NORTHERN CALIFORNIA WITH SIMULATED HYSPIRI IMAGERY

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Objective

Land-cover and its change are important variables used by the science, policy and conservation communities.

Will HyspIRI imagery produce better land-cover maps than possible with conventional satellites?

- More classes and with greater accuracy
- Reliable estimates of change (subtle and drastic)
# Land Cover Classification System (LCCS)

Global, universal system - U.N. FAO

<table>
<thead>
<tr>
<th>Closed-Canopy: &gt; 65% cover trees or shrubs</th>
<th>Open-Canopy: 15% - 65% cover trees or shrubs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Crops</td>
<td>Open-Canopy Conifer</td>
</tr>
<tr>
<td>Bare</td>
<td>Open-Canopy Deciduous Broad-leaf</td>
</tr>
<tr>
<td>Built-up</td>
<td>Open-Canopy Evergreen Broad-leaf</td>
</tr>
<tr>
<td>Closed-Canopy Conifer</td>
<td>Open-Canopy Mediterranean Shrubs</td>
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<tr>
<td>Closed-Canopy Mediterranean Shrubs</td>
<td>Perennial Crops (Orchards, Vineyards)</td>
</tr>
<tr>
<td>Closed-Canopy Mixed Broad-leaf</td>
<td>Tidal Salt &amp; Marsh</td>
</tr>
<tr>
<td>Closed-Canopy Mixed Forest</td>
<td>Upland Grasses and Forbs</td>
</tr>
<tr>
<td>Dune Vegetation</td>
<td>Urban Vegetated Area</td>
</tr>
</tbody>
</table>
San Francisco Bay Area Analysis

- SF Bay Area box (HyspIRI Prep. Science)
  - 2013 AVIRIS-C, ER2: Spring (April), Summer (June), Fall (Nov-Dec)
- Simulated HyspIRI products, 30 and 60 m
  - Reflectance: 186 “good bands” x 3 seasons = 558 reflectance bands
  - Minimum Noise Fraction (MNF): 100 MNF bands from 558 refl. bands
  - Spectral metrics: 88 metrics x 3 seasons = 264 metrics
- Simulated Landsat OLI, 30 m
  - 7 radiance bands x 3 seasons = 21 bands
- Reference data
  - Google Earth visual interpretation with web tool (VIEW-IT)
  - Percent cover classified to LCCS
- Random Forests classifier
  - 999 decision trees, majority vote
SF Bay Area Box
AVIRIS-C Reflectance
Summer: June 7, 2013
SF Bay Area Box
AVIRIS-C Reflectance
Fall: Nov 22-Dec 5, 2013
Land cover reference data

**MODIS EVI**

**COVER TYPES (%)**
- Impervious Surface
- Water
- Urban Landscape
- Annual Crops
- Perrenial Crops
- Beaches or Dunes
- Sparsely Vegetated
- Non-Vegetated
- Aquatic Vegetation
- Riparian Shrubs
- Riparian Trees
- Freshwater Wetlands
- Tidal Salt & Marsh
- Upland Grasses and Forbs
- Dune Vegetation
- Semi desert Shrubs
- Mediterranean Shrubs
- Conifer Trees
- Evergreen Broadleaf Trees
- Deciduous Broadleaf Trees
VIEW-IT land-cover reference data

14 undergrads, 1 grad, 1 post-doc, 1 professor

<table>
<thead>
<tr>
<th>HyspIRI Box</th>
<th>Samples</th>
</tr>
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<tbody>
<tr>
<td>Bay Area</td>
<td>2,895</td>
</tr>
<tr>
<td>Santa Barbara</td>
<td>1,115</td>
</tr>
<tr>
<td>Soda Straw</td>
<td>57</td>
</tr>
<tr>
<td>Southern California</td>
<td>1,618</td>
</tr>
<tr>
<td>Tahoe</td>
<td>851</td>
</tr>
<tr>
<td>Yosemite-NEON</td>
<td>1,149</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7,685</strong></td>
</tr>
</tbody>
</table>

SF Bay Area
n = 1,877 land samples

Source: Earl, DigitalGlobe, GeoEye, landsat, Esri, Esri Geographics, CHM/AltaData, USGS, USDA, AEX, GeoEye, Aerogrid, IGN, IGP, coxetopo, and the ES User Community
Over 50% of the vegetative cover is managed.

**Cultivated/Managed** {perennial crop, annual crop, urban landscape}

- **Terrestrial Vegetated**
  - **A1**
- **Natural/Semi-natural**
  - **A12**

**Herbaceous Vegetation** {Upland grass, Dune veg}

**Woody Vegetation** {forests, shrubs}

- **>15% Woody**
  - **Trees**
    - **>15% Tree Cover**
      - Conifer
        - >65% Conifer
      - Mixed Forest
      - Broadleaf
        - >65% Broadleaf
    - Mediterranean
      - >50% of Shrub
    - Semi-Desert
      - >50% of Shrub
  - **Shrubs**
    - >15% Shrub Cover
      - Upland Grasses and Forbs
        - >65% of Herbaceous
      - Dune Vegetation
        - >65% of Herbaceous
  - Mixed, Unclassified
    - <10% of any vegetation class

**Herbaceous**

- <15% Woody

**Herbaceous Vegetation** {Upland grass, Dune veg}

**VIEW-IT % cover to LCCS (hard) class**

Closed-Canopy: > 65%
Open-Canopy: 15% - 65%
Multi-temporal mask – 60 m

Final mask shows good pixels where Spring & Summer & Fall masks were either land or cloud shadow.
Spectral metrics

Summary of hyperspectral metrics organized by methods (in bold) and dominant spectral features and region (in italics).

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<tr>
<th>Indices</th>
<th>Absorption-Based</th>
<th>Derivative</th>
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<td><strong>Photosynthetic pigments, LAI, structure, physiology, stress (VIS-NIR)</strong></td>
<td></td>
</tr>
<tr>
<td>SR, NDVI, EVI, SAVI, ARVI</td>
<td>Blue-D,W,A,As</td>
<td>BE-Wvl, Mag, DArea</td>
</tr>
<tr>
<td>ARI1, ARI2, mARI, CRI1, CRI2</td>
<td>Red-D,W,A,As</td>
<td>GP-Wvl, Refl</td>
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<tr>
<td>PRI, RVS1</td>
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<td>YE-Wvl, Mag, DArea</td>
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<tr>
<td>mSR705, NDVI705, MCARI</td>
<td></td>
<td>RW-Wvl, Refl</td>
</tr>
<tr>
<td>VOG1, VOG2, VOG3</td>
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<td>RE-Wvl, Mag, DArea</td>
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<td>VIgreen, VARIgreen, CIrededge</td>
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<tr>
<td>PSRI, NDII</td>
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<td></td>
<td><strong>Water and structure (NIR)</strong></td>
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<tr>
<td>WBI</td>
<td>EWT</td>
<td>NE1-Wvl, Mag</td>
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<tr>
<td>NDWI</td>
<td>NIR1-D,W,A,As</td>
<td>NE2-Wvl, Mag</td>
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<tr>
<td>MSI</td>
<td>NIR2-D,W,A,As</td>
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<td></td>
<td><strong>Lignin, cellulose, nitrogen (SWIR)</strong></td>
<td></td>
</tr>
<tr>
<td>CAI</td>
<td>SWIR1-D,W,A,As</td>
<td>SE-Wvl, Mag</td>
</tr>
<tr>
<td>NDLI</td>
<td>SWIR2-D,W,A,As</td>
<td></td>
</tr>
<tr>
<td>NDN1</td>
<td>SWIR3-D,W,A,As</td>
<td></td>
</tr>
</tbody>
</table>

Wvl = wavelength, Mag = derivative magnitude, Refl = percent reflectance, D = depth, W = width, A = area (width x depth), As = Asymmetry.
Processing flow (continued)

- **Spectral Metrics** 30, 60 m
  - *RF* Summer, 3 Seasons
  - **CLASSIFIED RUNS** Spectral Metrics 30, 60 m Summer, 3 Seasons
  - MOSAICKED MAP Max Confidence 30, 60 m Summer, 3 Seasons

- **Stacked Masked HyspIRI Reflectance** 20 runs 30, 60 m
  - *RF* Summer, 3 Seasons
  - **CLASSIFIED RUNS** Reflectance 30, 60 m Summer, 3 Seasons
  - MOSAICKED MAP Max Confidence 30, 60 m Summer, 3 Seasons

- **MNF** 30, 60 m
  - *RF* Summer, 3 Seasons
  - **CLASSIFIED RUNS** MNF 30, 60 m Summer, 3 Seasons
  - MOSAICKED MAP Max Confidence 30, 60 m Summer, 3 Seasons

- **Stacked Masked Landsat OLI Radiance** 20 runs, 30 m
  - *RF* Summer, 3 Seasons
  - **CLASSIFIED RUNS** Landsat OLI 30 m Summer, 3 Seasons
  - MOSAICKED MAP Max Confidence 30 m Summer, 3 Seasons

- **50% Training** VIEW-IT LCCS Samples n = 1,877
- **50% Testing** Accuracy Assessment
Random Forests Overall Accuracy

**HypSIRI 30m**

- Reflectance: Summer 67.6%, Spring-Summer-Fall 71.8%
- MNF: Summer 47.1%, Spring-Summer-Fall 46.8%
- Spectral Metrics: Summer 75.1%, Spring-Summer-Fall 78.6%

**HypSIRI 60m**

- Reflectance: Summer 64.5%, Spring-Summer-Fall 71.8%
- MNF: Summer 38.0%, Spring-Summer-Fall 63.2%
- Spectral Metrics: Summer 64.5%, Spring-Summer-Fall 79.0%

- **20 classes**
- **Independent test data**
- **Same VIEW-IT boxes used in all tests**
- **Simulated data have duplicate pixels from scene overlap (↑ sun-view variation than satellite-based HypSIRI image)**
Multi-temporal HyspIRI spectral metrics – 30 m

Class in each pixel determined by majority vote out of 999 decision trees in Random Forests

Sonoma and Napa Region

30-m pixels

- Annual Crops
- Bare
- Built-up
- Closed-Canopy Conifer
- Closed-Canopy Deciduous Broad-leaf
- Closed-Canopy Evergreen Broad-leaf
- Closed-Canopy Mediterranean Shrub
- Closed-Canopy Mixed Broad-leaf
- Closed-Canopy Mixed Forest
- Dune Vegetation
- Open-Canopy Conifer
- Open-Canopy Deciduous Broad-leaf
- Open-Canopy Evergreen Broad-leaf
- Open-Canopy Mediterranean Shrub
- Open-Canopy Mixed Broad-leaf
- Open-Canopy Mixed Forest
- Perennial Crops (Orchards, Vineyards)
- Tidal Salt & Marsh
- Upland Grasses and Forbs
- Urban Vegetated Area
Multi-temporal HyspIRI spectral metrics – 60 m

Class in each pixel determined by majority vote out of 999 decision trees in Random Forests

Sonoma and Napa Region

60-m pixels
Multi-temporal HyspIRI spectral metrics – 60 m

Scene overlap handled by picking the class with highest “confidence” between overlapping pixels.

Confidence = % of votes from all 999 decision trees in Random Forests that were for the majority class.

Confidence =

Sonoma and Napa Region

60-m pixels

Mean = 58.8
Random Forests Classification

Overall Accuracy
Simulated HyspIRI and Landsat OLI
30 m, Spring-Summer-Fall

- Landsat OLI Radiance: 71.0%
- HyspIRI Reflectance: 71.8%
- HyspIRI Spectral Metrics: 78.6%

20 classes
Independent test data
Same VIEW-IT boxes used in all tests
Simulated data have duplicate pixels from scene overlap (↑ sun-view variation than satellite-based HyspIRI image)
Random Forests LCCS classification

- 20 classes focused on natural vegetation
- HyspIRI multi-temporal spectral metrics best predictors
- Overall accuracy 78.6% (30 m) and 79.0% (60 m)
- Multi-temporal HyspIRI 7.6% greater accuracy than Landsat OLI

Anthropogenic classes and homogeneous vegetation had best accuracy

Several forest classes with < 20% accuracy

- Fine-scale mosaic of forest types – gradients, not hard classes
- Confusion in forests
  - Conifer ↔ Mixed forest ↔ Broadleaf (BL) forests
  - Evergreen BL ↔ Mixed BL forest ↔ Deciduous BL forests
  - Open-canopy ↔ Closed-canopy
K-means Clusters
(5 per class)
Next steps for Bay Area analysis

- Multi-temporal MESMA – fractions mapped to LCCS classes
- Two-phase classification – RF, then MESMA on forests
- Alliance (species dominant) mapping of forests in Napa, Marin, & Sonoma Counties
### HyspIRI 30-m Error Matrix

| Annual Crops | Bare | Built | Closed-Canopy Conifer | Closed-Canopy Deciduous Broadleaf | Closed-Canopy Evergreen Broadleaf | Closed-Canopy Mediterranean Shrubs | Closed-Canopy Mixed Broadleaf | Dune Vegetation | Open-Canopy Conifer | Open-Canopy Deciduous Broadleaf | Open-Canopy Evergreen Broadleaf | Open-Canopy Mediterranean Shrubs | Open-Canopy Mixed Broadleaf | Open-Canopy Mixed Forest | Open-Canopy Deciduous Broadleaf | Perennial Crops | Tidal Salt & Marsh | Total | User |
|--------------|------|-------|----------------------|-----------------------------------|----------------------------------|--------------------------------|-------------------------------|-----------------|-------------------|----------------------|---------------------------------|----------------------------------|--------------------------------|-------------------------|-------------------------------|----------------|------|
| Bare         | 417  | 118   | 289                  | 1                                 | 0                                | 0                              | 0                             | 0               | 0                 | 0                    | 0                              | 0                                | 0                              | 0                        | 0                             | 0               | 0    | 0    |
| Built        | 42   | 97    | 28975               | 60                                | 0                                | 0                              | 49                            | 0               | 0                 | 0                    | 0                              | 0                                | 0                              | 0                        | 0                             | 0               | 0    | 0    |
| Closed-Canopy Conifer | 0    | 0     | 27302               | 0                                | 0                               | 496                            | 92                            | 12               | 698               | 0                    | 0                              | 0                                | 0                              | 0                        | 0                             | 0               | 0    | 0    |
| Closed-Canopy Evergreen Broadleaf | 2    | 0     | 17                  | 820                               | 697                             | 12098                          | 800                            | 4761             | 318               | 0                   | 23                             | 12                             | 105                           | 11                       | 0                            | 465             | 23   | 0    |
| Closed-Canopy Mediterranean Shrubs | 0    | 0     | 12                  | 0                                | 0                               | 73                             | 24488                         | 18               | 12                | 252                  | 21                             | 365                            | 67                             | 20                       | 40                           | 0               | 24   | 0    |
| Closed-Canopy Mixed Broadleaf | 3    | 0     | 35                  | 4                                | 1147                            | 2813                           | 414                            | 4036             | 95                | 0                   | 6                              | 29                             | 40                             | 12                       | 42                           | 225             | 4    | 0    |
| Closed-Canopy Mixed Forest | 0    | 0     | 87                  | 3580                             | 143                             | 1430                           | 437                            | 103              | 372               | 0                   | 0                              | 152                            | 53                             | 6                        | 1                             | 2603            | 3     | 4    |
| Dune Vegetation | 352  | 158   | 8                   | 3                               | 0                                | 28                             | 0                             | 874              | 0                 | 0                   | 0                              | 0                                | 0                              | 0                        | 0                             | 0               | 213  | 83   |
| Open-Canopy Conifer | 0    | 0     | 8                   | 1                               | 19                               | 68                             | 1545                          | 187              | 7                 | 0                   | 85                             | 468                            | 20                             | 0                        | 2                             | 412             | 2    | 0    |
| Open-Canopy Deciduous Broadleaf | 224  | 0     | 101                 | 10                              | 294                             | 295                            | 358                            | 109              | 12                | 0                   | 122                            | 2987                           | 34                             | 42                       | 215                           | 110             | 56   | 1183 |
| Open-Canopy Evergreen Broadleaf | 12   | 0     | 16                  | 441                             | 29                               | 134                            | 84                             | 49               | 11                | 0                   | 0                              | 106                            | 92                             | 1                        | 16                            | 623             | 93   | 0    |
| Open-Canopy Mediterranean Shrubs | 9    | 0     | 120                 | 0                               | 0                               | 32                             | 243                           | 0                | 0                 | 12                  | 0                              | 37                             | 249                            | 15                       | 0                             | 329             | 23   | 0    |
| Open-Canopy Mixed Broadleaf | 11   | 0     | 18                  | 0                               | 192                             | 146                            | 52                             | 188              | 14                | 0                   | 0                              | 27                             | 11                             | 0                        | 30                            | 275             | 38   | 8    |
| Open-Canopy Mixed Forest | 10   | 0     | 28                  | 480                             | 210                             | 804                            | 423                            | 106              | 50                | 9                   | 134                            | 107                            | 5                              | 53                       | 560                           | 134             | 116  | 247  |
| Perennial Crops | 1637 | 0     | 349                 | 0                               | 14                              | 74                             | 50                             | 16               | 0                 | 0                   | 0                              | 84                             | 10                             | 3                        | 0                             | 2754            | 741  | 93   |
| Tidal Salt & Marsh | 37   | 0     | 98                  | 19                               | 1                               | 0                              | 17                            | 0                | 0                 | 0                   | 0                              | 0                                | 0                              | 0                        | 0                             | 12              | 36   | 19   |
| Upland Grasses and Forbs | 1270 | 0     | 73                  | 0                               | 0                               | 0                              | 18                            | 0                | 0                 | 0                   | 0                              | 0                                | 0                              | 0                        | 337                           | 6    | 19  | 20   |
| Urban Vegetated Area | 447  | 0     | 2543                | 99                              | 19                               | 65                             | 268                            | 6                | 0                 | 2                   | 0                              | 0                                | 11                             | 0                        | 10                            | 493             | 529  | 441  |
| Total         | 1208 | 562   | 33265               | 32972                           | 3061                            | 18777                          | 31628                         | 10107            | 1589              | 1855                | 511                            | 4374                           | 878                            | 414                       | 401                           | 5512            | 10546| 9593 |
| Producer      | 80%  | 95%   | 93%                 | 89%                             | 15%                             | 66%                            | 79%                           | 43%              | 11%               | 32%                 | 0%                             | 20%                            | 3%                             | 43%                       | 2%                            | 27%             | 86%  | 74%  |

**Total User**: 12931

**Producer**: 78.6%
### HyspIRI 60-m Error Matrix

| Annual Crops | Bare | Built | Closed-Canopy Conifer | Closed-Canopy Deciduous Broad-leaf | Closed-Canopy Evergreen Broad-leaf | Closed-Canopy Mediterranean Shrubs | Dune Vegetation | Open-Canopy Conifer | Open-Canopy Deciduous Broad-leaf | Open-Canopy Evergreen Broad-leaf | Open-Canopy Mediterranean Shrubs | Open-Canopy Mixed Broad-leaf | Open-Canopy Mixed Forest | Perennial Crop | Upland Grasses and Forbs | Totals | Total | User |
|--------------|------|-------|------------------------|-----------------------------------|---------------------------------|----------------------------------|-----------------|-------------------|----------------------|-------------------------------|-------------------------------|-------------------------|-----------------------------|----------------|--------------------------|-------|
| **Annual Crops** |      |       |                        |                                   |                                 |                                  |                 |                   |                      |                               |                               |                         |                             |               |                         |       |
| **Annual Crops** | 480  | 2     | 9                      | 0                                 | 0                               | 0                                 | 1                             | 10                | 0                   | 0                     | 0                             | 0                       | 0                        | 125           | 27                       | 12    | 2                       | 668   | 54%                     |
| **Bare**      | 0    | 10    | 23                     | 0                                 | 0                               | 0                                 | 0                             | 0                  | 0                   | 0                     | 0                             | 0                       | 0                        | 0              | 0                        | 0     | 0                       | 34    | 25%                     |
| **Built**     | 0    | 2     | 2203                   | 0                                 | 0                               | 0                                 | 1                             | 0                  | 0                   | 0                     | 0                             | 0                       | 0                        | 16             | 0                        | 40    | 97%                     |
| **Closed-Canopy Conifer** | 0    | 0     | 1517                   | 0                                 | 21                              | 1                                 | 0                             | 76                 | 0                   | 0                     | 0                             | 0                       | 1                        | 0              | 0                        | 0     | 0                       | 1616  | 96%                     |
| **Closed-Canopy Deciduous Broad-leaf** | 0    | 0     | 0                      | 43                                | 11                              | 25                                | 26                            | 0                  | 0                   | 1                     | 0                             | 1                       | 1                        | 0              | 0                        | 0     | 0                       | 111   | 24%                     |
| **Closed-Canopy Evergreen Broad-leaf** | 0    | 0     | 0                      | 11                                | 9                                | 697                               | 10                            | 130                | 18                  | 0                     | 0                             | 4                       | 0                        | 2               | 0                        | 0     | 0                       | 1882  | 57%                     |
| **Closed-Canopy Mediterranean Shrubs** | 0    | 0     | 1                      | 0                                 | 0                               | 6                                 | 1073                         | 3                  | 1                   | 12                   | 17                            | 13                      | 29                       | 3               | 1                        | 42    | 96%                     |
| **Closed-Canopy Mixed Broad-leaf** | 0    | 0     | 0                      | 2                                 | 56                              | 185                               | 39                            | 269                | 10                  | 0                     | 0                             | 1                       | 4                        | 0               | 5                        | 1     | 39%                     |
| **Closed-Canopy Mixed Forest** | 0    | 0     | 153                    | 1                                 | 43                              | 8                                 | 15                            | 21                 | 0                   | 0                     | 0                             | 0                       | 0                        | 0               | 1                        | 0     | 242%                    |
| **Dune Vegetation** | 0    | 0     | 0                      | 0                                 | 0                               | 0                                 | 0                             | 0                  | 0                   | 5                     | 0                             | 0                       | 0                        | 16             | 0                        | 0     | 7%                       | 48    | 48%                     |
| **Open-Canopy Conifer** | 0    | 0     | 1                      | 0                                 | 0                               | 1                                 | 4                             | 1                  | 2                   | 0                     | 0                             | 0                       | 0                        | 13              | 0                        | 0     | 0                       | 23    | 2%                      |
| **Open-Canopy Deciduous Broad-leaf** | 1    | 0     | 2                      | 0                                 | 35                              | 7                                 | 4                             | 89                 | 5                   | 0                     | 9                             | 57                      | 2                        | 1               | 78                       | 39    | 19%                     |
| **Open-Canopy Evergreen Broad-leaf** | 0    | 0     | 0                      | 0                                 | 0                               | 1                                 | 4                             | 11                  | 0                   | 0                     | 0                             | 4                       | 2                        | 0               | 1                        | 5     | 0%                      |
| **Open-Canopy Mediterranean Shrubs** | 0    | 0     | 0                      | 0                                 | 0                               | 0                                 | 116                           | 0                  | 0                   | 0                     | 0                             | 3                       | 1                        | 11              | 0                        | 0     | 0                       | 161   | 8%                      |
| **Open-Canopy Mixed Broad-leaf** | 0    | 0     | 0                      | 17                                | 19                              | 3                                 | 66                            | 1                   | 0                   | 0                     | 12                            | 3                       | 2                        | 1               | 1                        | 1     | 136%                    |
| **Open-Canopy Mixed Forest** | 0    | 0     | 13                     | 4                                 | 9                                | 34                                | 24                            | 28                 | 13                  | 0                     | 2                             | 16                      | 11                       | 3               | 0                        | 36    | 222%                    |
| **Perennial Crops** | 15   | 0     | 34                     | 0                                 | 0                               | 0                                 | 5                             | 0                   | 0                   | 0                     | 0                             | 1                       | 3                        | 13              | 3                        | 761   | 30%                     |
| **Tidal Salt & Marsh** | 0    | 0     | 0                      | 0                                 | 0                               | 0                                 | 16                            | 0                   | 0                   | 7                     | 0                             | 0                       | 0                        | 0               | 249                       | 3     | 275%                    |
| **Upland Grasses and Forbs** | 82   | 0     | 1                      | 0                                 | 0                               | 0                                 | 2                             | 0                   | 0                   | 0                     | 0                             | 0                       | 0                        | 0               | 0                        | 0     | 0                       | 275   | 86%                     |
| **Urban Vegetated Area** | 4    | 0     | 62                     | 0                                 | 0                               | 0                                 | 1                             | 0                   | 0                   | 0                     | 0                             | 0                       | 0                        | 0               | 1                        | 4     | 238%                    |
| **Total**    | 582  | 14    | 2349                   | 1687                               | 170                             | 1025                               | 1336                          | 629                 | 146                 | 24                    | 23                            | 132                     | 55                       | 28              | 108                      | 147   | 925                     |
| **Producer** | 82%  | 71%   | 94%                    | 90%                                | 25%                             | 68%                                | 80%                           | 43%                 | 14%                 | 21%                   | 0%                            | 43%                      | 4%                        | 39%             | 1%                        | 24%   | 82%                     |

User: 79.0%
Napa area
HysplRI Spectral Metrics – 30 m
Land Cover Classification System (LCCS)

Closed-Canopy: > 65% cover trees or shrubs
Open-Canopy: 15% - 65% cover trees or shrubs
Western Central Valley/Diablo Range
HyspIRI Spectral Metrics – 30 m
Multi-temporal HyspIRI spectral metrics – 30 m

Scene overlap handled by picking the class with highest “confidence” between overlapping pixels

Confidence = % of votes from all 999 decision trees in Random Forests that were for the majority class

Sonoma and Napa Region

Confidence

High : 100

Low : 9

Mean = 60.3
Summer HyspIRI spectral metrics – 60 m

Sonoma and Napa Region

60-m pixels

- Annual Crops
- Bare
- Built-up
- Closed-Canopy Conifer
- Closed-Canopy Deciduous Broad-leaf
- Closed-Canopy Evergreen Broad-leaf
- Closed-Canopy Mediterranean Shrubs
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- Perennial Crops (Orchards, Vineyards)
- Tidal Salt & Marsh
- Upland Grasses and Forbs
- Urban Vegetated Area
Multi-temporal HyspIRI reflectance – 60 m

Class in each pixel determined by majority vote out of 999 decision trees in Random Forests
Scene overlap handled by picking the class with highest “confidence” between overlapping pixels.

Confidence = \% of votes from all 999 decision trees in Random Forests that were for the majority class.

Sonoma and Napa Region

Confidence

Mean = 59.6
Multi-temporal Landsat OLI Radiance – 30 m

Class in each pixel determined by majority vote out of 999 decision trees in Random Forests.
Multi-temporal Landsat OLI Radiance – 30 m

Scene overlap handled by picking the class with highest “confidence” between overlapping pixels.

Confidence = \% of votes from all 999 decision trees in Random Forests that were for the majority class.

Confidence = High: 100, Low: 9

Mean = 60.8

Sonoma and Napa Region

30-m pixels
Summer mask – 60 m

- Mask from Random Forests trained from 18-m samples selected from all boxes, all seasons
- One mask per season, 30 and 60 m
- Independent test had a 99.2% overall accuracy, with all classes >98% user and producer accuracy