More on Habitat Models

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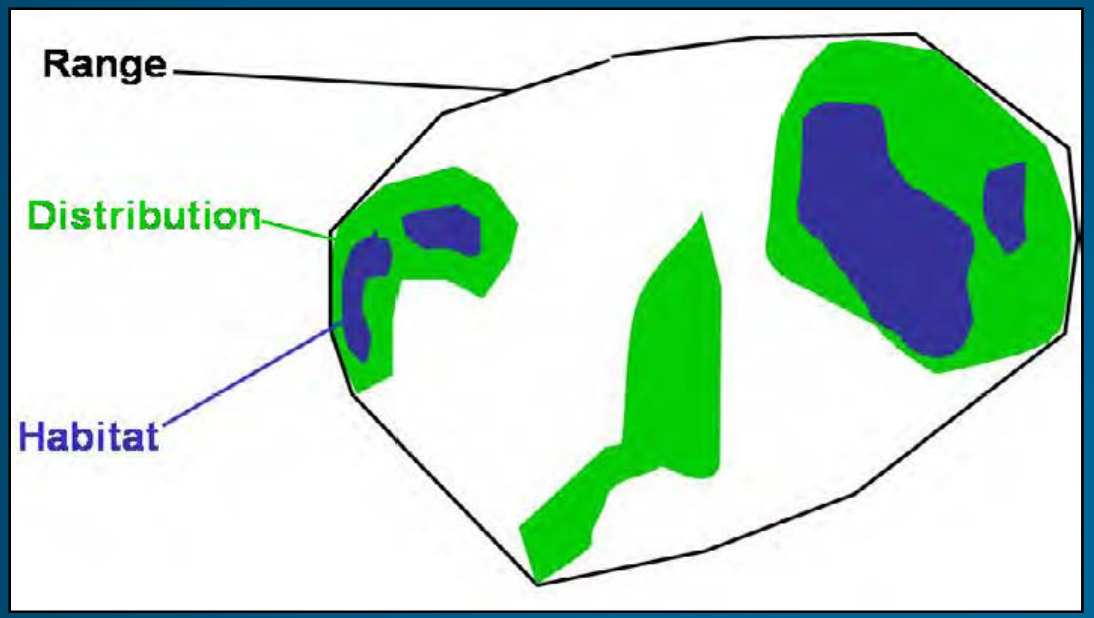
USGS science for a changing world

Area of occupancy

Range - spatial limits within which a species can be found

Distribution - finer-scale depiction of a species spatial patterning

Habitat - combination of resources and conditions that promote occupancy, survival, and reproduction



Morrison and Hall 2002

Modeling Approaches

Deductive
and
Inductive
modeling
approaches

Methods of Reasoning

Theory

↓

Hypothesis

↓

Observation

↓

Confirmation

Deduction Reasoning

Theory

↑

Hypothesis

↑

Pattern

↑

Observation

Induction Reasoning

Lambing Habitat Model

45-315 degrees aspect

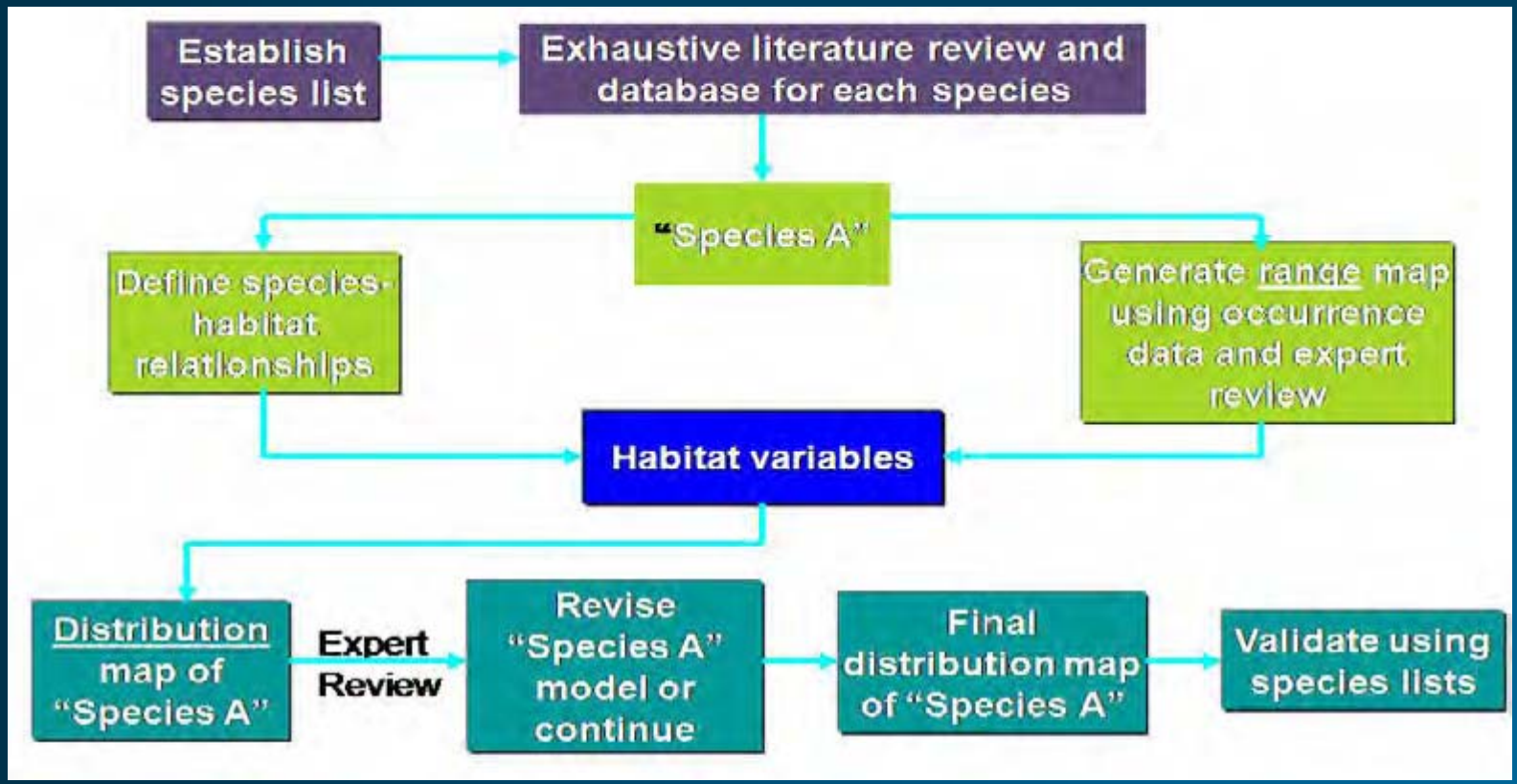
31-85 degrees slope

<=1000m from streams

>=2 ha (20,000 m2)

NLCD = 12,31,33,51,71

Deductive Models

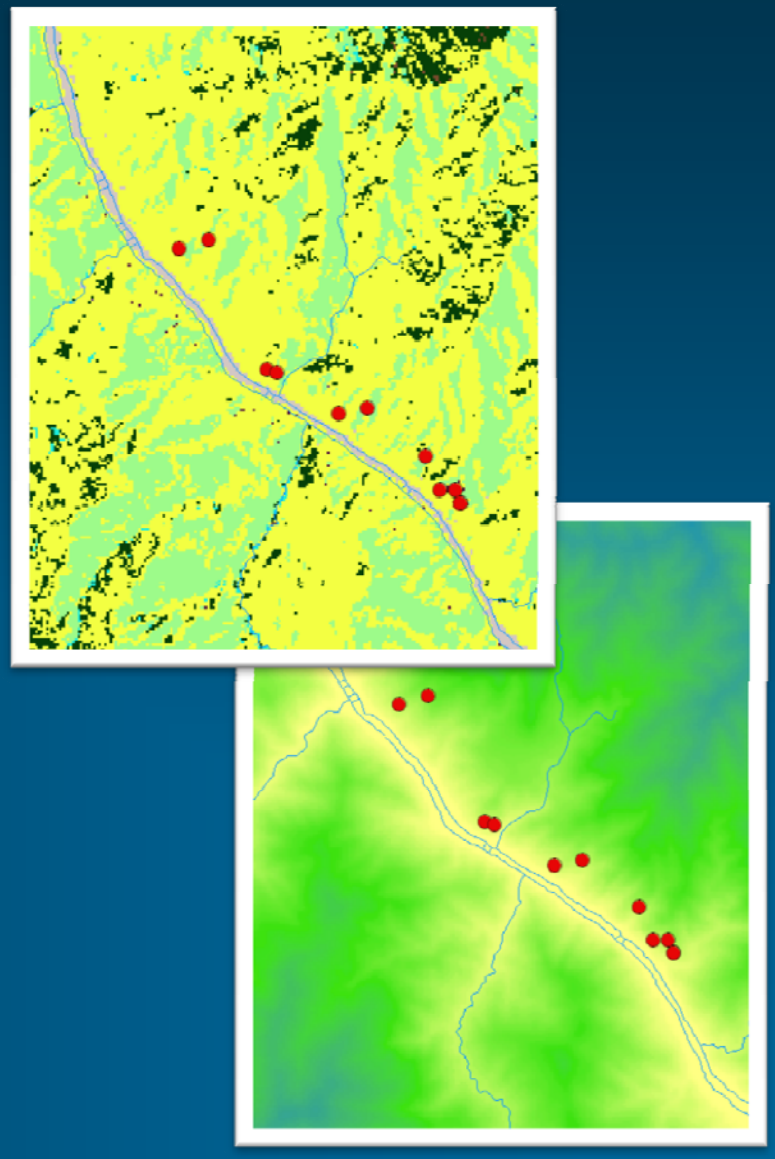


Properties of Deduction

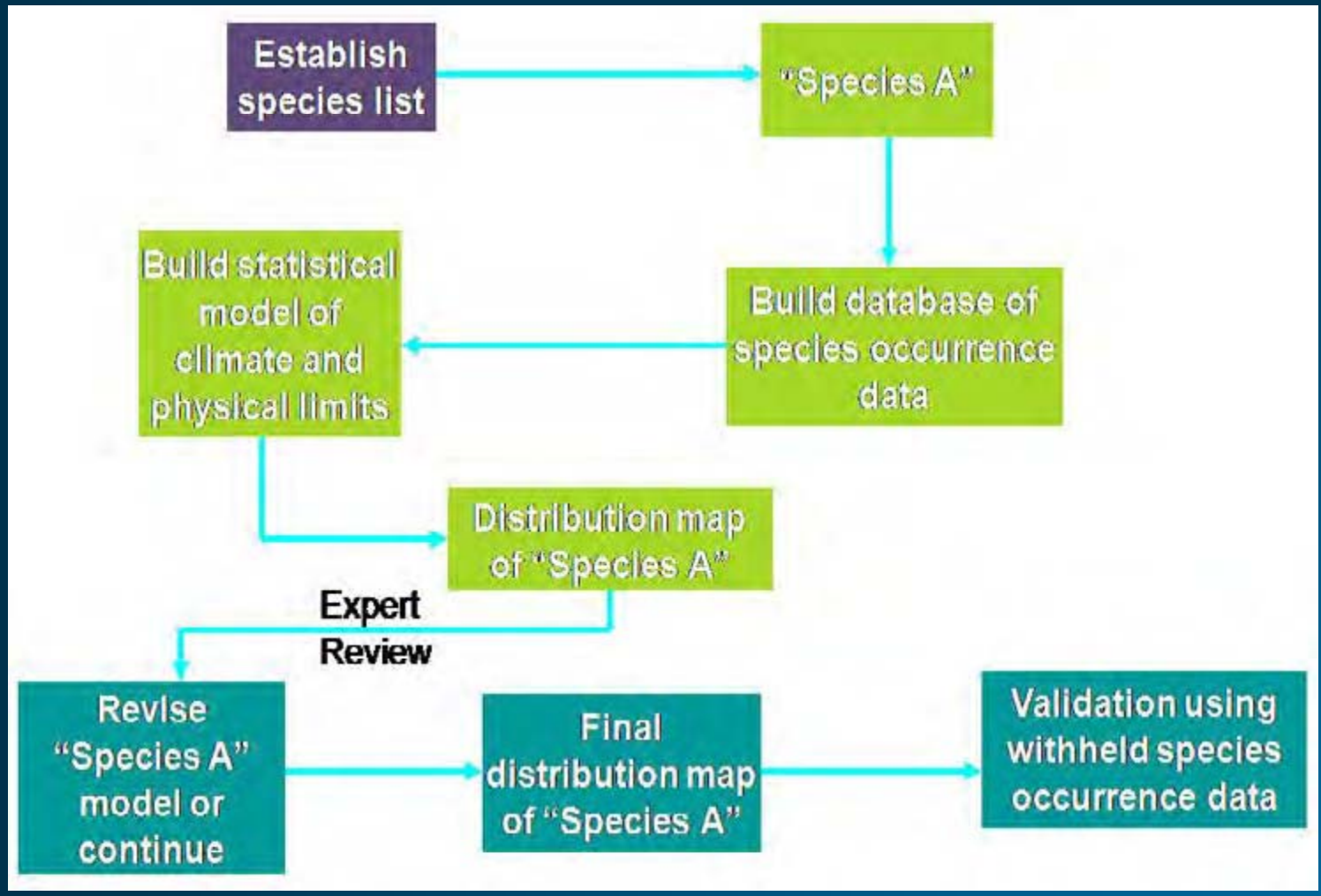
- In a valid deductive argument, all of the content of the conclusion is present
- If the premises are true, the conclusion must be true
- Deductive validity is an all-or-nothing matter; validity does not come in degrees. An argument is totally valid, or it is invalid.

Inductive Model?

Probability of use =
f (aspect, slope,
distance to water, …..)



Inductive Models



Properties of Induction

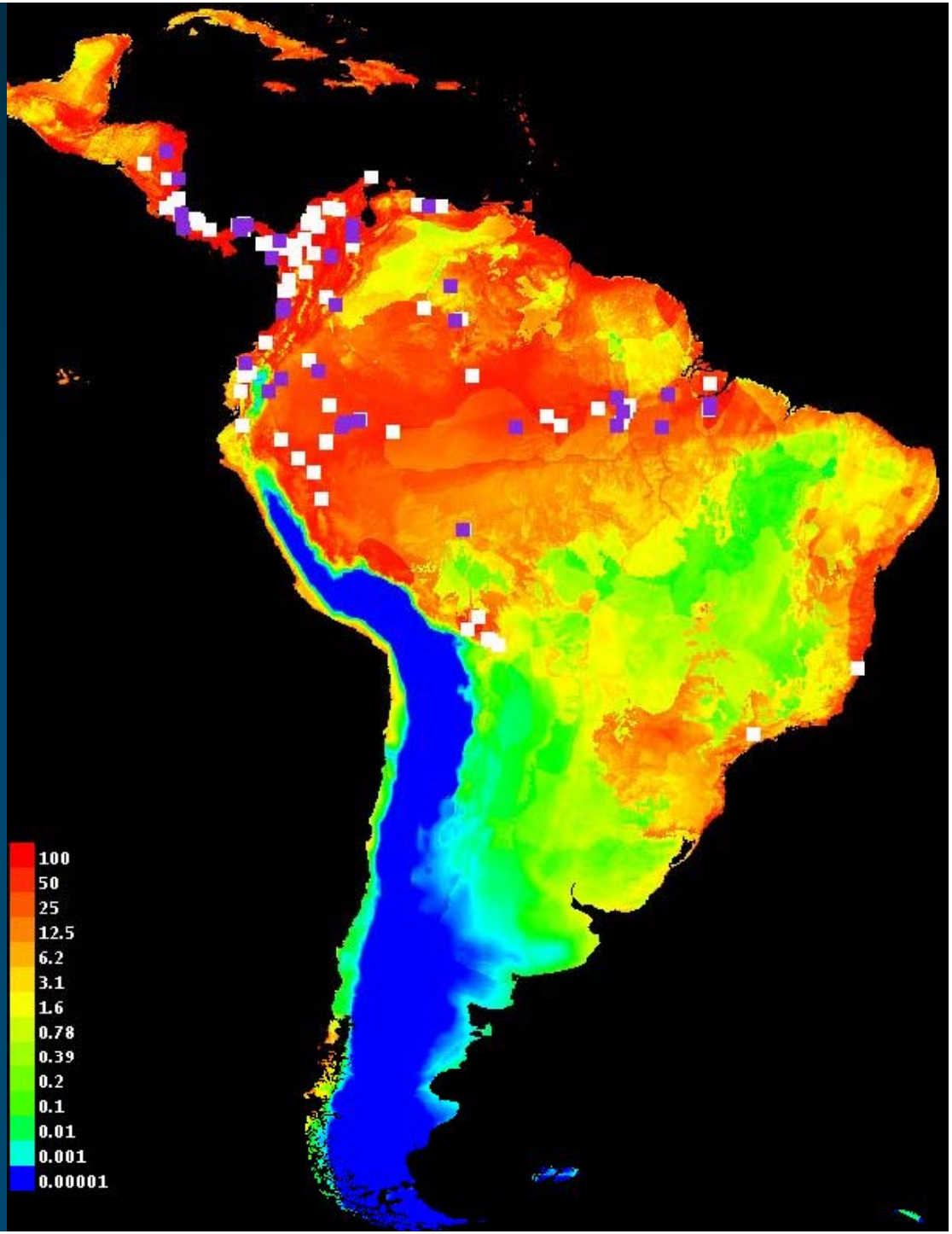
- The conclusion of an inductive argument has content that goes beyond the content of its premises
- A correct inductive argument may have true premises and a false conclusion. Induction is not necessarily truth preserving
- New premises may completely undermine a strong inductive argument
- Inductive arguments come in different degrees of strength

Examples of Models

- Generalized Linear Model (GLM)
- Generalized Additive Model (GAM)
- Classification and Regression Tree (CART)
- Minimum Distance Model
- Domain Modelling Domain (DOMAIN)
- Genetic Algorithm for Rule-set Production (GARP)
- Ecological Niche Factor Analysis (ENFA)
- Maximum Entropy Modeling

Output from MAXENT

http://www.cs.princeton.edu/~schapire/maxent/



Issues of Scale and Accuracy

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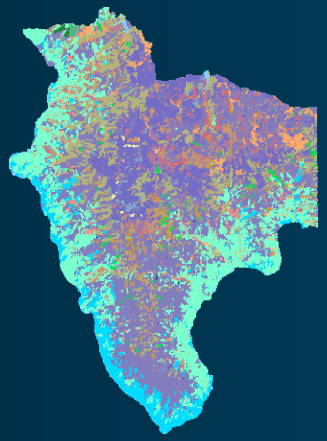
Map Scale



Craig Mountain
Fine scale

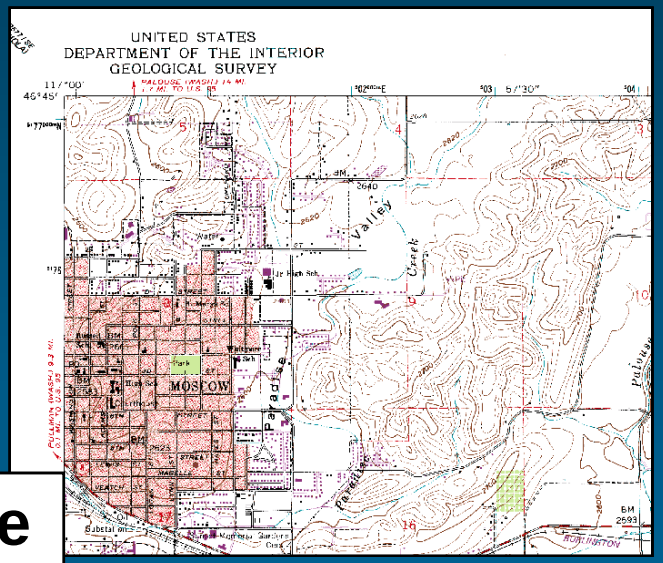
State of Idaho
Mid scale

North America
Broad scale

Effects of Scale

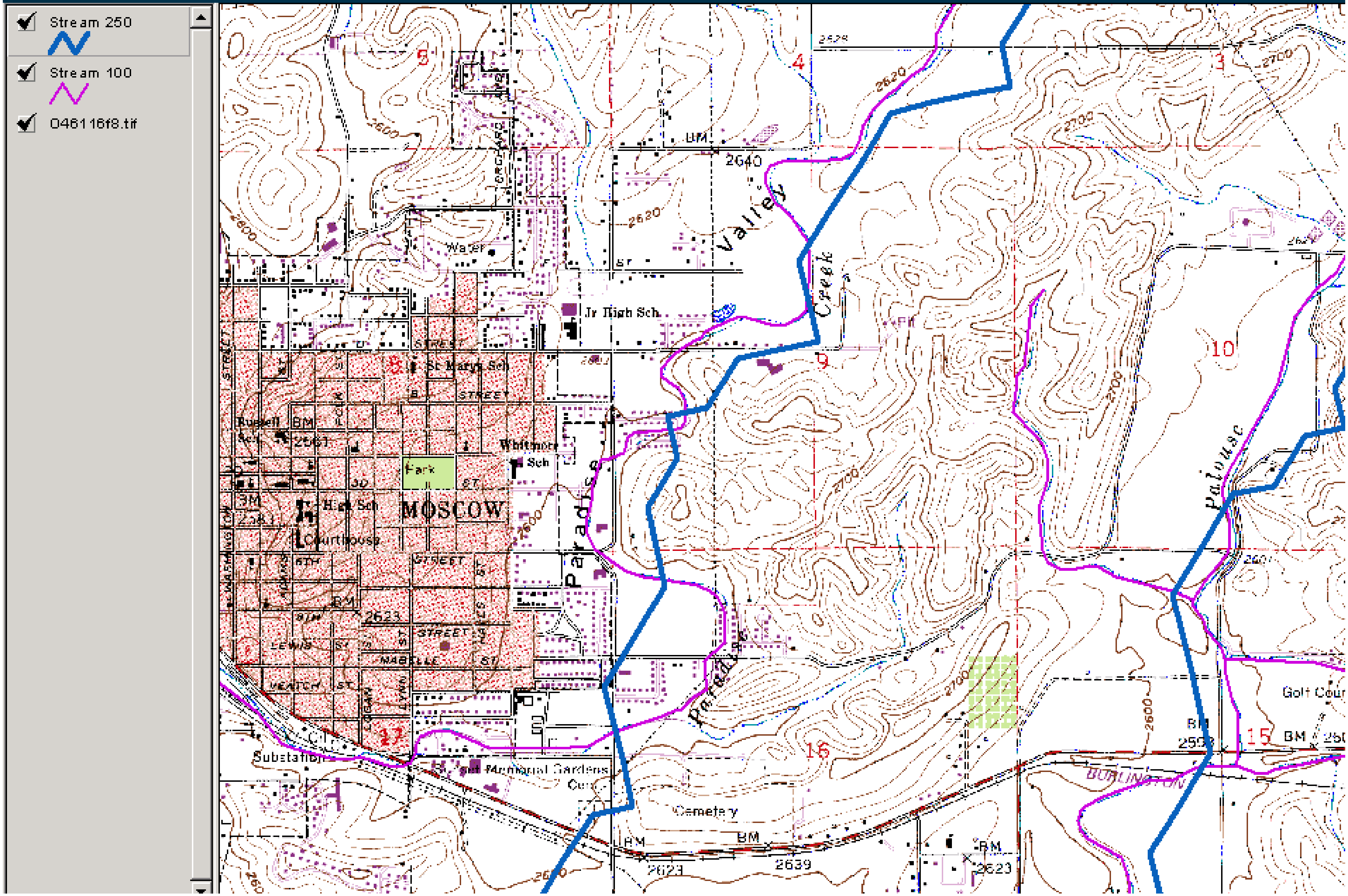
USGS standard formats

	Raster
1: 24,000	30 m
1: 100,000	90 m
1: 250,000	500 m

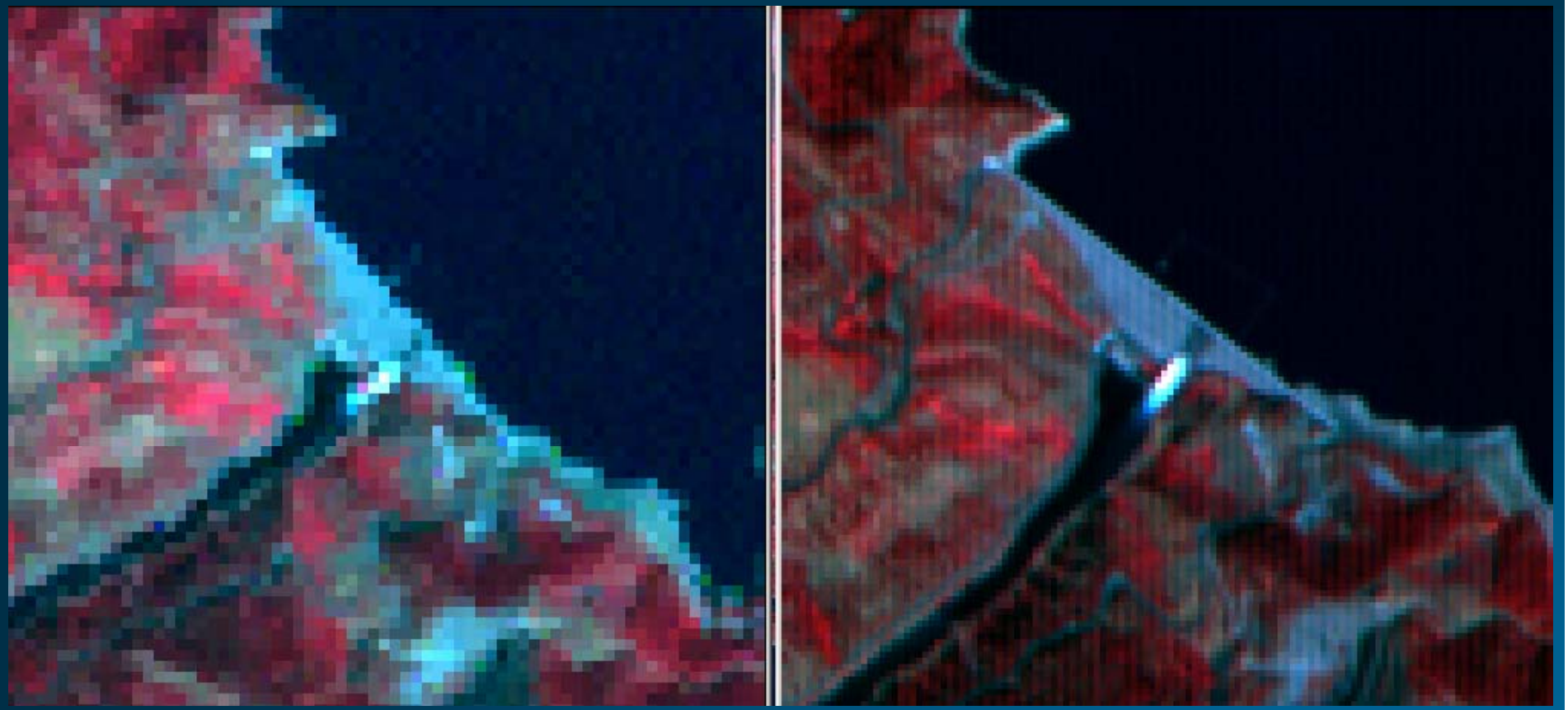


40 ft is an acceptable error for the USGS 1:24,000 scale topo maps.

1:24k topo with streams at 1:100k and 1:250k



Dworshak Dam



Landsat 7 imagery at 30 m resolution

Aster imagery at 15 m resolution

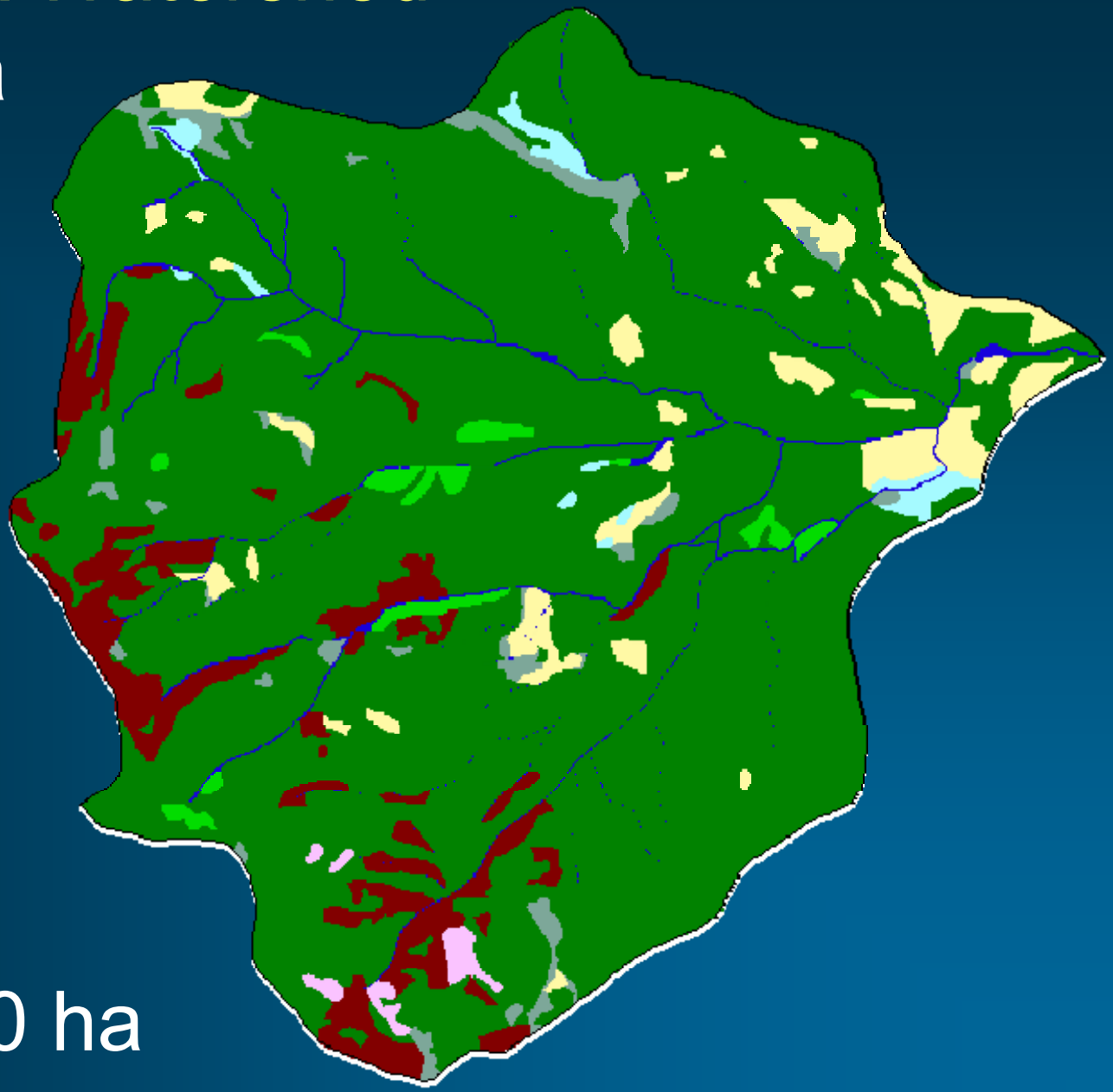
U of I Campus

SPOT imagery
10 m resolution

Orthophoto at
1 m resolution

Smith Creek Watershed

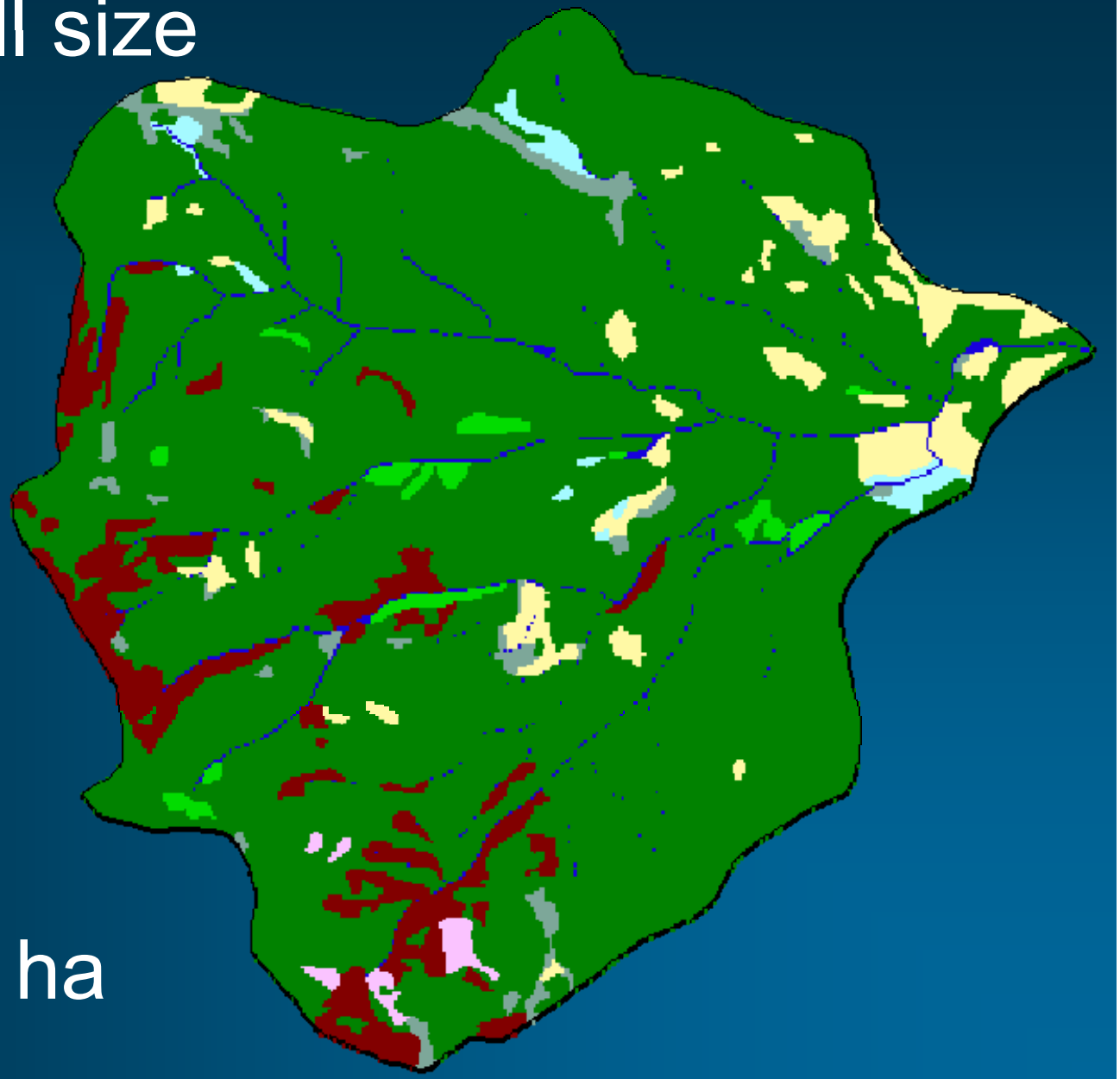
MMU = 1 ha



Riparian 110 ha

Smith Creek Watershed

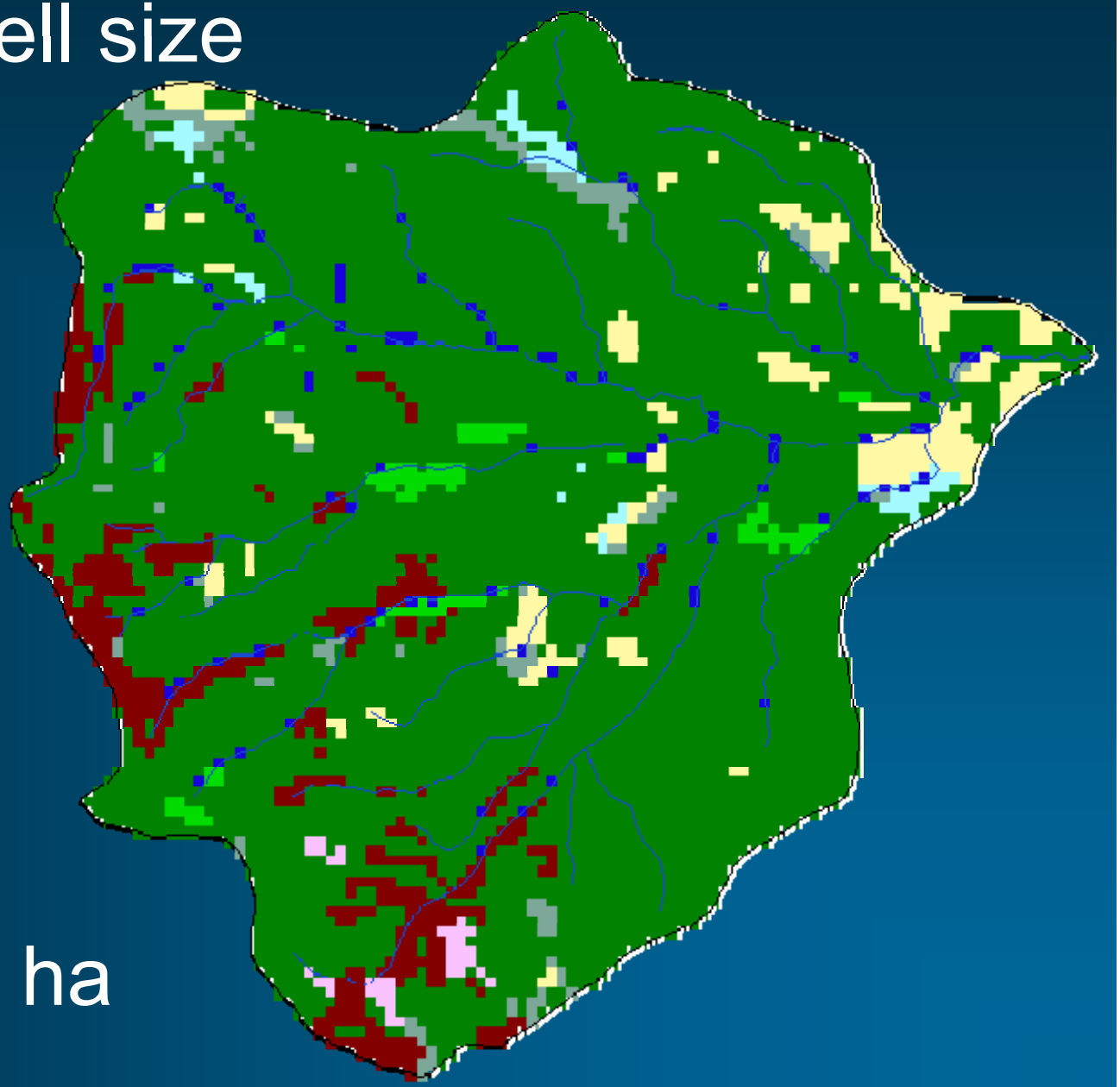
Grid 30 m cell size



Riparian 110 ha

Smith Creek Watershed

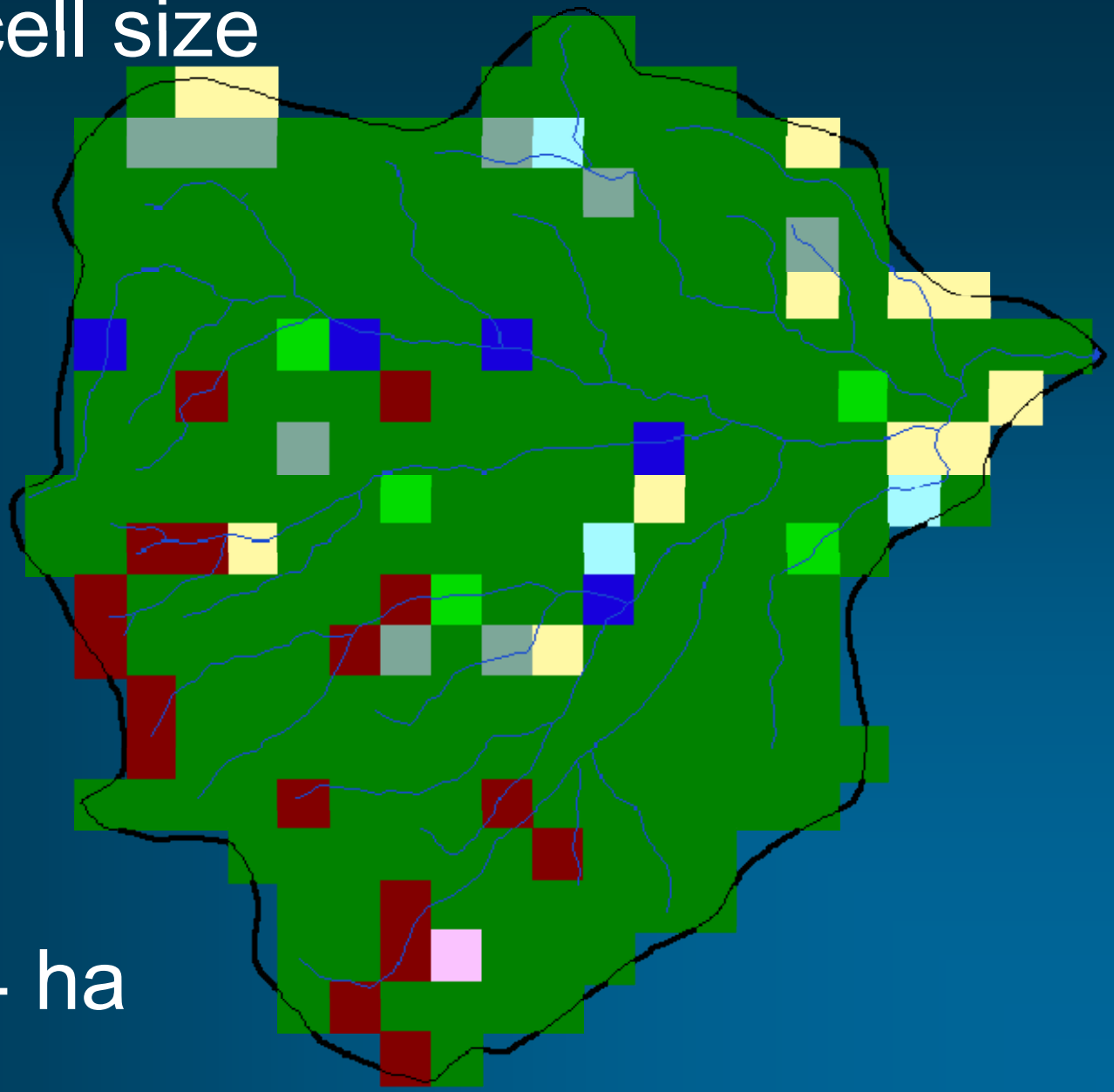
Grid 100 m cell size



Riparian 104 ha

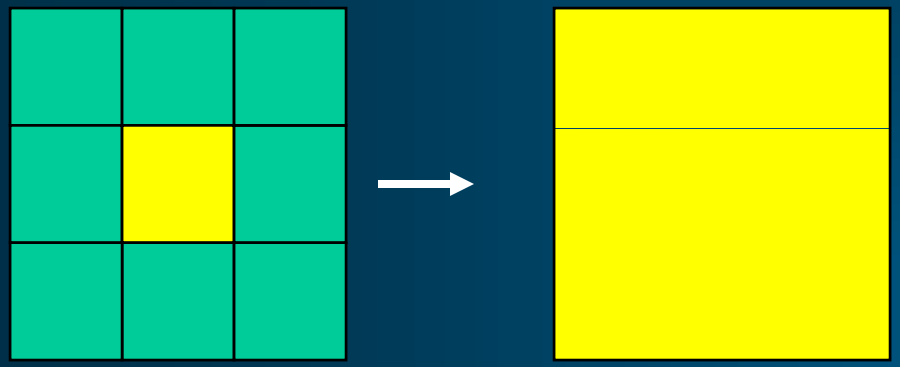
Smith Creek Watershed

Grid 500 m cell size



Riparian 104 ha

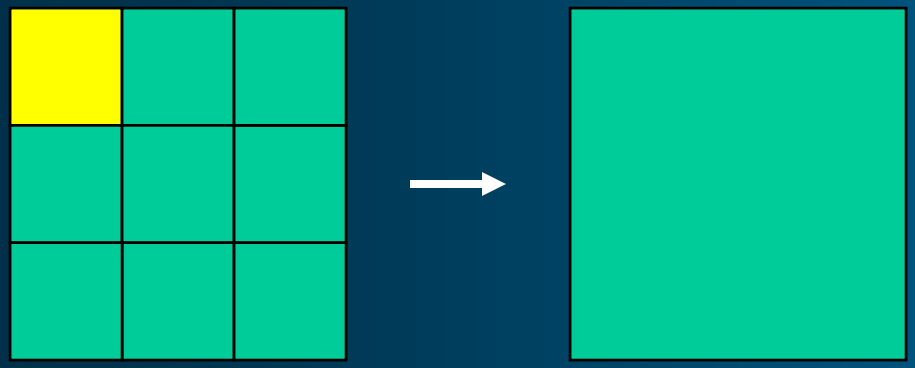
How does the scale of the data affect your analysis?



30 m pixels

90 m pixels

Habitat area overestimated



Habitat area underestimated or lost

Accuracy Assessments

1980's -- Models and model predictions first tested against independent data.

1990's -- Increased attention given to assessments of models developed in a management context. (eg spotted owl)

Alldredge and Ratti 1986, Verner et al 1986, Thomas and Taylor 1990, Scott et al 2002

Model Errors

Omission : species was detected but not predicted (Type II error)

Commission: species was predicted but not detected (Type I error)

Actual Error:
model is inappropriate for the species

Apparent Error:
incomplete surveys

Testing Accuracy

Actual \ Model	Present	Absent
Present	Correct Present (CP)	Omission (OM)
Absent	Commission (CO)	Correct Absent (CA)

% Omission = OM / (CP + OM)

% Commission = CO / (CP + CO)

Errors

Causes of False Commission

- Failure to sample appropriate spatial or temporal strata
- Inadequate sampling effort
- Ineffective or inappropriate survey technique

Model Errors

- Statistical models derived from field data tend to under predict species occurrences.
- Habitat association models derived from literature and expert review tend to over predict.

Hepinstall et al 2002 *Predicting Species Occurrences*

Accuracy & Sample Size

- Reliability asymptotes around 1000 independent observations
- Small sample sizes cause instability
- At small sample sizes, apparent error can account for 55% of commission error

Scott et al, eds. 2002 *Predicting Species Occurrences*

"Small sample sizes preclude reliable estimates of accuracy of habitat relationship models for rare species."

Karl et al 2002,
Predicting Species Occurrences: Issues of Accuracy and Scale

Useful Criteria

Precision

ability to replicate system parameters

Accuracy

how well it reflects reality

Generality

ability to represent a range of systems

Sensitivity

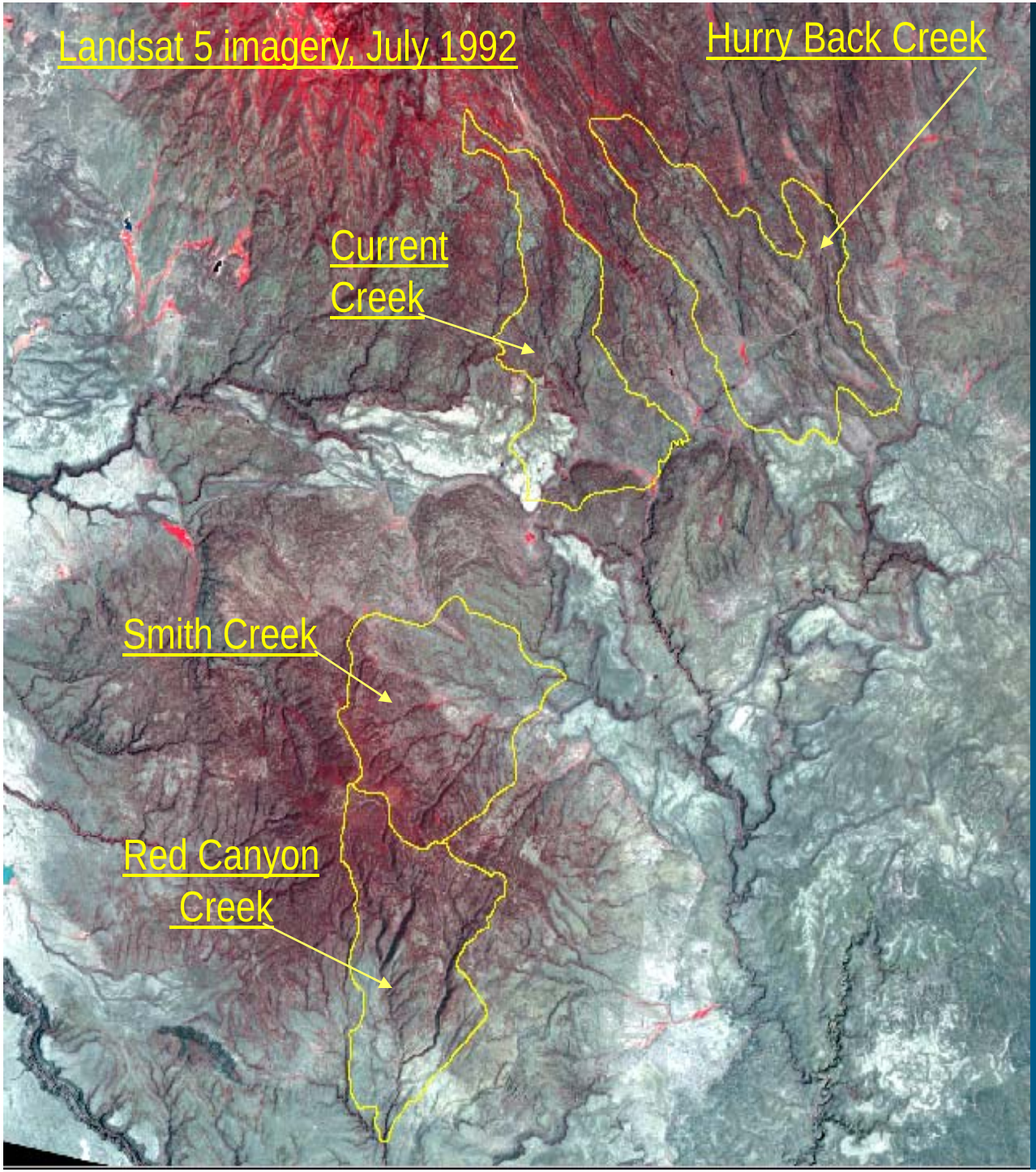
parameters match real-world variables

Adaptability

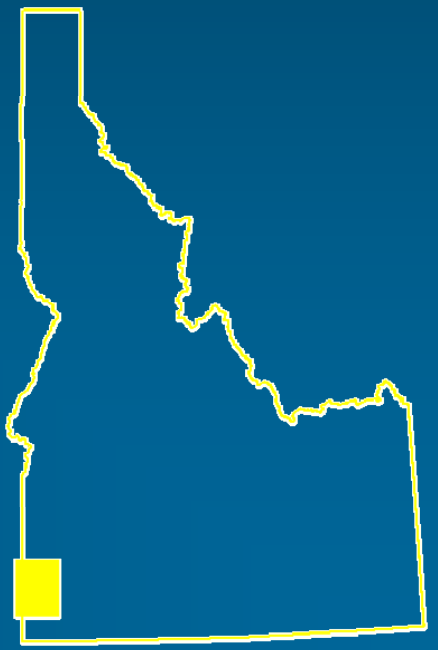
possibilities for future development

Accuracy Assessment

An Example



Succession in a Western Juniper / Sagebrush Steppe Mosaic



Accuracy can be assessed using GPS ground control points

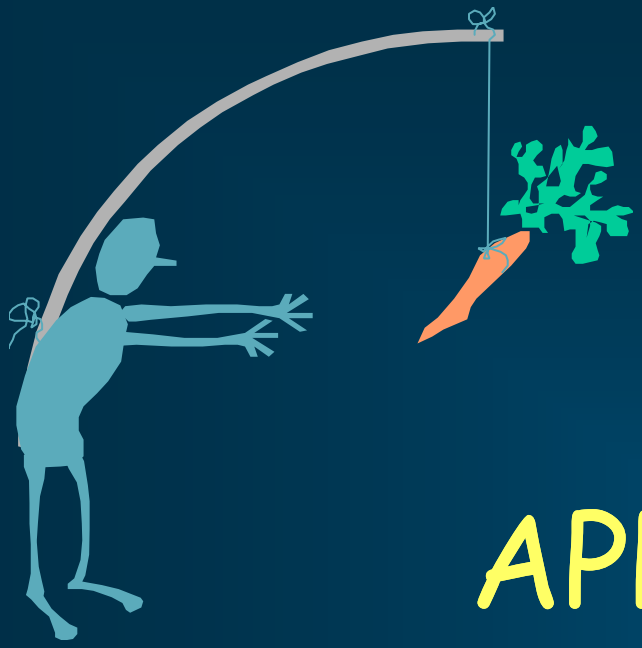
Assessment

Map classification from Landsat TM imagery	Ground classification, GPS points: Low sage	Mtn big sage	Stand initiat. woodl	Open young woodl	Young multi-story	Old multi-strata	Juniper-mahog-any	Sum	Commission error	Error (%)	User accuracy
Low sagebrush	3	0	0	0	0	0	0	3	0	0.0	100.0
Mountain big sagebrush	0	12	2	0	0	0	0	14	2	14.3	85.7
Stand initiation woodland	4	3	4	0	0	0	0	11	7	63.6	36.4
Open young woodland	0	3	4	6	0	0	0	13	7	53.8	46.2
Young multi-story woodland	1	1	0	6	26	8	4	46	20	43.5	56.5
Old multi-strata woodland	0	2	0	1	1	27	3	34	7	20.6	79.4
Juniper-mountain-mahogany	0	1	0	1	3	3	24	32	8	25.0	75.0
Sum	8	22	10	14	30	38	31	153			
Omission error	5	10	6	8	4	11	7				
Error (%)	62.5	45.5	60.0	57.1	13.3	28.9	22.6				
Producer's accuracy	37.5	54.5	40.0	42.9	86.7	71.1	77.4				

	Landsat TM	Aerial photo
Total points:	153	150
Accurate points:	102	109
Percent accuracy:	66.7	72.7
Kappa statistic:	59.2	67.2

Errors in Assessing Accuracy

- Variation in classifying data on the ground
- Incorrect location due to GPS errors
- Changes in vegetation between map creation and collection of ground control data
- Variation in interpretation of aerial photos
- Ground control points were taken in an area smaller than the minimum mapping unit of the map



APPROPRIATE QUESTIONS & EXPECTATIONS

What data should I use?

Are you…

Comparing the use of grass vs shrub vegetation? Or Bunchgrass vs Yellow Star Thistle?

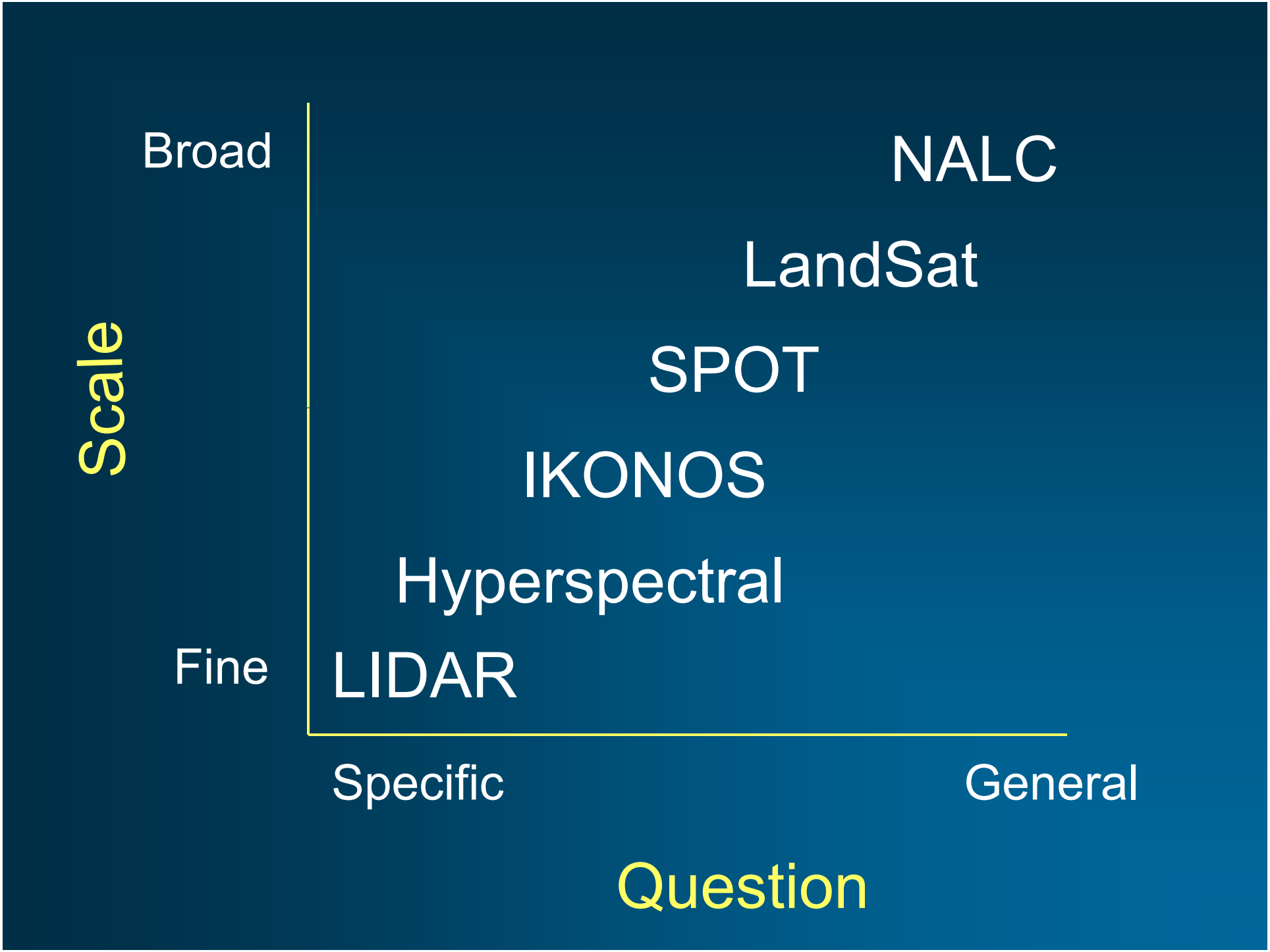
Looking for seasonal change? Or change over decades?

At what scale?

That depends on…

- The scale perceived by the species
- The scope of the question
- Data availability

Knowledge about a species does not always match available GIS & RS data.


Broad
Scale
Fine
NALC
LandSat
SPOT
IKONOS
Hyperspectral
LIDAR
Specific
General
Question

How accurate is it?

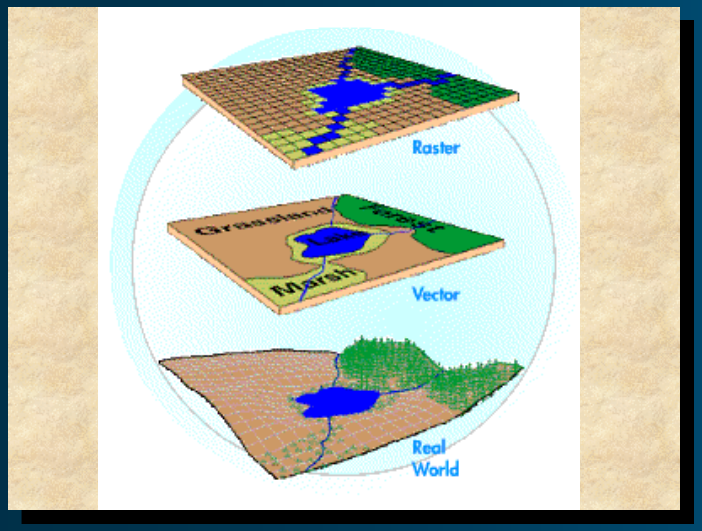
- Polygons are not homogenous units and lines are not real

- Pixel vs Point

- GIS & RS generally squeeze a round peg into a square hole.

Some Thoughts

- Models should be viewed as testable hypotheses not the "truth"



- Know what level of error you're willing to accept (errors multiply)