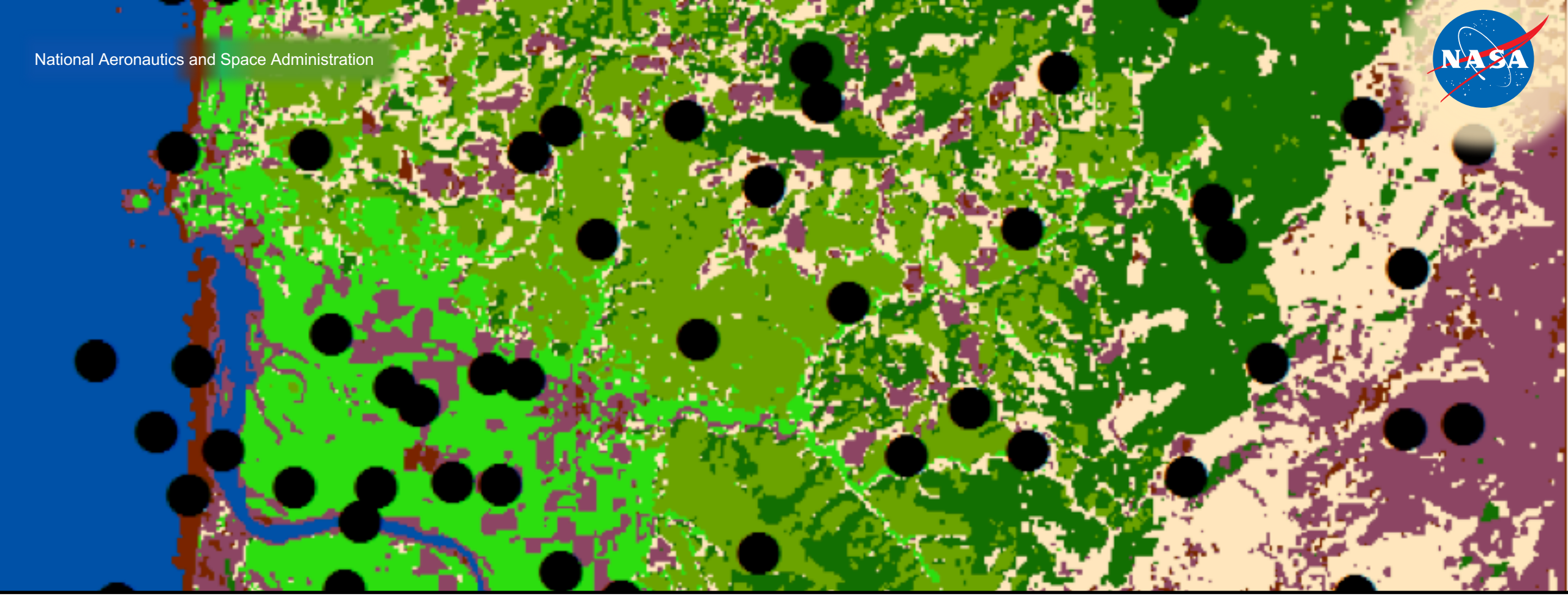


Assessing the Accuracy of Land Cover Classifications

Cindy Schmidt and Amber McCullum

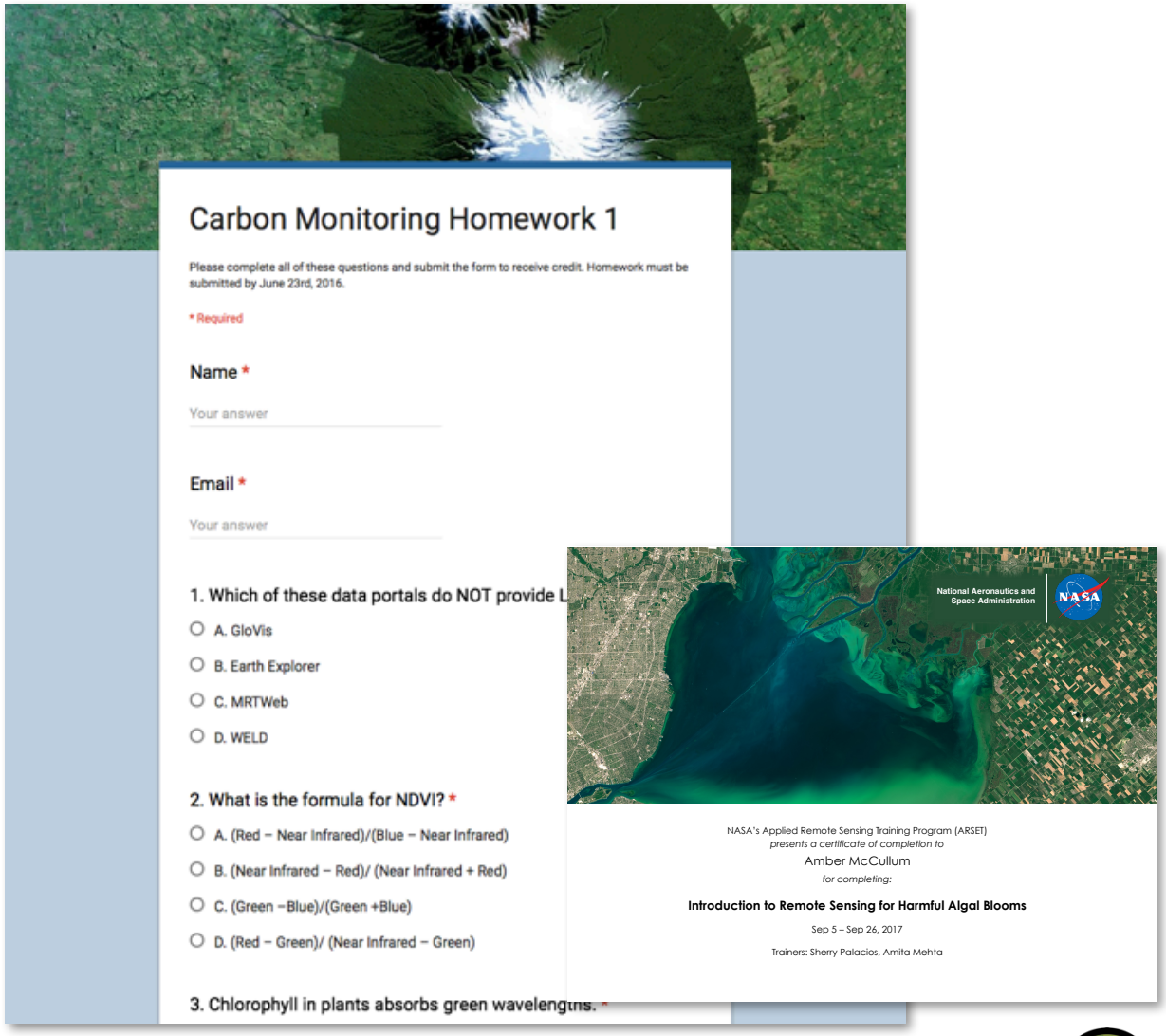
Week 1: February 13, 2018

Course Structure

- Two, two hour sessions
- Sessions will be held Tuesdays, February 13 and February 20, 2018
- We will have two sessions to reach our international audience. Please only sign up for and attend one session each week.
  - Session times: 11:00 - 13:00 EST and 23:00 - 01:00 EST (UTC-5)
- Each session will consist of a lecture followed by a hands-on exercise
- Webinar recordings, PowerPoint presentations, exercises, and the homework assignment can be found after each session at:
  - https://arset.gsfc.nasa.gov/land/webinars/18adv-land-classification
  - Q&A: Following each lecture and/or by email
    - cynthia.l.schmidt@nasa.gov, or
    - amberjean.mccullum@nasa.gov

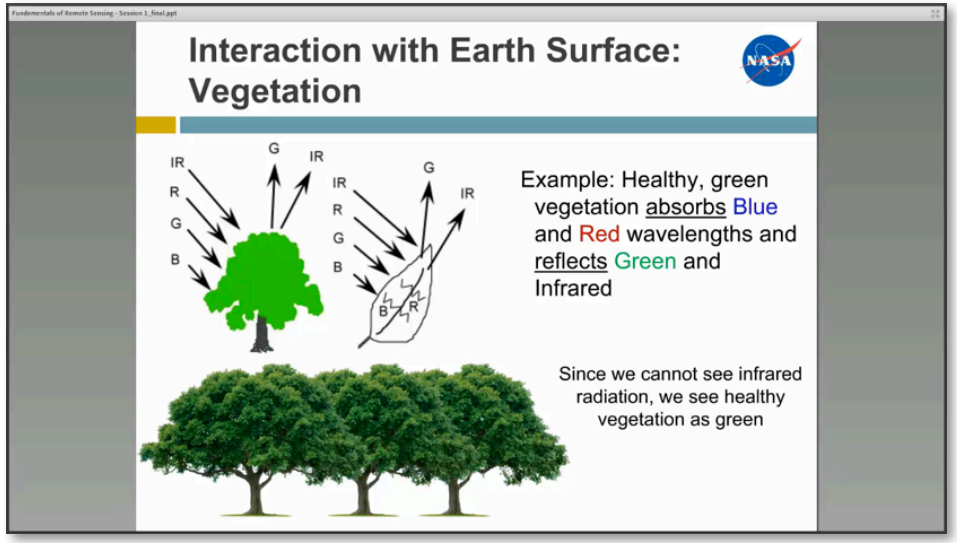
Homework and Certificates

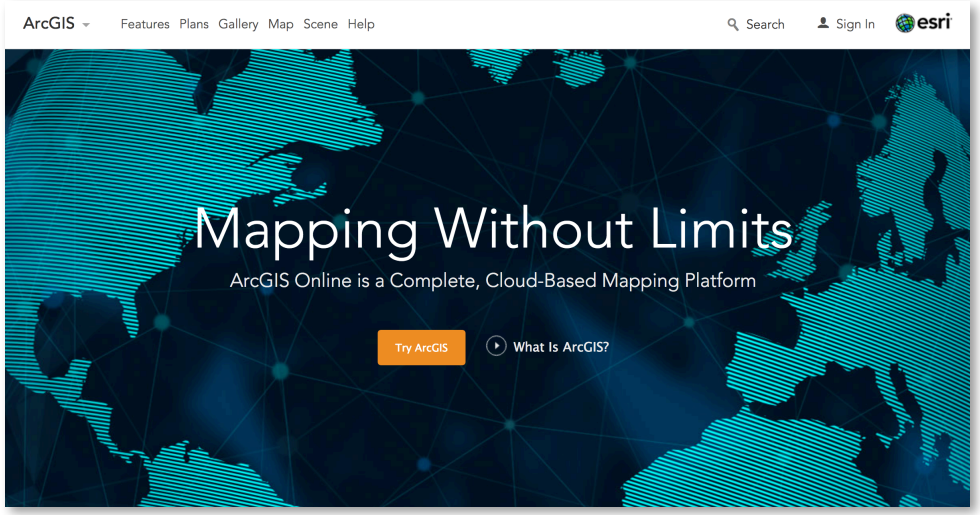
- Homework
  - One homework assignment
  - Answers must be submitted via Google Forms
- Certificate of Completion:
  - Attend both live webinars
  - Complete the homework assignment by the deadline (access from ARSET website)
    - **HW Deadline: March 6th**
  - You will receive certificates approx. two months after the completion of the course from: marines.martins@ssaihq.com



Prerequisites

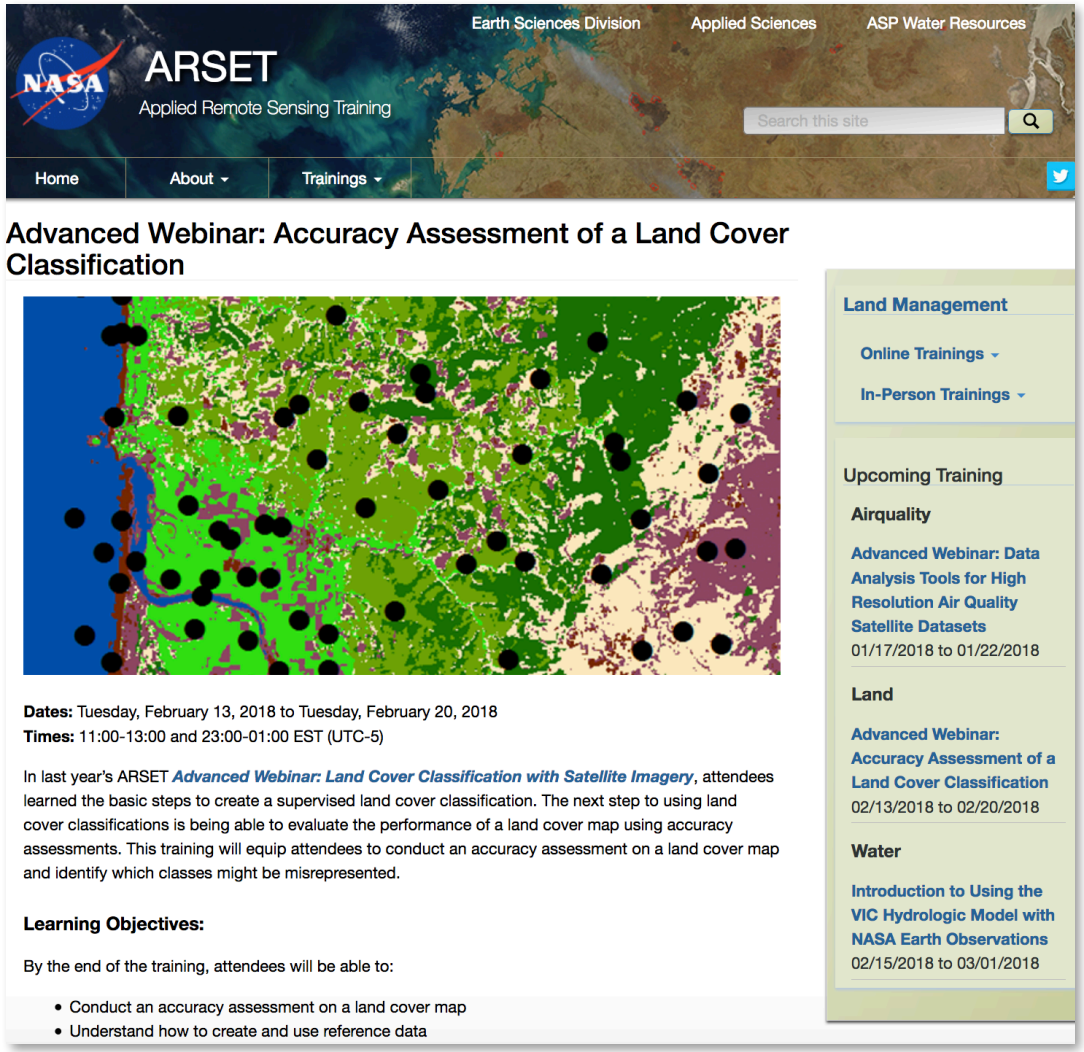
- Complete Sessions 1 & 2A of Fundamentals of Remote Sensing, or equivalent experience
  - https://arset.gsfc.nasa.gov/webinars/fundamentals-remote-sensing
- Complete the Advanced Webinar: Land Cover Classification with Satellite Imagery
  - https://arset.gsfc.nasa.gov/land/webinars/advanced-land-classification
- Download and install ArcGIS 10.4 or higher and all accompanying software
- Download and install Excel 2011 or higher

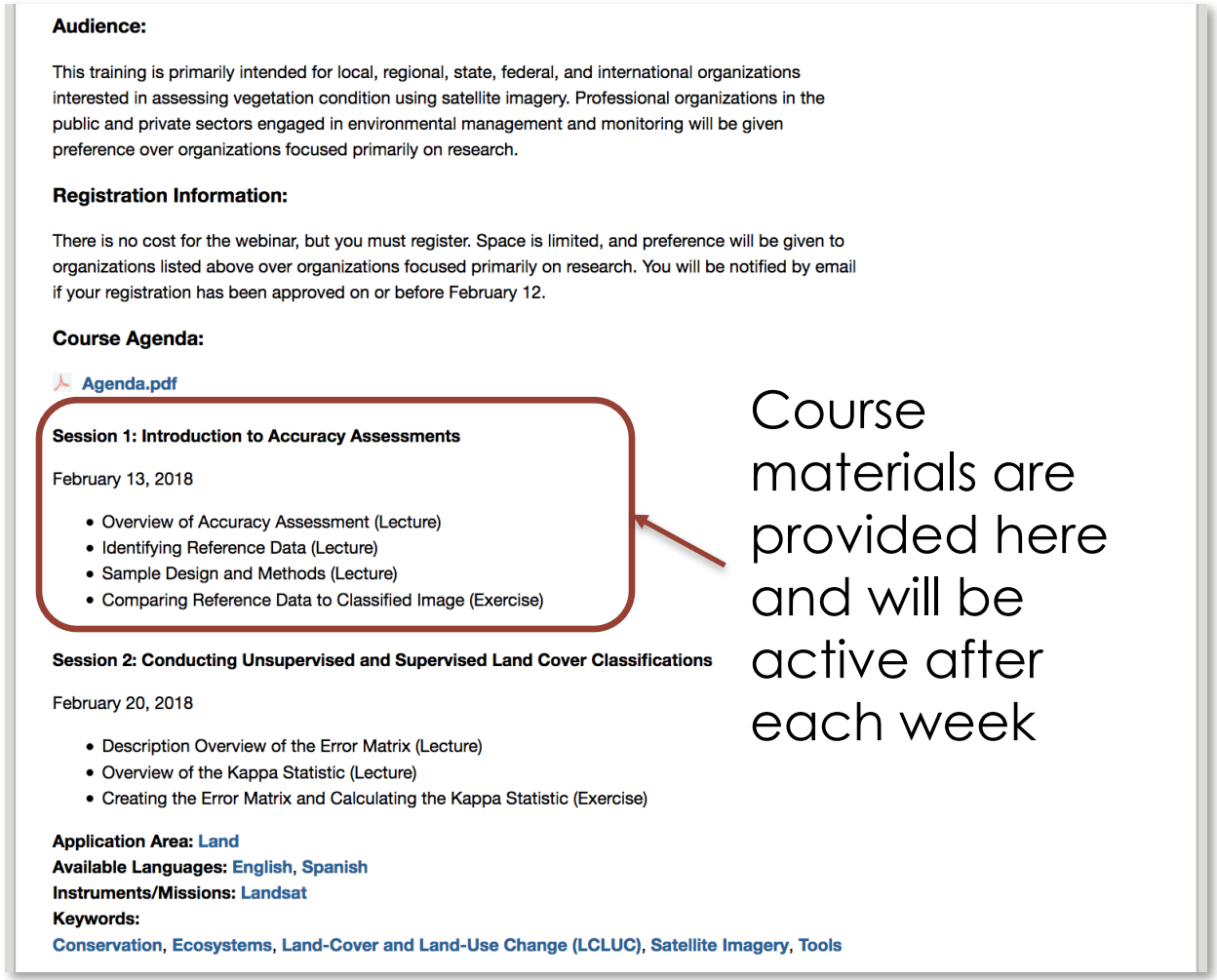




Accessing Course Materials

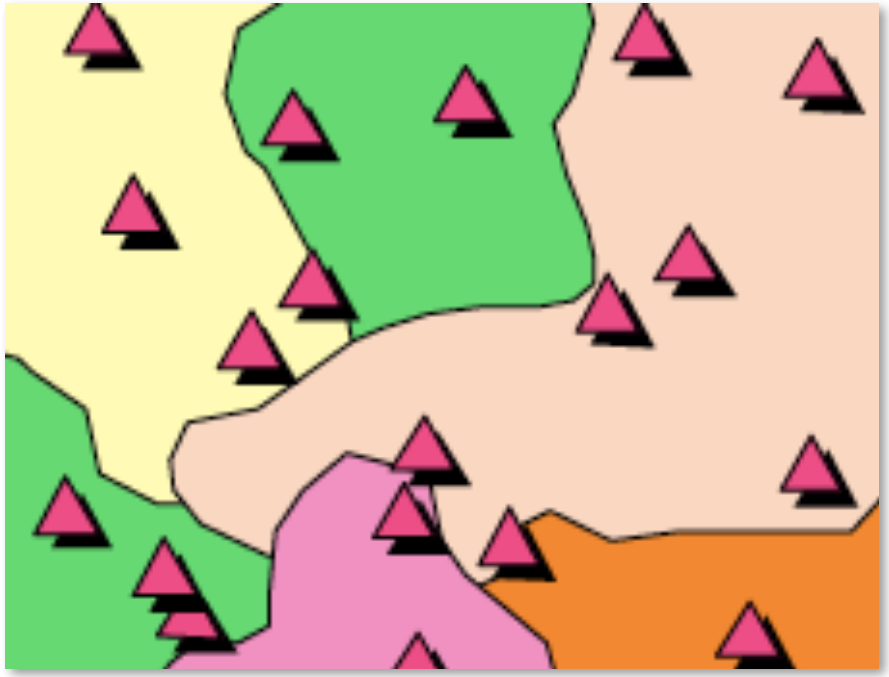
https://arset.gsfc.nasa.gov/land/webinars/18adv-land-classification



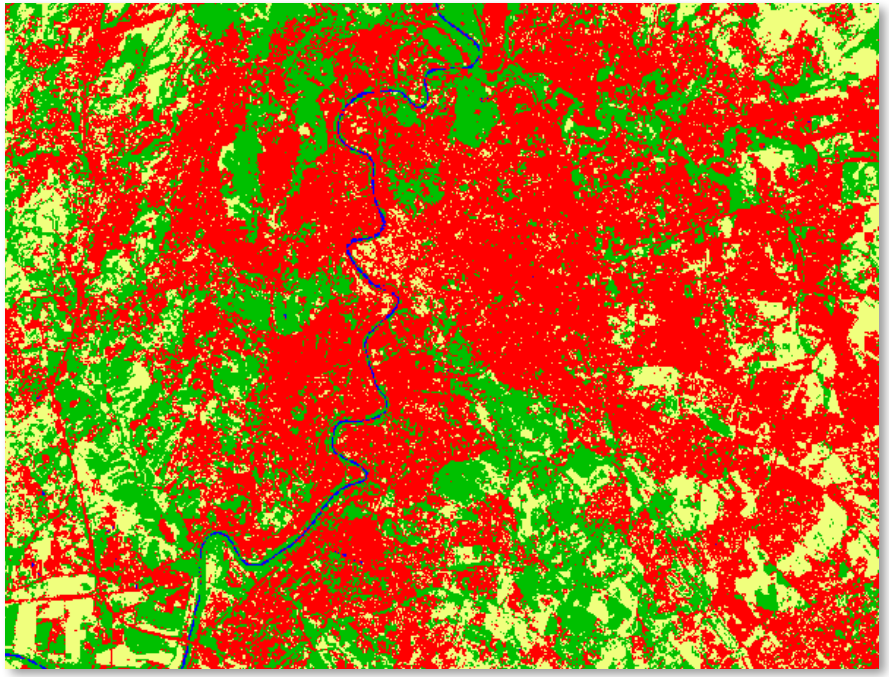


Course materials are provided here and will be active after each week

Course Outline



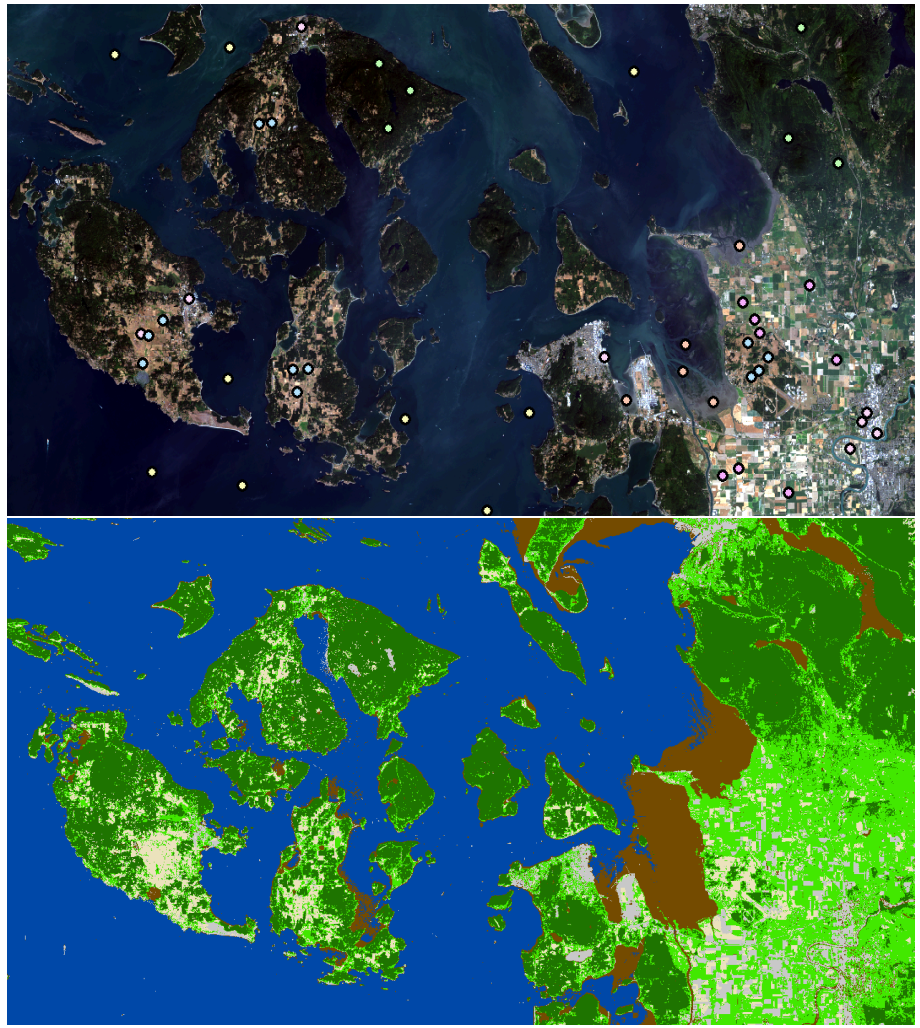
Session 1: Accuracy Assessment Basics



Session 2: Area Estimation

Session 1 Agenda

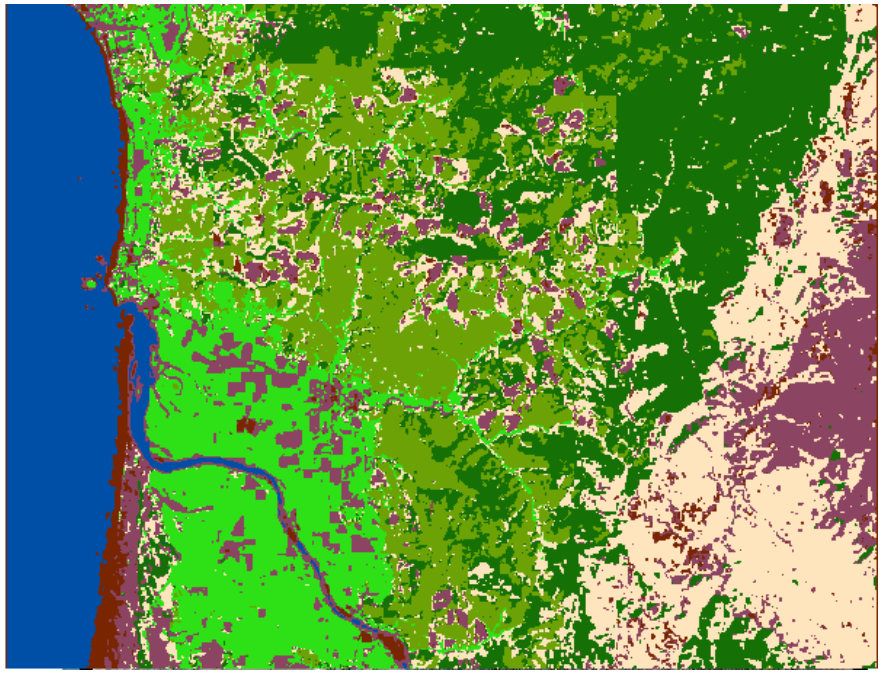
- What is accuracy assessment?
- Sample Design
  - Sampling Methodologies
- Reference Data
- Creating an Error Matrix
- Class Accuracy
- Exercise 1
- Q&A Session



Example of sampling locations (top) and a classified image (bottom)

What is Accuracy Assessment?

- The process by which the accuracy or correctness of an image classification is evaluated
- Involves the comparison of the image classification to reference data that are assumed to be true



Reference (text): Maus, P., & Golden, M. L. (1996). *Guidelines for the use of digital imagery for vegetation mapping*. Washington, DC: U.S. Dept. of Agriculture, Forest Service

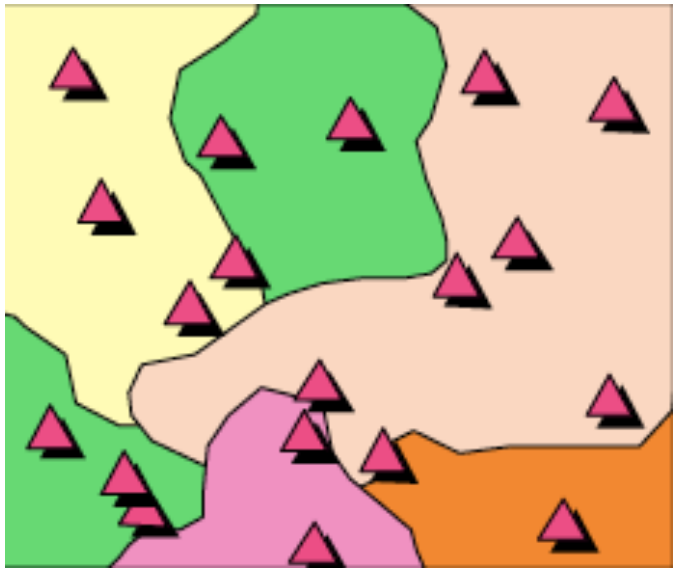
Sample Design

- Objective: obtain information that is representative of the population (i.e. the number of classes and the size of the classes)
- Basic Rules:
  - Data used for accuracy assessment must be independent of training data (for supervised classification)
  - Avoiding bias is key
  - All classes must be sampled
- Since you cannot identify every pixel, a reference point sample design is needed to determine point location:
  - Sample size
  - Sampling method

Sample Size

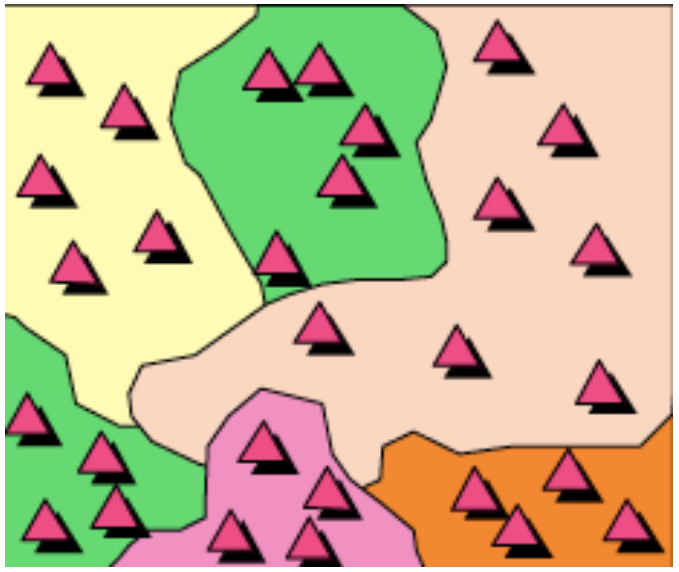
- The number of samples must be sufficiently large to statistically represent all classes, with enough in each class
- The minimum number of samples can be determined for each class using statistical methods:
  - Binomial Probability Theory – uses the expected percent accuracy and allowable error
  - Other methods use the proportion of area of each class
- Generally, at least 50 points per class is recommended
- For more information:
  - ARSET online webinar: Remote Sensing of Forest Cover and Change Assessment for Carbon Monitoring Session 4: Accuracy Assessment
  - BEEODA (Boston Education in Earth Observation Data Analysis): https://beeoda.org

Sampling Methods



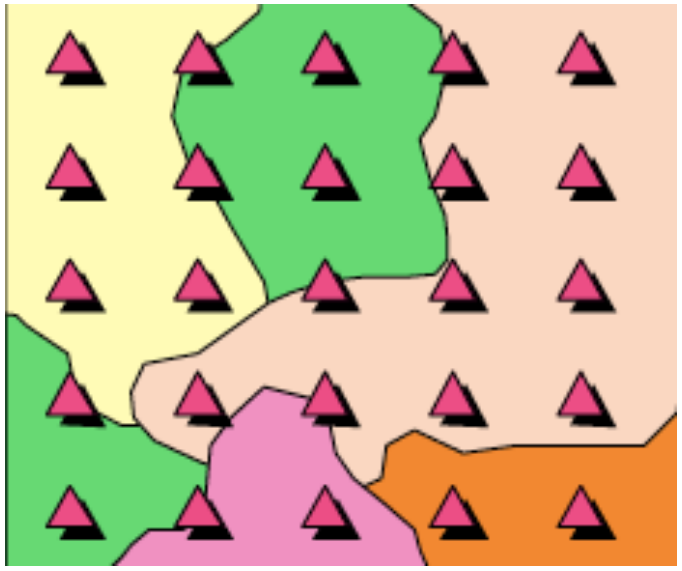
Simple Random Sampling:

Observations are randomly placed



Stratified Random Sampling:

A minimum number of observations are randomly placed in each category

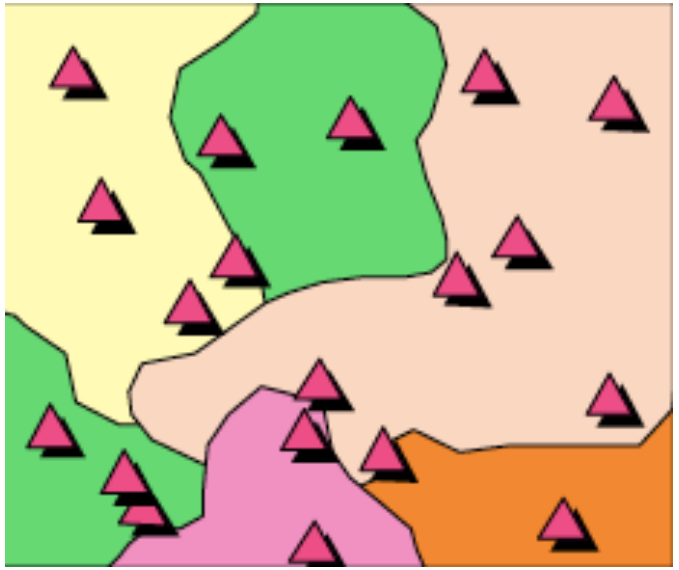


Systematic Sampling:

Observations are placed at equal intervals according to a strategy

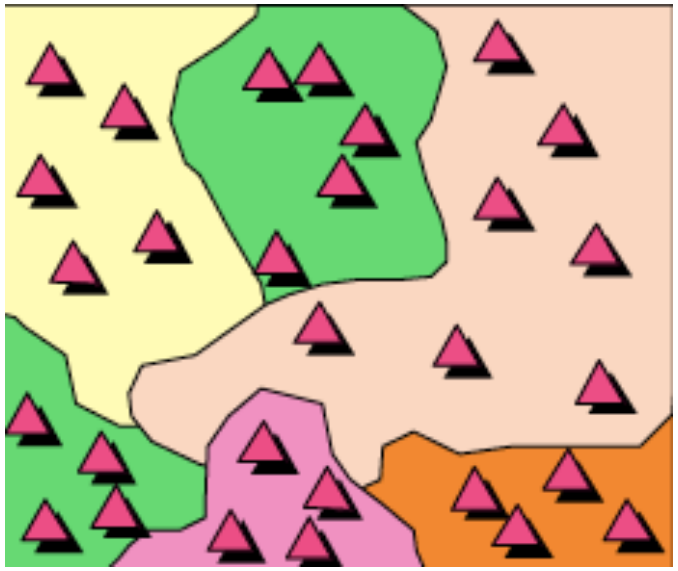
Sampling Methods

Preferred



Simple Random Sampling:

Observations are randomly placed



Stratified Random Sampling:

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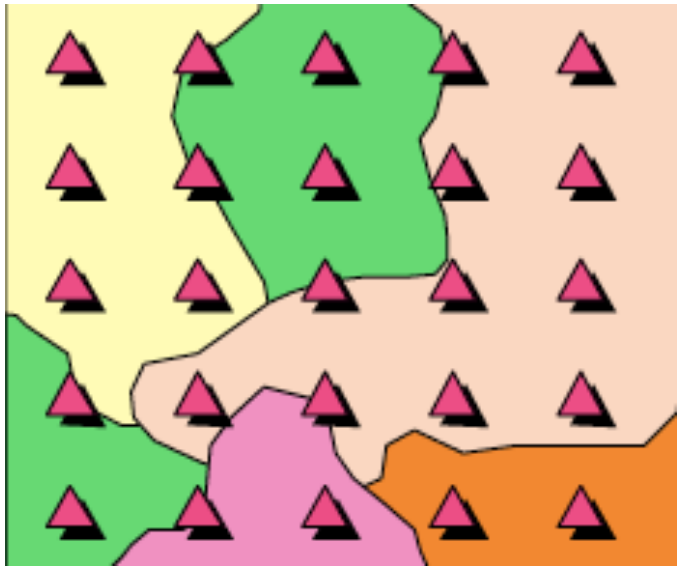


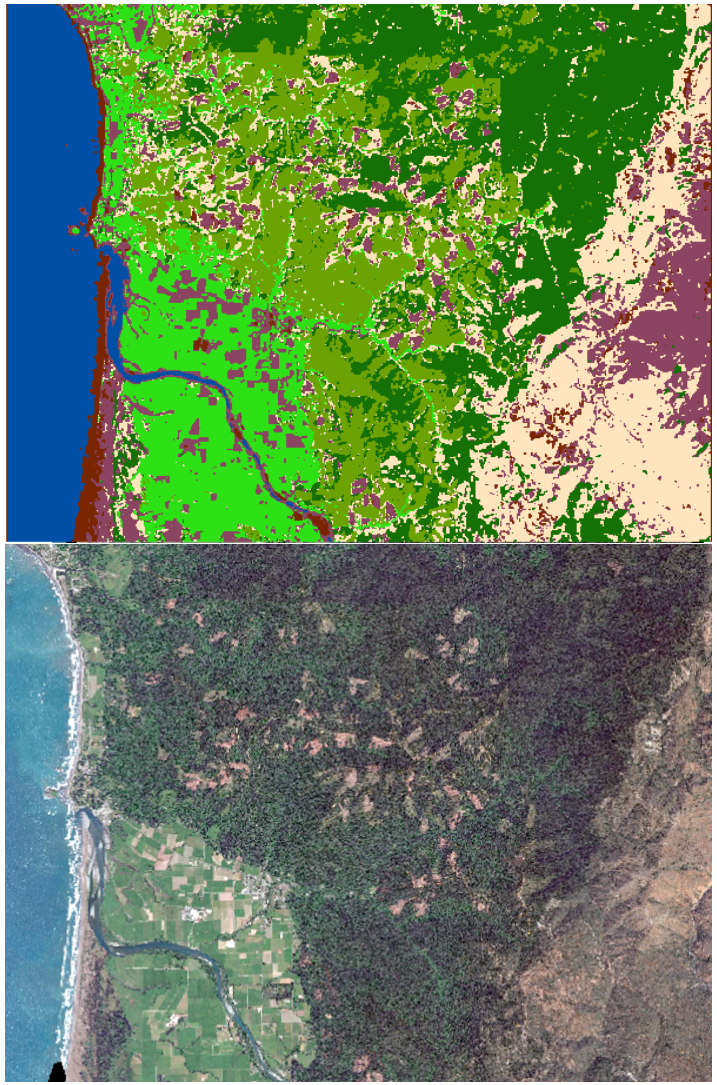
Systematic Sampling:

Observations are placed at equal intervals according to a strategy

Reference Data

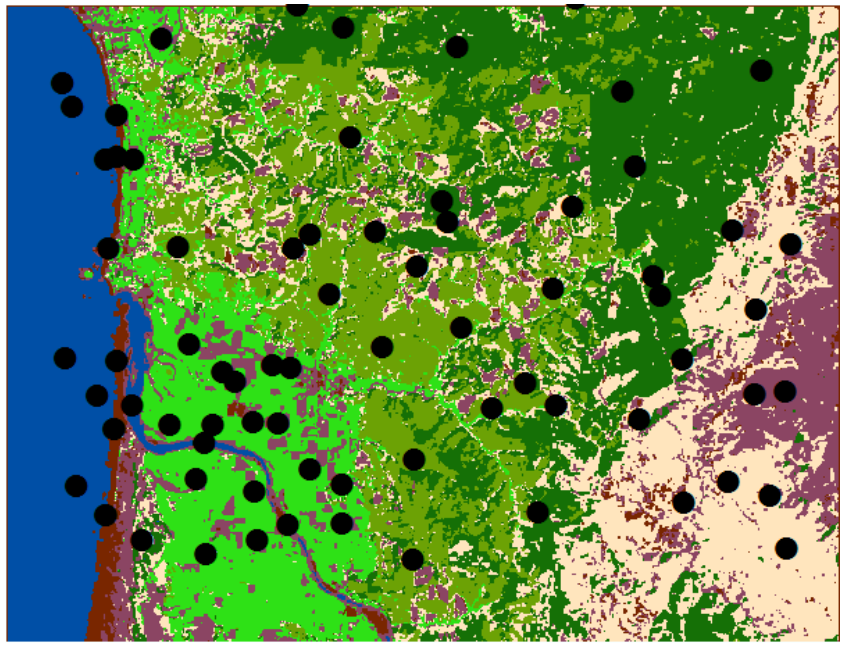
- An existing map
- Existing inventory data
- Aerial photo interpretation
- High resolution satellite imagery
- Ground collected (usually preferred but most expensive)

- Ideally, the reference data should be acquired at or near the same time as the classified image



Using Reference Data to Select Your Pixels

- Place reference points on your classified image and select those pixels
  - May be created with data from GPS
  - May be interpreted from maps or photos



- The result is a table that gives you the land cover class, the associated reference point, and the number of points (frequency) for each combination

Landsat Land Cover	Reference Point	Frequency
1	1	24
1	2	10
2	2	30
2	3	5
3	3	23
3	1	1

Creating an Error Matrix

Land Cover Classes

1 – Hardwood
2 – Conifer
3 - Other

Landsat Land Cover	Reference Point	Frequency
1	1	24
1	2	10
2	2	30
2	3	5
3	3	23
3	1	1

Creating an Error Matrix

Land Cover Classes
1 – Hardwood
2 – Conifer
3 - Other

Landsat Land Cover	Reference Point	Frequency
1	1	24
1	2	10
2	2	30
2	3	5
3	3	23
3	1	1

Correctly classified

Error Matrix

- Compares the reference data to the classified map
- Here is an example of an Error Matrix using three classes:
  - hardwoods, conifers, and other

Classification Data	Reference Data: Hardwood	Reference Data: Conifer	Reference Data: Other	Total
Hardwood	24	10	4	38
Conifer	5	30	2	37
Other	1	1	23	25
Total	30	41	29	100

Error Matrix

Reference Data

Classification Data	Hardwood	Conifer	Other	Total
Hardwood	24	10	4	38
Conifer	5	30	2	37
Other	1	1	23	25
Total	30	41	29	100

Diagonals are pixels classified correctly according to the reference data

Error Matrix

Reference Data

Classification Data	Hardwood	Conifer	Other	Total
Hardwood	24	10	4	38
Conifer	5	30	2	37
Other	1	1	23	25
Total	30	41	29	100

Column totals are the total number of reference pixels in each class

Error Matrix

Reference Data

Classification Data	Hardwood	Conifer	Other	Total
Hardwood	24	10	4	38
Conifer	5	30	2	37
Other	1	1	23	25
Total	30	41	29	100

Row totals are the total number of classified pixels in each class

Error Matrix

Reference Data

Classification Data	Hardwood	Conifer	Other	Total
Hardwood	24	10	4	38
Conifer	5	30	2	37
Other	1	1	23	25
Total	30	41	29	100

Off diagonal numbers represent errors in the classification

Error Matrix

Reference Data

Classification Data	Hardwood	Conifer	Other	Total
Hardwood	24	10	4	38
Conifer	5	30	2	37
Other	1	1	23	25
Total	30	41	29	100

Overall accuracy is the sum of the diagonals divided by the total:
(24 + 30 + 23) / 100 = 77/100 = 77%

Error Matrix

Reference Data

Classification Data	Hardwood	Conifer	Other	Total
Hardwood	24	10	4	38
Conifer	5	30	2	37
Other	1	1	23	25
Total	30	41	29	100

Individual class accuracy is the diagonal value divided by the row **or** column sum:
Conifer: 30/37 = 0.81 = **81%** OR 30/41 = 0.73 = 73%

Individual Class Accuracy

- Classification error occurs when a pixel belonging to one category is assigned to another category
- There are two types of errors: Omission and Commission
  - Errors of omission occur when a pixel is left out of the category being evaluated (of all the pixels that are actually conifers, those that have been classified as hardwood)
  - Errors of commission occur when a pixel is incorrectly included in the category being evaluated (of all the classified hardwood pixels, those that are actually conifers)
- Measures of accuracy (% correct) are called User's and Producer's Accuracy
  - User's Accuracy measures errors of commission
  - Producer's Accuracy measures errors of omission

Error Matrix

Reference Data

Classification Data	Hardwood	Conifer	Other	Total
Hardwood	24	10	4	38
Conifer	5	30	2	37
Other	1	1	23	25
Total	30	41	29	100

User's accuracy (errors of commission): Diagonal value divided by the row total:

30 / 37 = 81%

Of the 37 pixels classified as conifers, 30 were identified as conifers in the reference data. 5 hardwood and 2 other pixels were included in the conifer classification.

Error Matrix

Reference Data

Classification Data	Hardwood	Conifer	Other	Total
Hardwood	24	10	4	38
Conifer	5	30	2	37
Other	1	1	23	25
Total	30	41	29	100

Producer's accuracy (errors of omission): diagonal value divided by the column total

30 / 41 = 73%

Of the 41 pixels that were referenced as conifer, only 30 were correctly classified as conifer. 10 were classified as hardwood and 1 was classified as other

Error Matrix

Remember that the overall accuracy is 77%

Classification Data	Reference Data: Hardwood	Reference Data: Conifer	Reference Data: Other	Reference Data: Total
Hardwood	24	10	4	38
Conifer	5	30	2	37
Other	1	1	23	25
Total	30	41	29	100

User's Accuracies

- Hardwood: 24/38 = 63%
- Conifer: 30/37 = 81%
- Other: 23/25 = 92%

Producer's Accuracies

- Hardwood: 24/30 = 80%
- Conifer: 30/41 = 73%
- Other: 23/29 = 79%

Accuracy Assessment Conclusions

- Determining sample size is not trivial!
- Avoiding bias is important
- Generally, 80% overall accuracy is considered good
- But…identifying error is more complicated than simply reporting overall accuracy
  – It is important to know which classes have the greatest error
- Next week: Using the error matrix to calculate unbiased area estimates