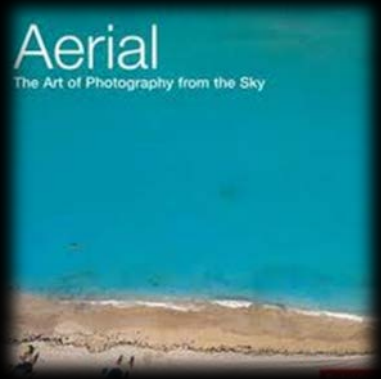
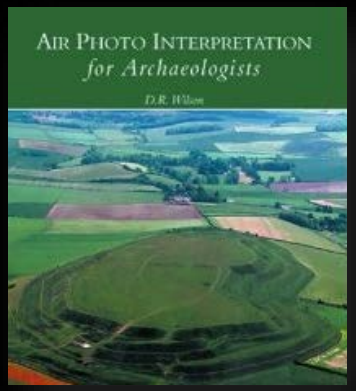
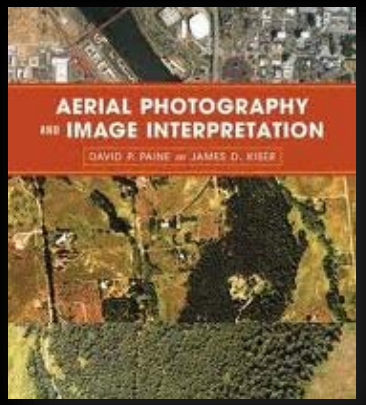
Aerial photography: Principles

Visual interpretation of aerial imagery



- Introduction
  - Benefits of aerial imagery
- Image interpretation
  - Elements
  - Tasks
  - Strategies
  - Keys
- Accuracy assessment



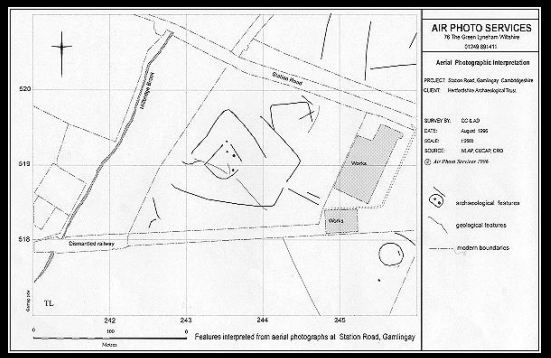


Overview

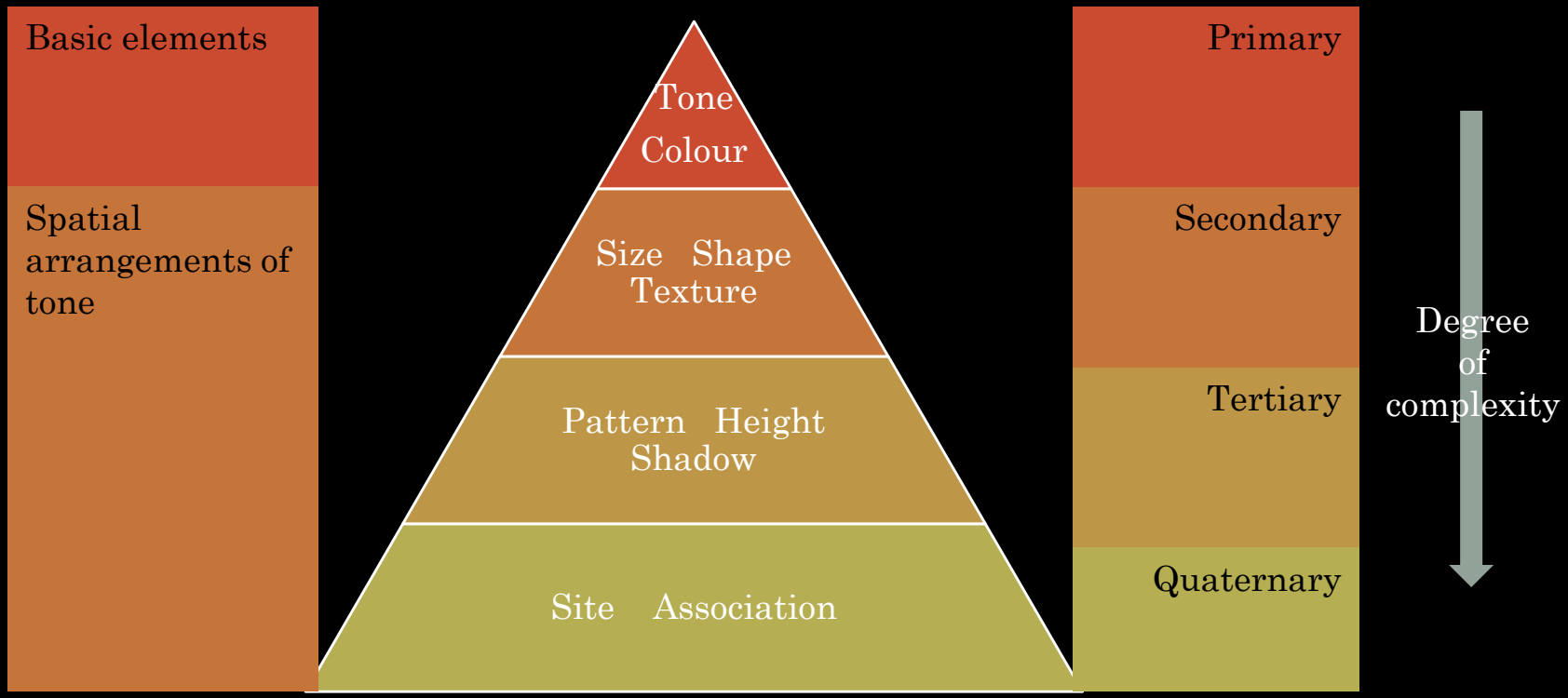
- Benefits of high resolution imagery (at scales greater than 1:40,000)
  - Planimetric presentations easily achieved
  - High spatial resolution
  - Fine attribute resolution
  - Spatial relations can be observed
  - Multi-temporal analyses possible, often over a long time period (decades)

Why?

- An image interpretation exercise is composed of several different stages:
  - Object recognition
  - Information derivation
- which can be approached with several different strategies using a variety of tools,
- the results of which need to quality assessed.

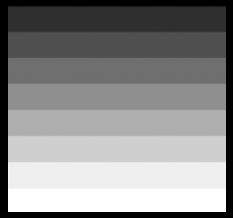


Overview

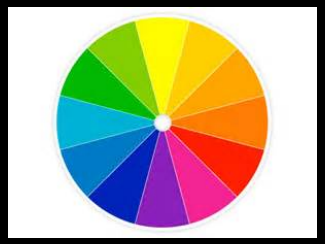


Elements of image interpretation

Tone and colour are the primary of elements used to identify features.

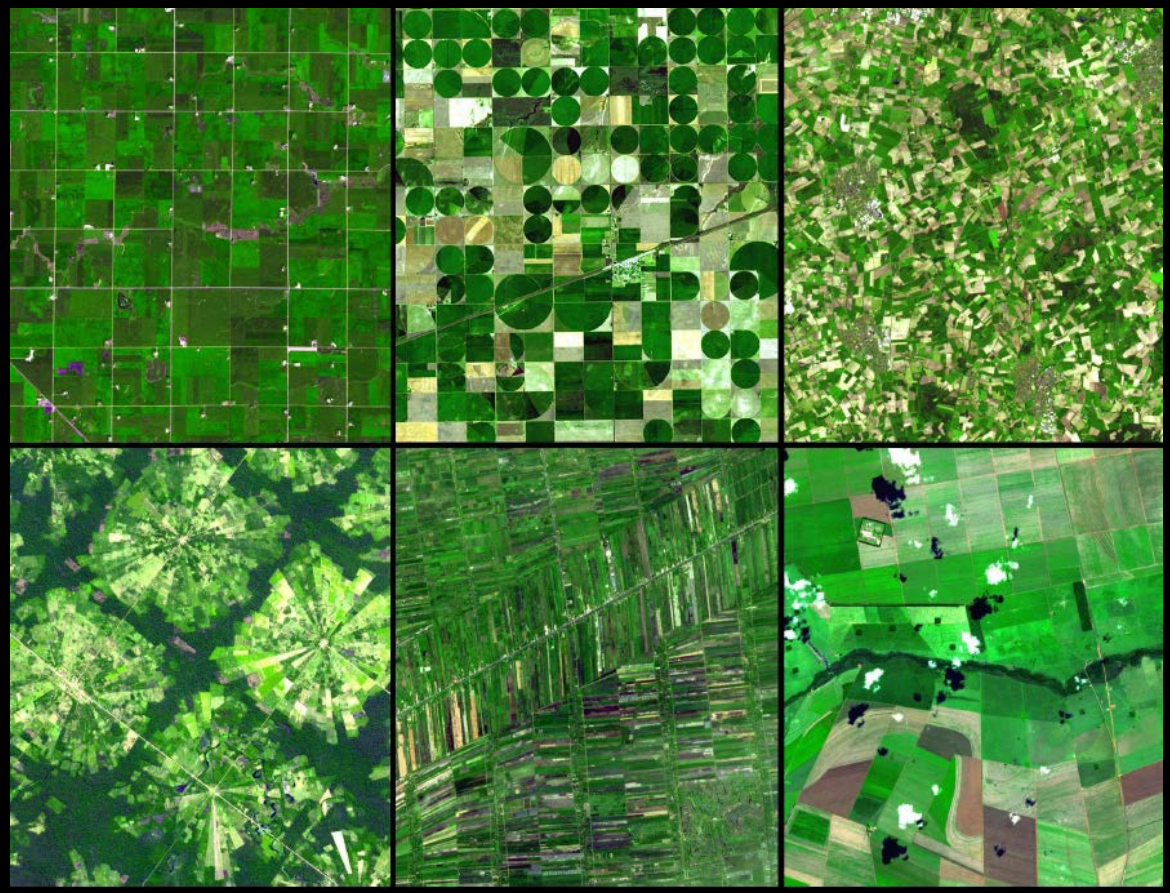


Radiometric



Bands

The same, but different



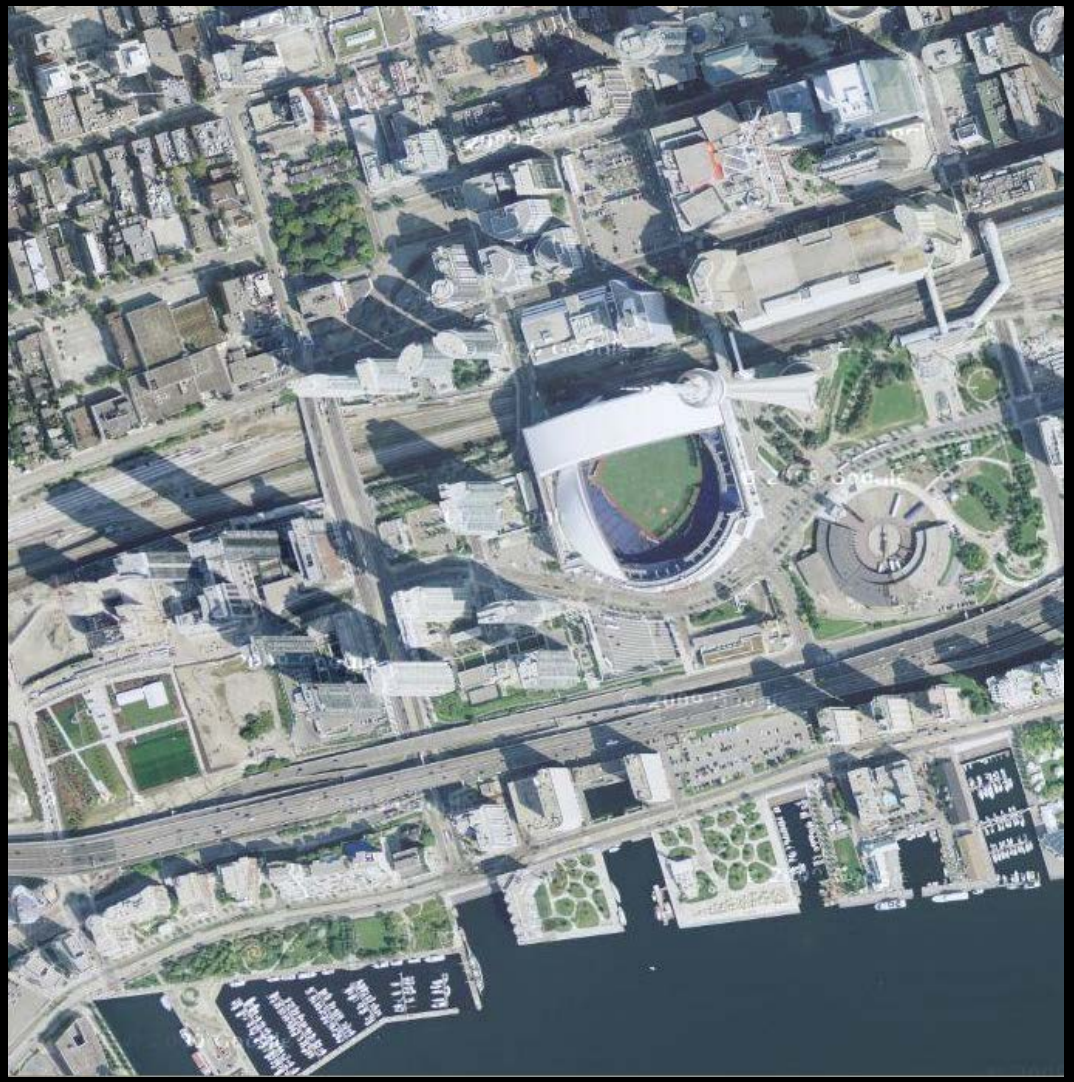
Size, both relative and absolute

Shape

Texture—the degree of coarseness or smoothness exhibited
(a function of the photo scale)

Pattern—the spatial arrangement of objects

Height

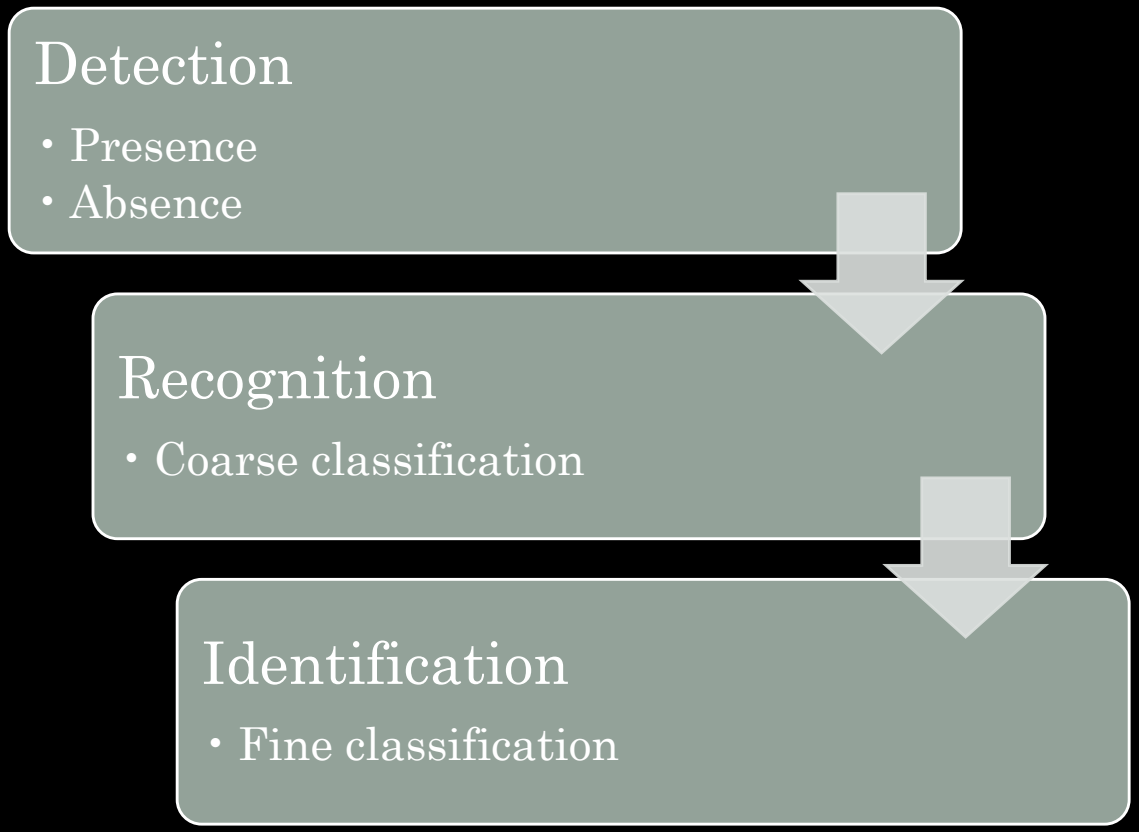


Shadows provide valuable clues, as well as obscuring features

Site—topographic position

Association

Classification



Task: Information derivation

- Enumeration
- Measurement or mensuration
  - Photogrammetry
- Delineation

How many homes in this trailer park?

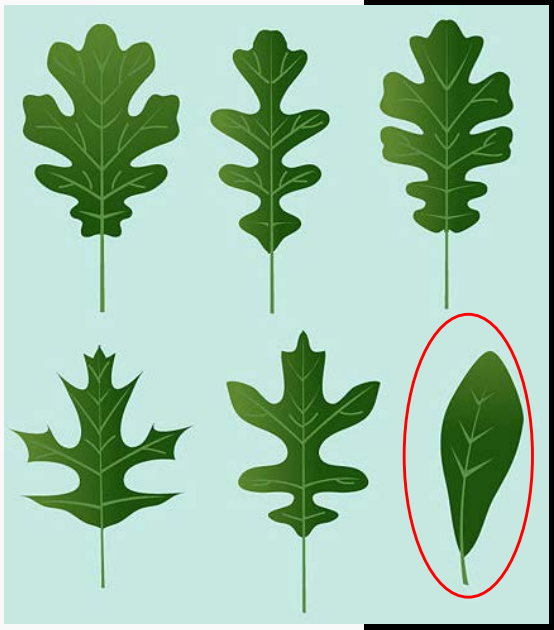
Task: Information derivation

- Field observations
  - Build familiarity
  - Quality assurance
- Direct recognition
  - Practice makes perfect
- Inference
  - Patterns reflect processes
- Interpretive overlays
  - Extracting singular classes (e.g., land cover, topography [photogrammetry -> contours]) which, when combined, enable inferences to be made.

Strategies for interpretation

Example of a diagnostic dichotomous key for some eastern United States oaks based on leaf characteristics

1. Leaves usually without teeth or lobes: 2
1. Leaves usually with teeth or lobes: 5
    2. Leaves evergreen: 3
    2. Leaves not evergreen: 4
3. Mature plant a large tree — Southern live oak *Quercus virginiana*
3. Mature plant a small shrub — Dwarf live oak *Quercus minima*
    4. Leaf narrow, about 4-6 times as long as broad — Willow oak *Quercus phellos*
    4. Leaf broad, about 2-3 times as long as broad — Shingle oak *Quercus imbricaria*
5. Lobes or teeth bristle-tipped: 6
5. Lobes or teeth rounded or blunt-pointed, no bristles: 7
    6. Leaves mostly with 3 lobes — Blackjack oak *Quercus marilandica*
    6. Leaves mostly with 7-9 lobes — Northern red oak *Quercus rubra*
7. Leaves with 5-9 deep lobes — White oak *Quercus alba*
7. Leaves with 21-27 shallow lobes — Swamp chestnut oak *Quercus prinus*



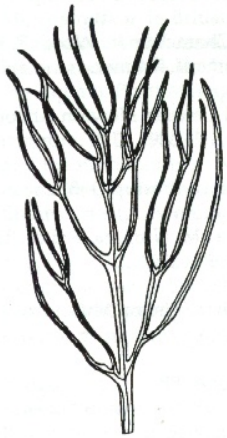
The keys to success

GENERAL KEY TO THE AQUATIC PLANTS OF BRITISH COLUMBIA

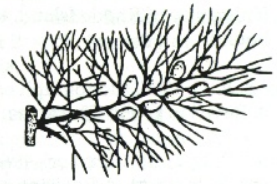
- 1. plants of lakes, ponds, rivers and other permanent freshwater habitats, all herbaceous, rooted emergents, floating or submersed.
  - 2. plants all floating freely on the surface of the water, or just under the surface, not rooted or attached, except sometimes when stranded. **General Key: Aquatic Plants of British Columbia: Part 1.**
  - 2. plants submersed or emergent, generally rooted or attached, not freely floating on or at the surface.
    - 3. plants fully submersed, leaves may float on the surface and flowers may be emergent, stems and petioles remain on or under the water.
      - 4. plants with at least some, and often all, the underwater leaves finely dissected, and with at most a few floating leaves. **General Key: Aquatic Plants of British Columbia: Part 2.**
      - 4. plants lacking finely dissected submersed leaves, leaves may all float on the surface, may all be fully submersed or be some combination of both. **General Key: Aquatic Plants of British Columbia: Part 3.**
    - 3. plants rooted in the sediment but emergent, much, if not most or all, of the stem is emergent for most or all of the year.
      - 5. leaves cauline, more or less evenly distributed along the stem.
        - 6. leaves opposite or whorled, in groups, or clusters of several leaves. **General Key: Aquatic Plants of British Columbia: Part 4.**
        - 6. leaves alternate, only one at a node. **General Key: Aquatic Plants of British Columbia: Part 5.**
      - 5. leaves in basal clusters or bunches, not evenly distributed along an elongate stem. **General Key: Aquatic Plants of British Columbia: Part 6.**
- 1. plants of marine or brackish lagoon habitats. **General Key: Aquatic Plants of British Columbia: Part 7.**

Figure 1

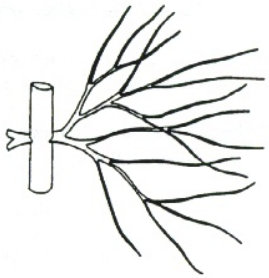
Examples of Dissected Underwater Leaves



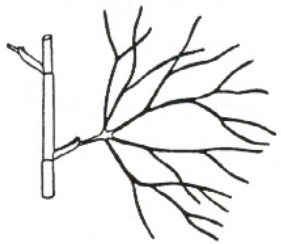
Limnophila sessiliflora



Utricularia vulgaris



Megalodonta beckii



Ranunculus aquatilis

Ceratophyllum demersum

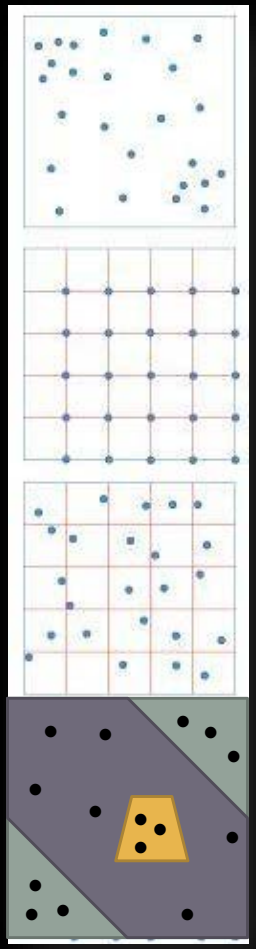
The keys to success

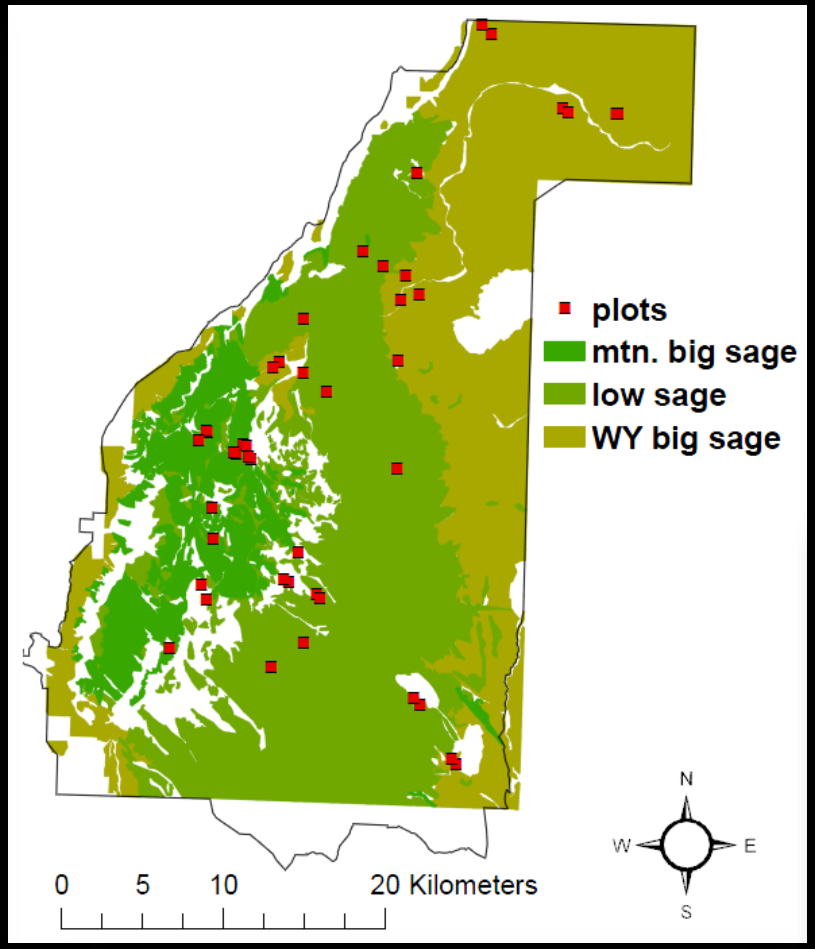
- It is (relatively) easy to quantify the accuracy of measurements such as the height or area of an object (using traditional statistics).

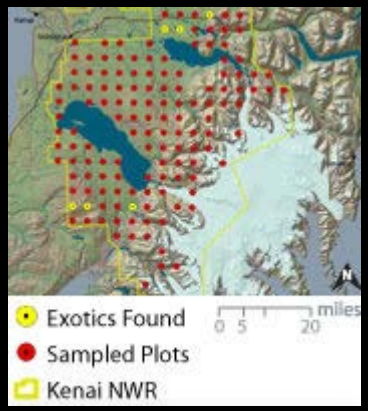
- However, how can you measure the accuracy of **nominal** attributes?
  - e.g., a vegetation cover map

- The confusion or misclassification matrix
  - compares recorded classes (the *observations*) with classes obtained by a more accurate process, or from a more accurate source (the *reference*)

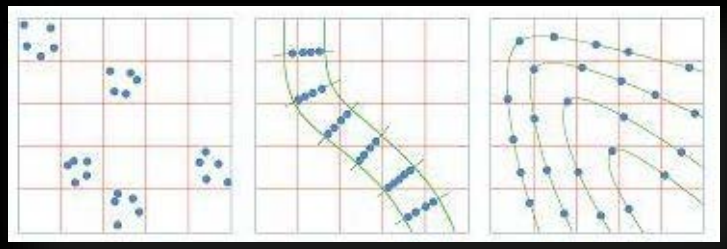
Quality assessment







Spatial sampling schemes



The **bolded numbers** (along the diagonal) reflect correct classification (i.e., where the land use in the database equaled the land use observed in the field). The off-diagonal numbers reflect incorrect land use records in the database.

Land use: photo identified	Land use: in the field A	B	C	D	E	Total
A	**80**	4	0	15	7	106
B	2	**17**	0	9	2	30
C	12	5	**9**	4	8	38
D	7	8	0	**65**	0	80
E	3	2	1	6	**38**	50
Total	104	36	10	99	55	304

Misclassification Matrix

- Percent correctly classified
  - total of diagonal entries divided by the grand total, times 100
  - 209/304*100 = 68.8%
    - but chance would give a score of better than 0%

- Kappa statistic
  - normalized to range from 0 (chance) to 100
  - evaluates to 58.3%

Land use: in the field

Land use: photo identified	A	B	C	D	E	Total
A	80	4	0	15	7	106
B	2	17	0	9	2	30
C	12	5	9	4	8	38
D	7	8	0	65	0	80
E	3	2	1	6	38	50
Total	104	36	10	99	55	304

Misclassification Statistics

Ground truth: Field data or a map

CALVEG Type Table 2

Classified data \ Reference data	DF	DP	MP	DW	MF	WF	RF	Row Total
DF	**18**	3	0	0	0	0	0	21
DP	2	**0**	0	0	0	0	0	2
MP	4	2	**2**	0	0	0	0	8
DW	3	0	0	**5**	2	0	0	10
MF	0	0	0	1	**4**	1	0	6
WF	0	0	0	0	0	**2**	0	2
RF	0	0	0	0	0	1	**1**	2
Column Total	27	5	2	6	6	4	1	**51**
							Center=	**32**

Overall Accuracy= 63%

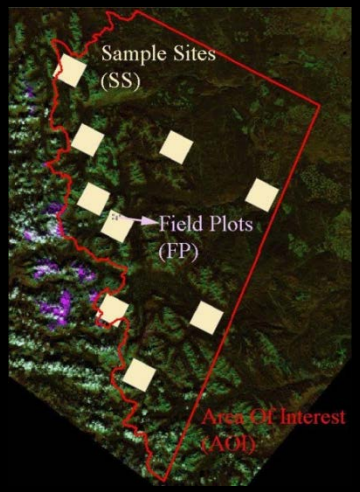
Producer's Accuracy		User's Accuracy	
DF=18/27=	67%	DF=18/21=	86%
DP=0/5=	0%	DP=0/2=	0%
MP=2/2=	100%	MP=2/8	25%
DW=5/6=	83%	DW=5/10=	50%
MF=4/6=	67%	MF=4/6=	67%
WF=2/4=	50%	WF=2/2=	100%
RF=1/1=	100%	RF=1/2=	50%

Producer's accuracy: It shows what %age of a particular ground class was correctly classified. Divide the number of correct pixels for a class by the actual number of ground truth pixels for that class

User's accuracy: It is a measure of the reliability of an output map. It is a statistic that can tell the user of the map what percentage of a class corresponds to the ground-truthed class.

Misclassification statistics

- Examining every parcel / polygon may not be practical
- Rarer classes should be sampled more often in order to assess accuracy reliably
  - sampling is often stratified by class



Collecting the Reference Data

- Error can occur in the attributes (e.g., a Douglas fir forest can be classified as a Ponderosa pine forest), but it can also occur in the positions of the boundaries (spatial inaccuracy).
  - While the interiors of most polygons may be accurately identified, the boundaries between classes are often uncertain (fuzzy boundaries).

Quality assurance complications

- Introduction
  - Benefits of aerial imagery
- Image interpretation
  - Elements
  - Tasks
  - Strategies
  - Keys
- Accuracy assessment

Summary

What bird is this,
the friendliest bird in BC?