Missouri GAP Analysis

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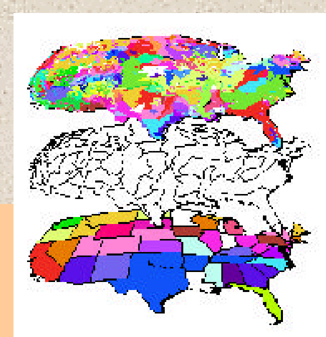


National GAP Analysis Program

U.S. Geological Survey
Biological Resources Division

A Geographic Approach to Planning for Biological Diversity

http://biology.usgs.gov/state.partners/gap.html

Missouri Resource Assessment Partnership (MoRAP)

Integrating GIS & Related Technologies into Natural Resource Planning & Management

Assessment & Planning Process	Information Needs	GIS Products
I. Divide Planning Region into Ecological Units	Landform General Geology General Soils Potential Natural Vegetation	Landtype Association (LTA_ Maps/Descriptiosn (1:100K)
	LTA Map 1:24K Hypsography Soil Series Maps Potential Vegetation	Ecological Landtypes (ELT) Maps/Descriptions (1:24K)
II. Describe Historic Conditions	· GLO Notes · Historic Accounts	
III. Describe Current Resource Status us and Trends		
A. Natural Resources	· Remote Sensing Data	Current Land Cover Maps/Description by LTA (Level III 1:100K)
	· Special Features Information	R/E Species Maps/Tables Other Special Features Maps/Tables (1:100K)
	· Aquatic Resources Information	Stream/Watershed Maps/Table (1:100K)
	· Animal/Plant Distribution – Habitat Information	Maps/Tables of Species/Habitat
B. Socio-Economic Resources	· Human Population/Demography	Maps/Tables (1:100K)
	· Land Ownership	Maps/Tables (1:100K)
	· Rec/Interp. Info	Maps/Tables (1:100K)
	· Resource Commodities	Maps/Tables (1:100K)
	· Public Attitudes/Demands	Maps/Tables (1:100K)
	· Potential Land Use Conflicts	Maps/Tables (1:100K) Maps/Tables (1:100K)

Missouri Resource Assessment Partnership (MoRAP)

Integrating GIS & Related Technologies into Natural Resource Planning & Management

Assessment & Planning Process	Information Needs		GIS Products
IV. Develop Resource Management Objective			Use the above information to identify resource needs and determine appropriate objectives
V. Identify Resource Management Opportunity Areas	· ECS · Land Use/Cover · Special Features · Animal/Plan Distribution · Aquatic Resources	· Land Ownership · Rec/Interp · Resource commodities · Potential Conflicts	Maps/Tables Illustrating Areas to meet objectives/assessing current ownership and identifying threats (1:24KK)
VI. Develop Resource Management Alternatives	· ECS · Land Use/Cover · Special Features · Animal/Plan Distribution · Aquatic Resources	· Land Ownership · Rec/Interp · Resource commodities · Potential Conflicts	Area/Project Maps Illustrating resource potential (ECS), current conditions (current cover, inventory info.) and sites to implement objectives. (1:24K)
VII. Agency Implementation of Resource Management Objectives	· ECS · Land Use/Cover · Special Features · Animal/Plan Distribution · Aquatic Resources	· Land Ownership · Rec/Interp · Resource commodities · Potential Conflicts	**Implementation of Chosen Alternatives** Area/Project Maps Illustrating resource potential (ECS), current conditions (current cover, inventory info.) and sites to implement objectives. (1:24K)
VIII. Monitor Resource Management Objectives	· ECS · Land Use/Cover · Special Features · Animal/Plan Distribution · Aquatic Resources	· Land Ownership · Rec/Interp · Resource commodities · Potential Conflicts	Change Detection Maps/Tables (1:24K) Maps and Data to support Animal/Plant Habitat Models. (1:24K)

Hierarchical Framework for a Missouri Ecological Classification

Draft 11/93

ECOLOGICAL UNIT (SIZE)	LEVEL OF USE	· MAJOR DIFFERENTIATING CRITERIA/STRONGLY ASSOCIATED FACTORS	SOURCE
SECTION (100's mi^2)	Statewide Planning	· Geomorphic Processes · Landform · Surficial Geology · Potential Natural Vegetation Major Soil Groups Regional Climate	Schroeder's Landforms General Geology of MO GLO Notes/Historic Accounts
SUBSECTION (10-100's mi^2)	Regional Planning Forest-wide & Range District Planning	· Landform · Surficial Geology · Potential Natural Vegetation Major Soil Groups	Schroeder's Landforms General Geology of MO GLO Notes/Historic Accounts Missouri Soil Associations
LAND TYPE ASSOCIATION (LTA) (1000 acres – 10's mi^2)	Regional & Area Planning	· Landform · Surficial Geology · Potential Natural Vegetation Stream/Aquatic Systems	Schroeder's Landforms General Geology of MO General Soils of MO Pre-settlement Veg Map Pflieger Aquatic Classification
ECOLOGICAL LAND TYPE (ELT) (10-100's acres)	Area & Project Planning	· Topographic Position · Soil Series Potential Natural Communities	7.5' Topographic Maps Soil Surveys Field Sampling/ Nelson & Pflieger
ECOLOGICAL LAND TYPE PHASE (<100's acres)	Project Planning	· Topographic Position · Soil Series Existing Natural Communities	7.5' Topographic Maps Soil Surveys Nelson/Pflieger Field Sampling

· Major Differentiating Criteria are those factors used in delineating the boundaries of the ecological unit. They are indicated with an · .
Strongly associated factors are characteristic of the unit which are important in describing and recognizing the unit.
To be developed.

Sensitivity also refers to…
Spatial Resolution

- Would increasing resolution give a better result?
- Would cost of additional data collection at higher resolution be justified?
- Can we put a value on spatial resolution required?

This information can be used in assessing the level of input accuracy that is needed.

For example, if the additional accuracy will not change the results, it may be unnecessary to carry out costly detailed surveys.

Can also use sensitivity analysis to assess the effects of uncertainty in the data - “confidence interval” measure for the results.

Consider...

- Use full observed range to test sensitivity
  - Response of the result to a change in one of the inputs from its minimum observed value to its maximum
- Layers which are important, but nevertheless do not show geographic variation over the study area will not have high sensitivity in this definition

Consider...

- Brings out the distinction between sensitivity *in principle* and *in practice*
  - A layer may be important in principle, but have no impact within the study area
- Examine both the decision rules & the value ranges to help determine which layers have the highest impact on the result

Sensitivity can be defined for:

Data Inputs

How much does the result change when the data input changes?

Data Weights

How much does the result change when the weight given to a factor changes?

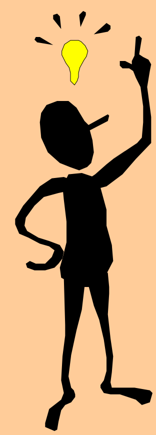
Errors in determining weights may be just as important as error in the database.

Sensitivity Analysis

- It is the response of the result (suitability) to a unit change in one of the inputs.
- Easy to see what a unit change means for temperature or precipitation data, but what does it mean for a vegetation class?

In some types of operations…

the accuracy of suitability is determined by the accuracy of the least accurate layer.



In other cases…

the accuracy of the result is significantly better than the accuracy of the least accurate layer.

How then do we determine the impact of inaccuracy on the result?

Effects of Cascading on an Error will be Complex

- Do errors get worse?
- Do errors cancel out?
- Are errors independent or related?

Suppose two maps, each with percent correctly classified of .90 are overlaid…

- Studies have shown that the accuracy of the resulting map is little better than .9 x .9 = .81
- When many maps are overlaid the accuracy of the resulting composite can be very poor.
- However, we are more interested in the accuracy of the composite suitability index than in the overlaid attributes themselves.

Inaccuracy arises primarily from...

- **Randomness**
  - May occur when an observation can assume a range of values
- **Vagueness**
  - May result from imprecision in taxonomic definitions
- **Incompleteness of Evidence**
  - May occur when sampling has been applied, there are missing values, or surrogate variables have been employed.

- The interdependence between location and value in spatial databases gives rise to spatial dependence and heterogeneity.
- In GAP analysis, we combine data from different sources with different levels of accuracy.
- What impact does error in each data layer have on the final result?
- Reliability is a function of both cartographic & ecological factors.
- Inaccuracy is often inadvertent but may also be intentional since generalization methods are frequently applied to enhance cartographic ease.

Useful Resolution Groups for Engineering & Planning

From: "Selection of Maps for Engineering & Planning", Committee on Cartographic Surveying, Journal of the Surveying and Mapping Division, Proceedings of the American Society of Civil Engineers, July, 1972. Table 1, p. 112

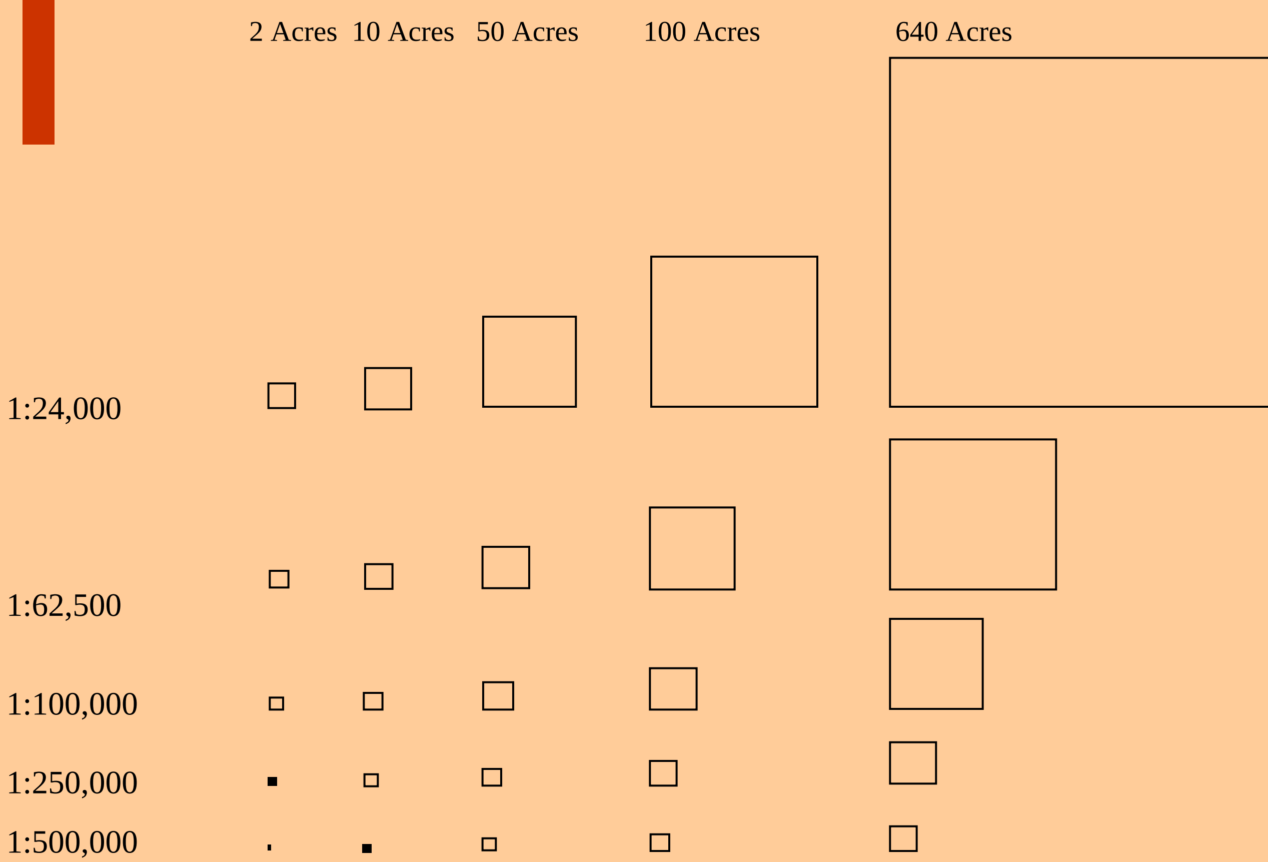
Type of Map	Scale			
	Feet per Inch	**Representative Fraction**	**Feet**	**Meters**
Design				
Critical	10 to 50	1:100 to 1:500	.2 to 5	.1 to 1
General	40 to 200	1:500 to 1:2,000	.05 to 10	.1 to 2
Planning				
Micro	100 to 1,000	1:1,000 to 1: 10,000	1 to 20	.2 to 5
Local	400 to 2,000	1:5,000 to 1: 25,000	2 to 50	.5 to 10
Regional	1,000 to 10,000	1:10,000 to 1:100,000	5 to 100	1 to 20
National	10,000 to 100,000 (2 miles) (20 miles)	1:100,000 to 1:1,000,000	10 to 1,000	2 to 200

Scale - Data Resolution

	Polygon	Lines	
	Acres	Mile	Feet
1:24,000	2-3	.05	250
1:62,500	5-10	.12	650
1:100,000	25-50	.2	1050
1:250,000	250-500	.5	2600
1:500,000	500-1000	1.0	5280

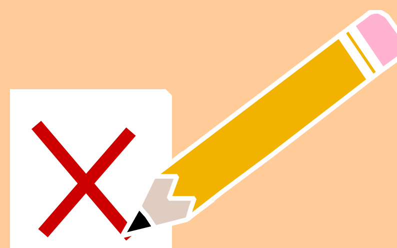
Data below these resolutions are generally merged into surrounding data, converted to a point or deleted.

Data Resolution



Scale ~ Map Resolution

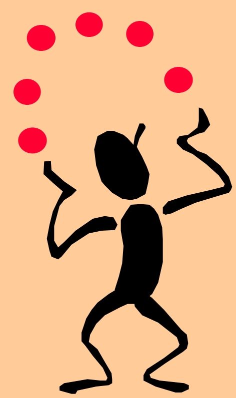
- **Definition:** The accuracy with which the location & shape of map features can be depicted for a given scale.
- Decreasing map scale results in lower map resolution as selected features are:
  - Smoothed
  - Simplified
  - Aggregated
  - Eliminated
  - Reduced in Dimension
    - Area (2) to Line (1)
    - Area (2) to Point (0)



- Understand/document all GIS data source resolutions
- Categorize sources by resolution groups
- Make careful choices regarding upward & lower bounds of resolution groups.
- Begin to define scales of the GIS database

Cartographic Considerations

- GIS Database is NOT an ordinary database
- Location is explicit in design
- Designer has to be aware of cartographic base that describes/specifies location
- Considerations include:
  - Scale
  - Coordinate Systems
  - Map Projections
  - Datums
  - Geodetic Control - GPS

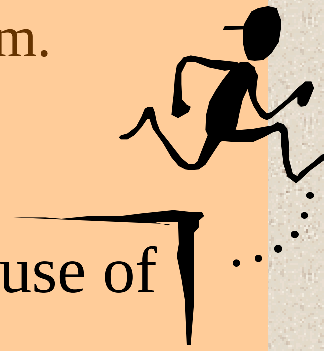


Points to Remember...

- ✗ The precision of GIS processing is effectively infinite.
- ✗ All spatial data are of limited accuracy.
- ✗ The precision of GIS processing exceeds the accuracy of the data.
- ✗ In conventional map analysis, precision is usually adapted to accuracy.
- ✗ The ability to change scale and combine data from various sources and scales in a GIS means that precision is usually not adapted to accuracy.
- ✗ We have no adequate means to describe the accuracy of complex spatial objects.
- ✗ The objective should be a measure of uncertainty on every GIS product.

There is a nearly universal tendency to lose sight of errors once the data are in digital form.

Errors...



- …are implanted in databases because of errors in the original source
- …are added during data capture and storage
- …occur when data are extracted from the computer
- …arise when the various layers of data are combined in an analytical exercise.

Accuracy & Scale

Accuracy → The closeness of results, computations, or estimates to true values.

Precision →

- **Computer-based:** The number of decimal places or significant digits in a measurement
- **Application based:** The regularity or consistency of a result, computation, or estimate.

CATEGORIES OF ERROR

Error in Source (Original Sin)

- Extremely common in non-mapped source data - locations of wells, lot descriptions
- Can be caused by doing inventory work from aerial photography and misinterpreting images
- Often occur because base maps are relied on too heavily

Classification Errors

- Are common when tabular data are rendered in map form
- Simple typing errors may be invisible until presented graphically
- Sampling strategies can bias classes

Data Capture Errors

- Manual data input introduces another set of errors
- Eye-hand coordination varies from person to person
- Hard to maintain quality over long periods of time

Boundaries

- Boundaries of soil types are actually transition zones but are mapped by lines
- Lakes fluctuate widely in area, yet have permanently recorded shorelines.

Data Layers

GAP ANALYSIS

1. Current Vegetation Cover (1:100K; 240 AC MMU)
2. Vertebrate Dist./Habitat Relations.
3. Heritage/Special Features.
4. Public Land Ownership

GAP ANALYSIS II

1. ECS Layer (LTA all; ELT select lands)
2. Historic Vegetation (use in ECS)
3. Current Veg. Cover (1:24K; 5ac MMU)
4. Aquatic Resources
5. Heritage Special Features
6. Public Land Ownership
7. Potential Conflicts/Threats
8. Recreation/Interp/Education
9. Resource Commodities

Biodiversity Assessment Strategy

GAP ANALYSIS

1. Use veg. cover and species dist/habitat relations to identify centers of potential species richness.
2. Overlay current public land ownership and identify gaps in conservation network.

GAP ANALYSIS II

1. Divide State & Planning Sections into Ecological Units (ECS)
2. Describe Historic Conditions (Hist. veg., ECS).
3. Assess Current Resource Status Trends (includes biological, as well as social & economic resources).
4. Develop Regional Resource management objectives.
5. Identify Resource Management Opportunity Areas (GAP)
6. Implement & Monitor Resource Management Objectives

Additional Resource Assessment

GAP ANALYSIS

None Planned

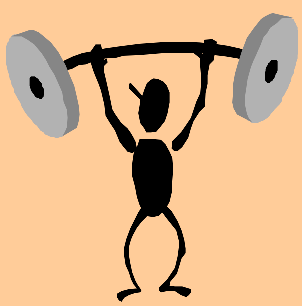
GAP ANALYSIS II

1. Identify potential conflicts/threats.
2. Use Rec/Interp/Educ layer to assess needs & identify regional objectives/strategies.
3. Use resource commodity information to assess needs and identify regional objectives/strategies.
4. Allocate lands/programs to integrate resource conservation & use.

Strengths of Program

GAP ANALYSIS

1. Current funding/staff in place.
2. Utilization of existing GRC resources (equipment, labor, etc.)



GAP ANALYSIS II

1. Develops information/methods to support coordinated management/planning within MO.
2. Focus conservation on ecosystems.
3. Higher resolution necessary for regional & area planning.
4. Adds use of natural resources (Red/Educ/Commodity) into conservation equation.
5. Develops interagency coordination/support

Weaknesses of Program

GAP ANALYSIS

1. Designed to meet national scale conservation objectives.
2. Focus on species richness, not ecosystems.
3. Gross information resolution.
4. Questionable species dist/habitat information
5. Questionable interagency coordination/support

GAP ANALYSIS II

1. No current funding/staff.
2. Higher costs of developing ECS, pres. veg., veg. cover map.

GIS helps us see the ***context*** as well as the ***substance*** of our problems more clearly and enables us to deal with them more effectively.

The development and implementation of a GIS...

… goes ***beyond*** a simple increase in speed with which we can produce maps, or even the increase in the quality of our maps.

…GIS ***offers*** the ***capability*** and ***capacity*** of making changes in the way in which we solve problems.

…GIS will ***alter*** the ***quality of information*** on which we base the decisions required to solve problems.