Data Entry
Getting coordinates and attributes into our GIS

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DATA SOURCES, INPUT, AND OUTPUT

Manually digitizing from image or map sources
- manually drawn maps
- legal records
- coordinate lists with associated tabular data
- Aerial photographs

Field coordinate measurement
- Coordinate Surveying
- GPS

Image data
- Manual or automated classification
- direct raster data entry

Manual Digitization – Map Digitization

Field Measurement

Coordinate Surveying

(courtesy NGS)

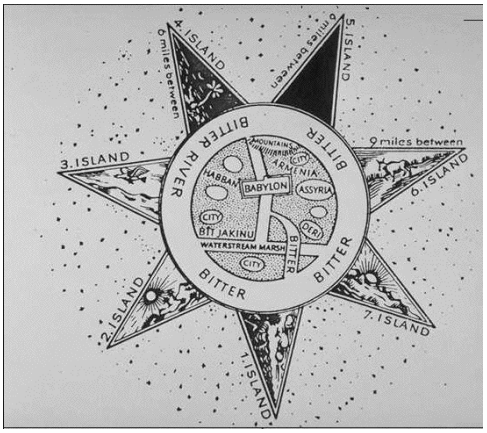
GPS

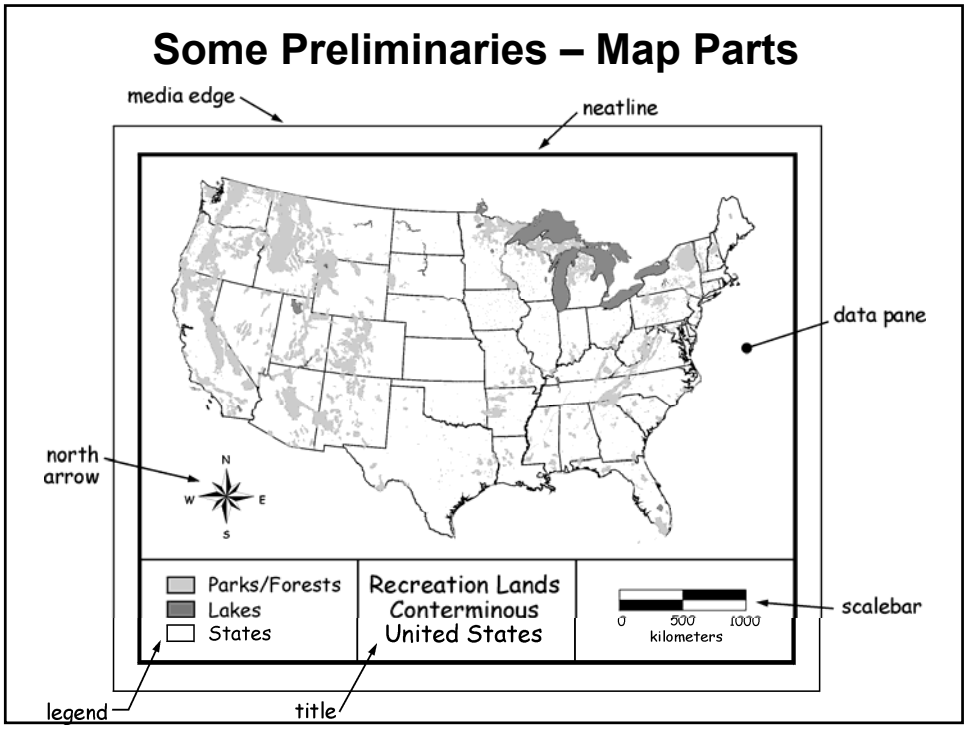
Satellite and Aerial Imagery

Image Data

Spatial Data in a GIS

Hardcopy Maps – Fixed on “Permanent” Media





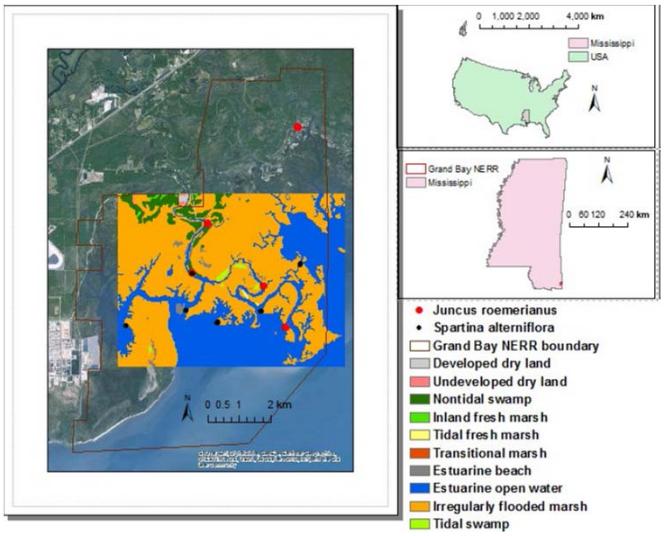
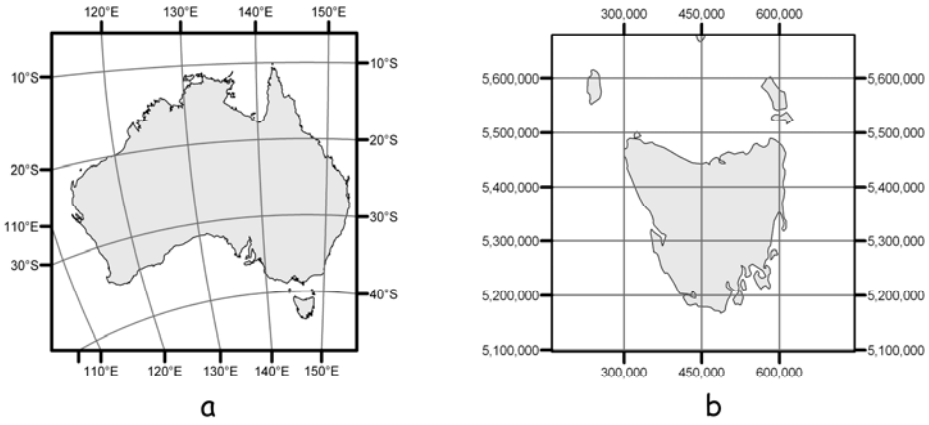


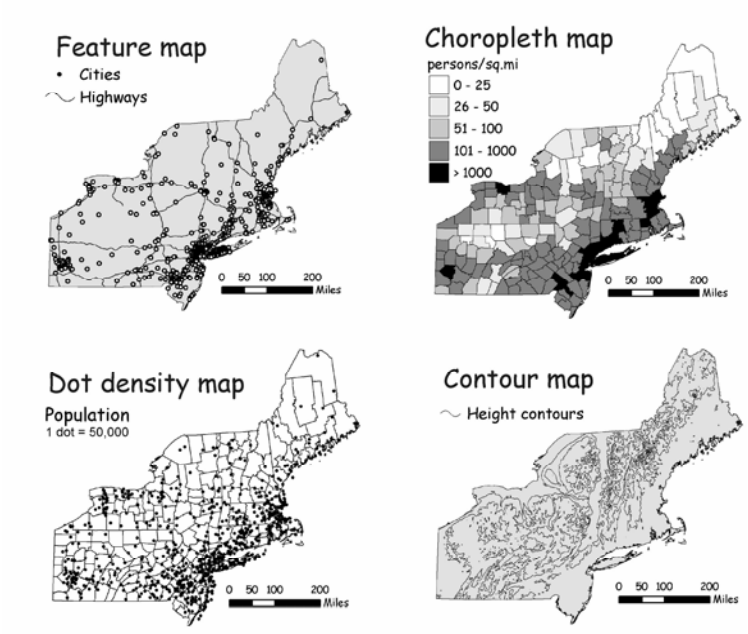
FIGURE 2 The study area (rectangle in the middle of left panel), mainly in the middle of Grand Bay NERR, with the sampling locations for above-ground biomass and 1988 NWI map. The inset on the upper left shows the detailed sampling method for a location. The Grand Bay NERR is located in Southeastern Mississippi in Southeastern US (the US map is from the CENSUS, the Mississippi state map is from the Mississippi Automatic Resource Information System, the reserve boundary is from the NERR centralized data management system, the background for the map on the left panel comes from Environmental Systems and Research Institute, and the legend of land cover is for the study area only)

Wu et al. 2017

Graticule and Grid



Map Type



Map Scale

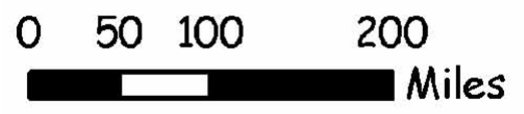
The ratio of :
a distance on a map
to a distance on the ground

Commonly reported as a:

Unitless ratio : 1: 100,000

Unit ratio : e.g., four inches to one mile

Scale bar:



Common Map Scale Confusion

People often say **"large scale" map when they mean "large area".**

Map scale is a number, a ratio of sizes, that is a fraction, e.g., 1:100,000 scale. As a number this is 0.00001.

A large scale map is one where the fraction is large. This happens when the denominator (bottom number) is small.

Example:

1 to 1 million map scale (1:1,000,000) expressed as a fraction is 0.000001;

a 1:200 map scale, expressed as a fraction, is 0.005.

Which is the larger scale, 0.000001, or 0.005?

Common Map Scale Misperception

If you have two map sheets which are 10 inches across, the 1:1,000,000 map (which is small scale) covers a distance of 10,000,000 inches

The 1:200 map (large scale) covers about 200*10=2000 inches.

Remember, larger scale maps cover less area, but show more detail.

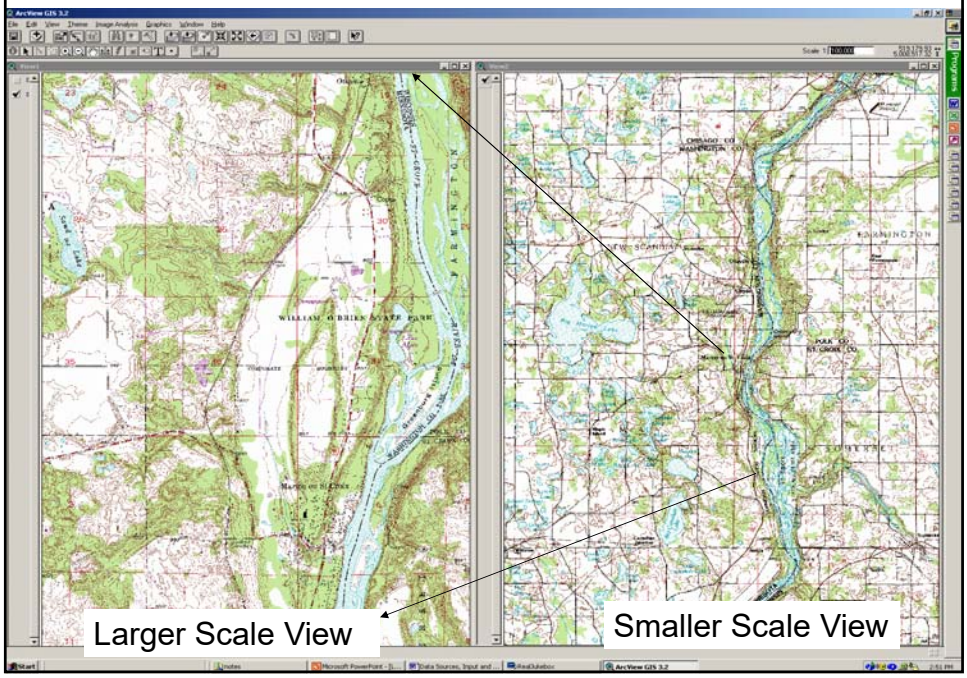
Map Scale

"Scale" of GIS data

Digital spatial data have no scale. An input map had a scale, but many data don't come from maps, e.g., GPS data.

Spatial data in a GIS may be displayed on-screen at a broad ranges of scales – there is no one scale.

We must think of a source scale, if it exists
And
A display scale, the ratio of ground to on screen size



Determining Scale on Source Materials

If map scale is not available, the best method is to measure paired distances,

e.g., the distance between two road intersections on the map is 4.3 cm,

field measurements between the same two road intersections shows the distance to be 1220 meters. The scale of the map is then

map distance / ground distance, or

{ 4.3cm *1m/100cm } / 1220 m or

0.043 / 1,220 = 1 / 28,372

Spatial Data Input from Hardcopy Sources

Common Input Methods:

- manual digitizing
- automatic map scanning

Manual Digitizing

Tracing the location of “important” coordinates

Done from an image or map source

Manual Digitizing

- On screen or on a digitizing tablet
- Connect the dots
- Digitize each point once
- Digitize each line segment once
- Combine line segments to create area (polygon) features

Hardcopy Map

On-screen, from digital image

Manual Digitization

Connect the dots - lines or points with an electrically sensitized puck.

Wire grid typically used to identify puck location on tablet

Puck location recorded relative to an arbitrary table coordinate system

Points locations are signaled by pressing buttons on the puck

Accuracies of between 0.01 and 0.001 inches

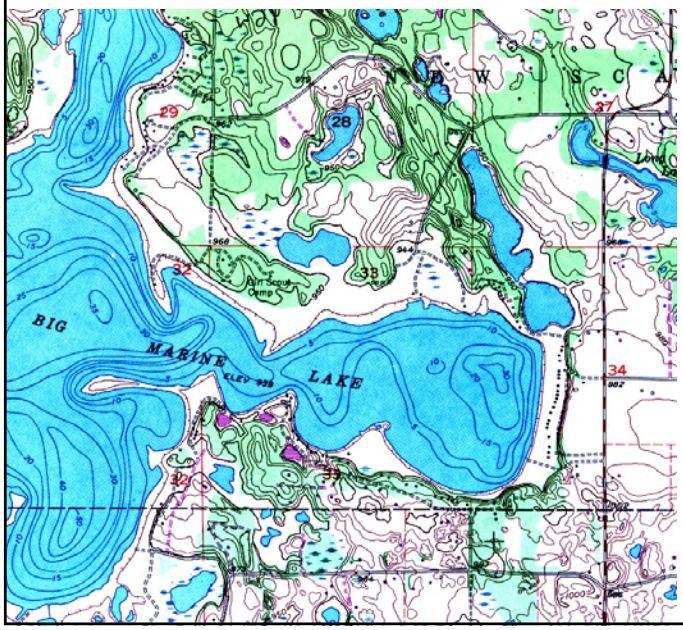
Manual Digitizing Process from hardcopy map:

1. Fix map to digitizer table
2. Digitize control points (tics, reference points, etc.) of known location
3. Digitize feature boundaries in stream or point mode
4. Proof, edit linework
5. Transform or register to known system (may also be done at start)
6. Re-edit, as necessary

Manual Digitizing Process from digital image:

1. Scan map or image
2. If image not referenced, collect ground coordinates of control points
3. Digitize control points (tics, reference points, etc.) of known location
4. Transform (register) image to known coordinate system
5. Digitize feature boundaries in stream or point mode
6. Proof, edit linework
7. Re-edit, as necessary

Digitize Primarily from Cartometric Maps



Based on coordinate surveys

Plotted and printed carefully

Manual Map Digitization, Pros and Cons

Advantages

- low cost
- short training intervals
- ease in frequent quality testing
- device ubiquity

Disdvantages

- upper limit on precision
- poor quality maps (much editing, interpretation)

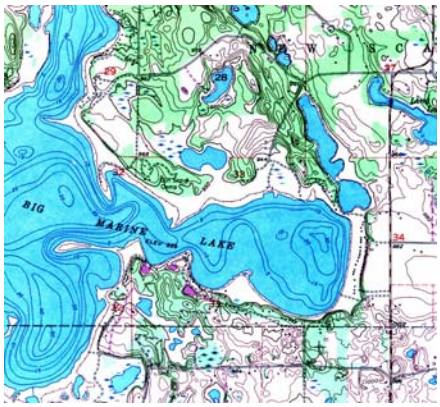
DATA SOURCES, INPUT, AND OUTPUT

Problems with source maps:

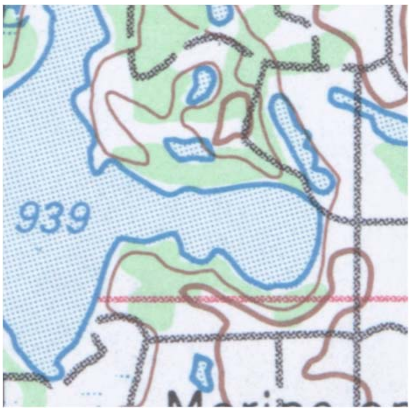
- Dimensional stability (shrink, swell, folds)
- Boundary or tiling problems
- Maps are abstractions of Reality
- Features are generalized:
  - classified (e.g., not all wetlands are alike)
  - simplified (lakes, streams, and towns in a scale example)
  - moved (offsets in plotting)
  - exaggerated (buildings, line roadwidths, etc).

Map Generalization: An Example

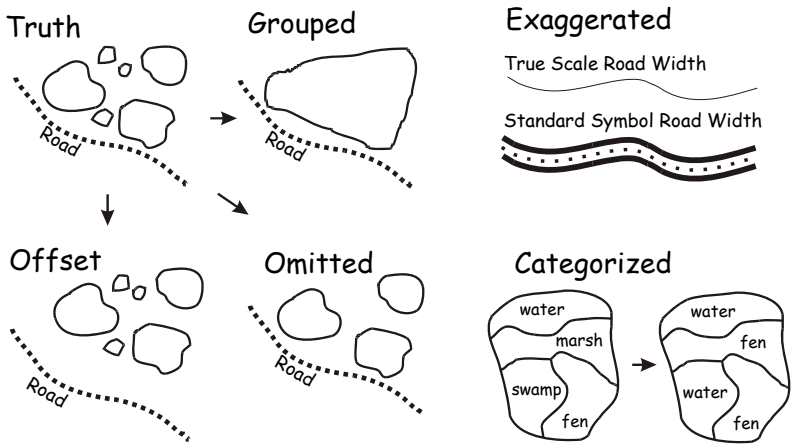
1:24,000 scale map



1:250,000 scale map

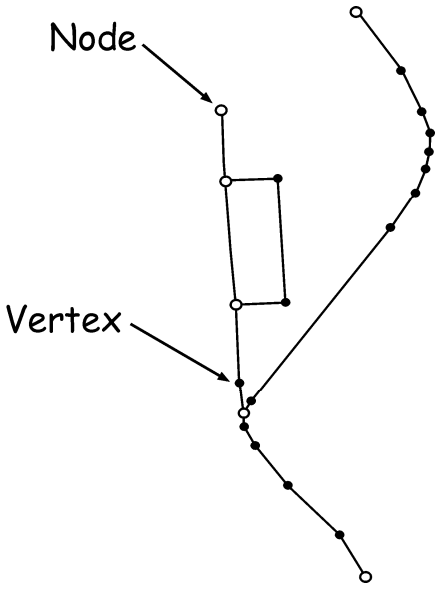


Types of Map Generalization

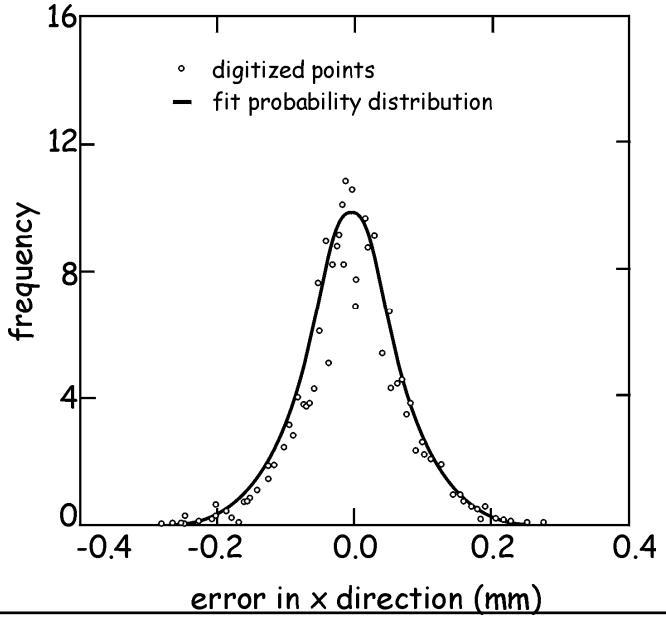


Manual Digitizing

- nodes at line endpoints
- vertices define line shape

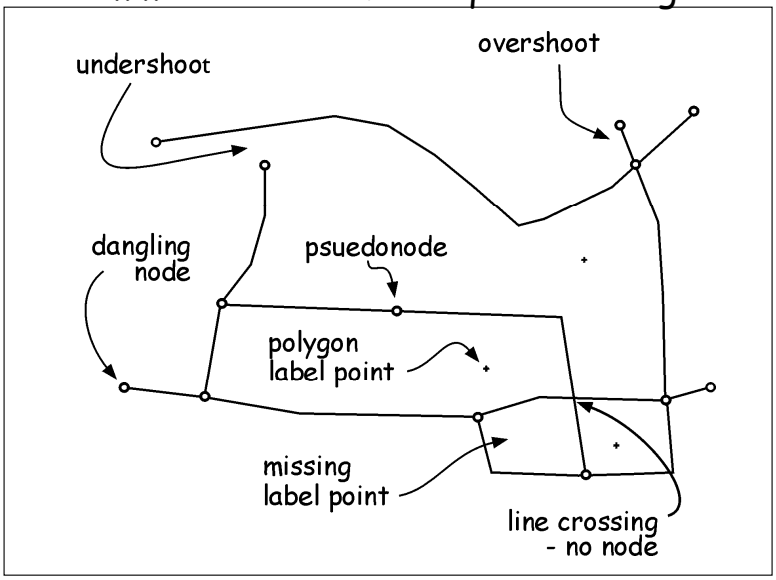


Digitizing Accuracy



Manual Digitizing

common errors that require editing



Editing

Manual editing:
Line and point locations are adjusted on a graphic display, pointing and clicking with a mouse or keyboard. Most controlled, most time-consuming .

Interactive rubbersheeting:
Anchor points are selected, again on the graphics screen, and other points selected and dragged around the screen. All lines and points except the anchor points are interactively adjusted.

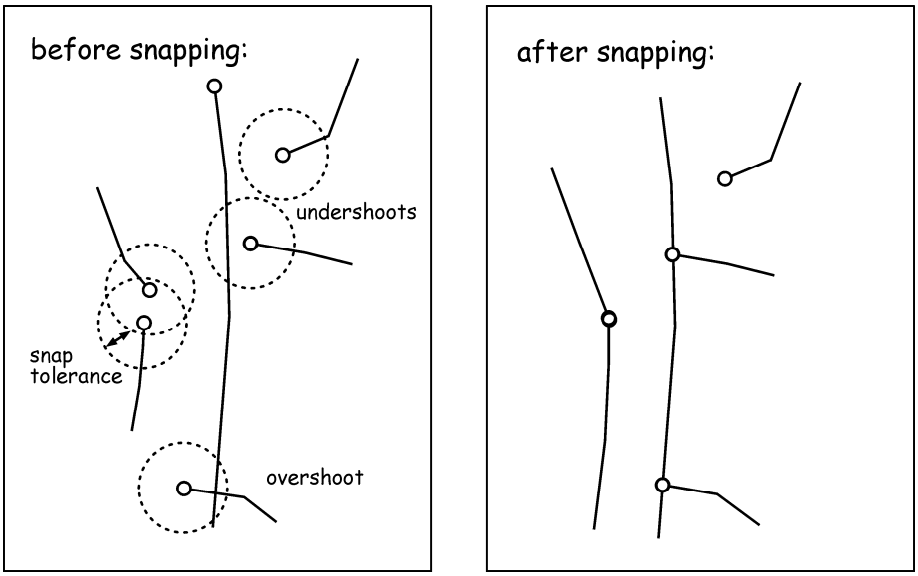
Editing

Attribute consistency analysis:
Identify contradictory theme types in different data layers, and resolve

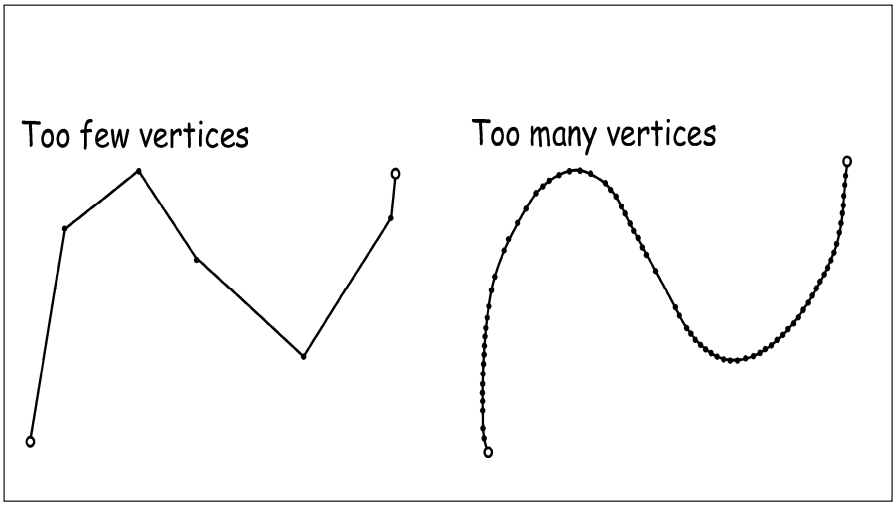
Line snapping:
When a vertex or node is “close” to a line or end point, the lines are “snapped” together

Point snapping:
Points which fall within a specified distance of each other are snapped (typically, on point eliminated).

Snapping

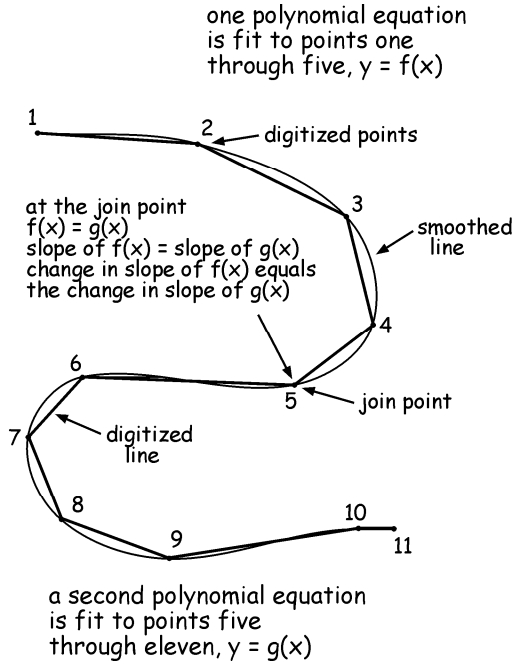


Manual Digitizing – Vertex Density

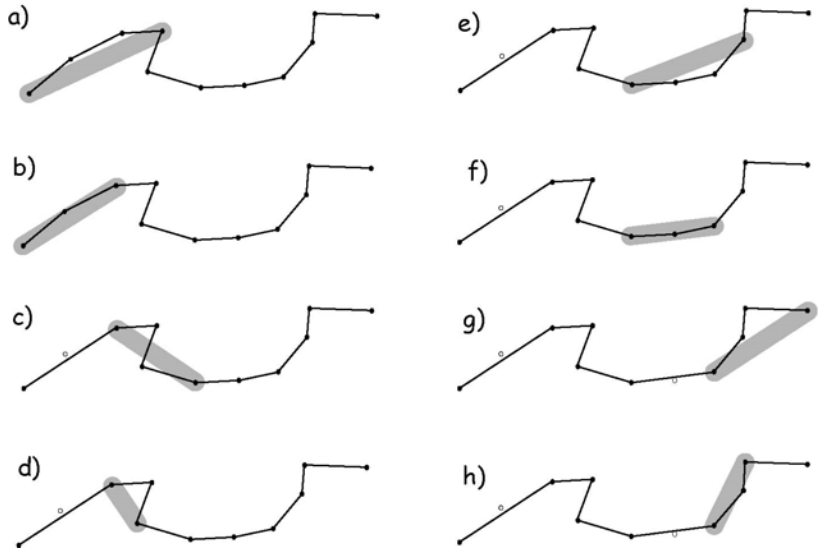


To Few Vertices – Spline Interpolation

Create smooth, curving lines by fitting piecewise polynomial functions

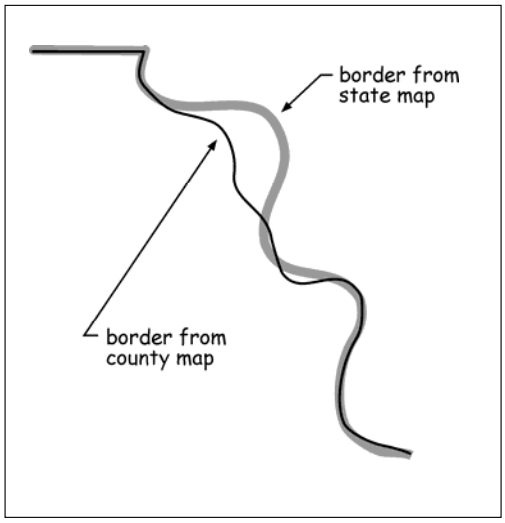


Line Thinning



Common problem:

Features which occur on several different maps rarely have the same position on each map



What to do?

1. **Re-drafting the data** from conflicting sources onto the same base map, or
2. **Establish a "master" boundary**, and redraft map or copy after digitizing

Digitizing Maps - Automated Scanners

•Main alternative to manual digitizing for hardcopy maps

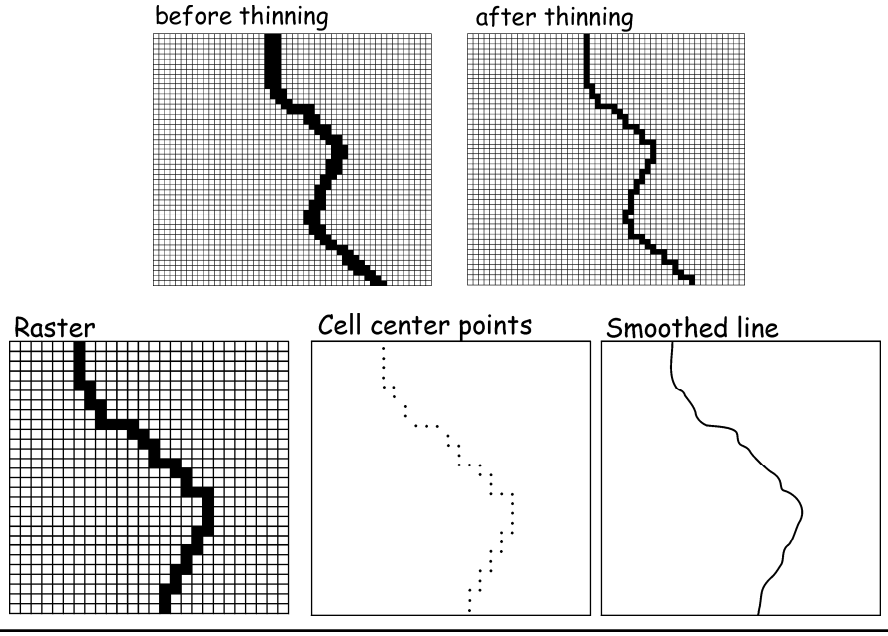
•Range of scanner qualities, geometric fidelity should be verified

•Most maps are now available digitally – however many began life as paper maps

Digitizing Maps - Automated Scanners

- Suitable threshholding allows determination of line or point features from the hardcopy map.
- Scanners work best when very clean map materials are available.
- Significant editing still required (thinning, removing unwanted features)

Cell Thinning and Vectorizing– After Scan-Digitizing



Coordinate Transformation

- Also referred as registration
- Control points
- The affine transformation

  $E = T_E + a_1x + a_2y$

  $N = T_N + b_1x + b_2y$
- Minimize RMSE