WEEK 4:

MAPS, DATA ENTRY, EDITING, AND OUTPUT

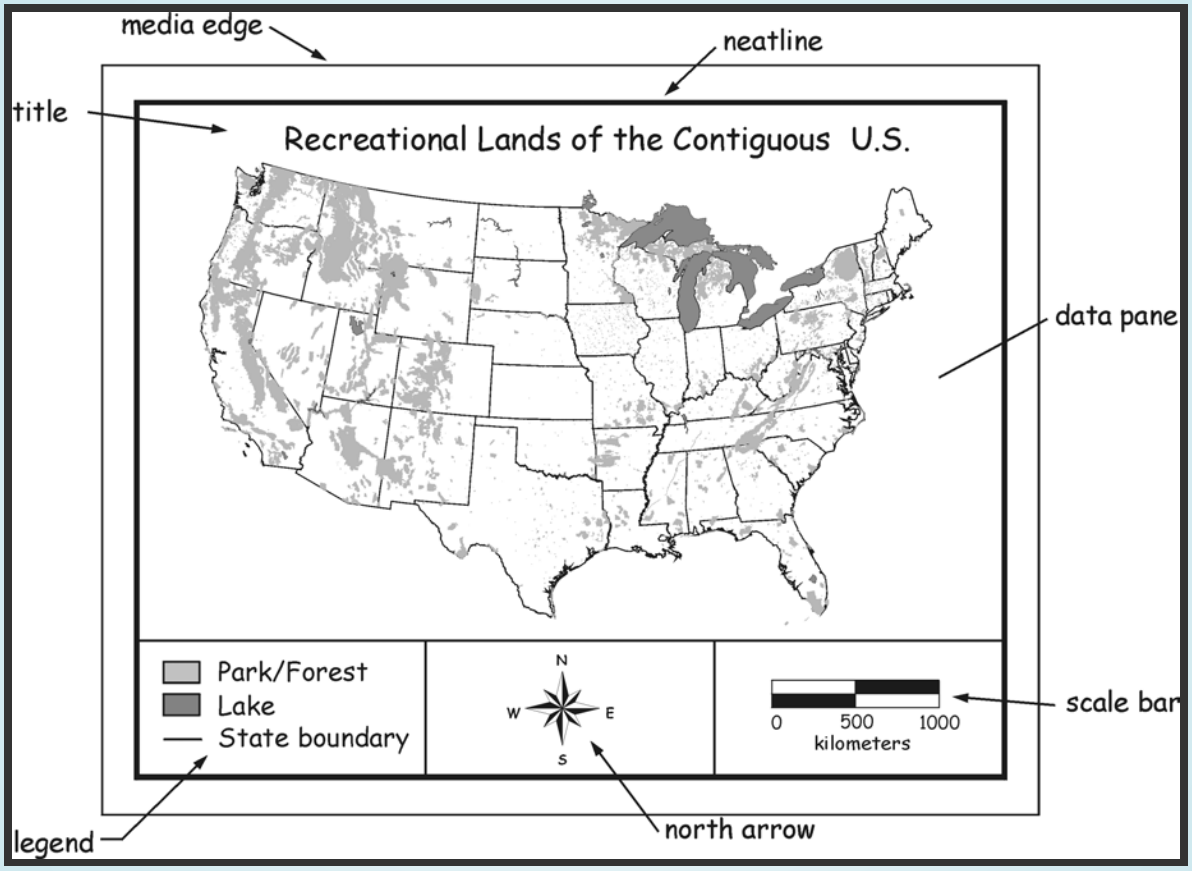
Intro to GIS

Evan Lue, PhD

KEY CONCEPTS

- Hardcopy vs. digital - the distinction between analog (e.g. hardcopy map) and digital information (e.g. GIS map)
- Digitizing - the process of converting analog data to digital data

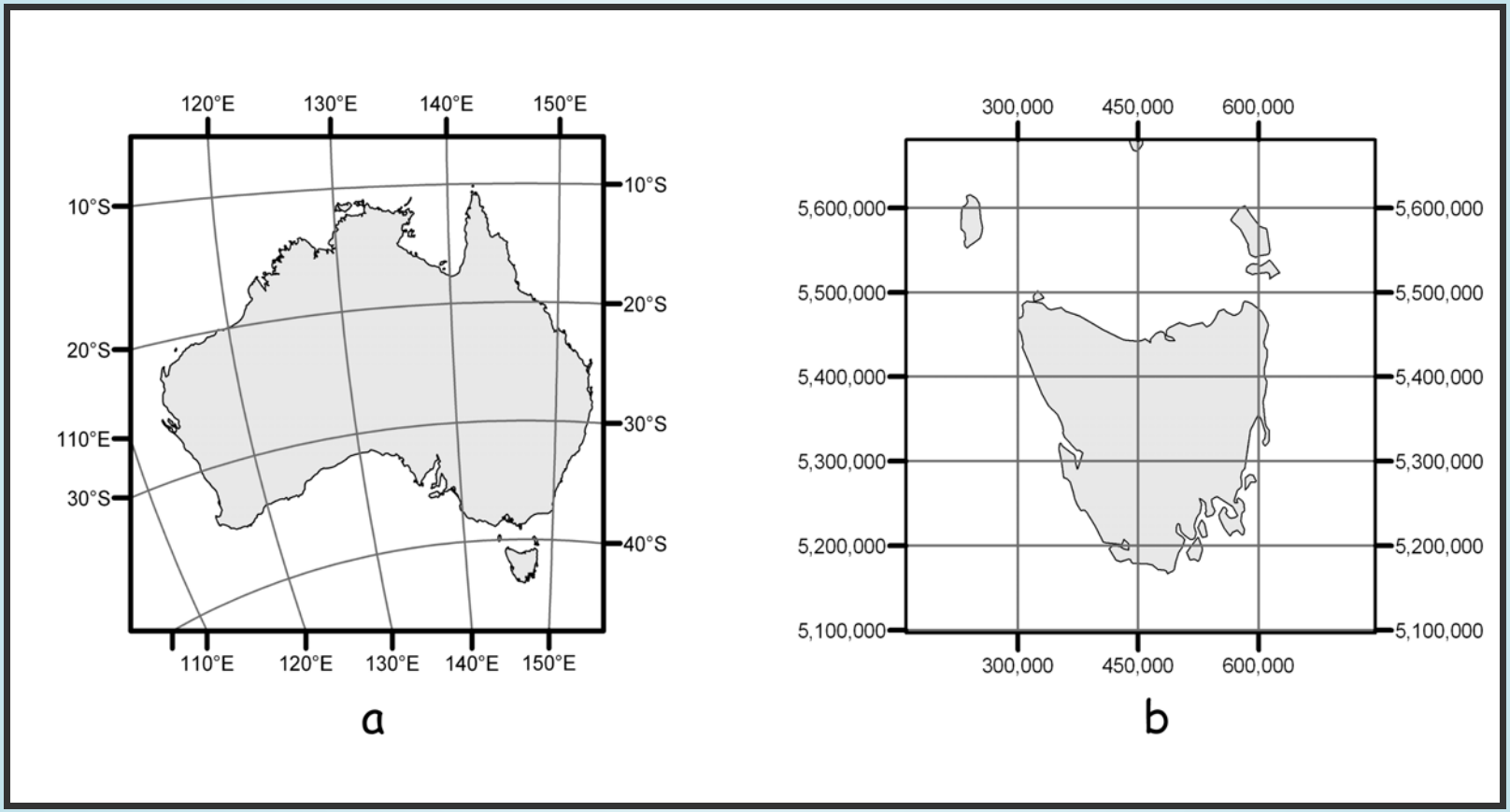
MAP ELEMENTS



Bolstad 2012, Fig 4-3

GRATICULES

- Graticule - a set of coordinate lines on a map

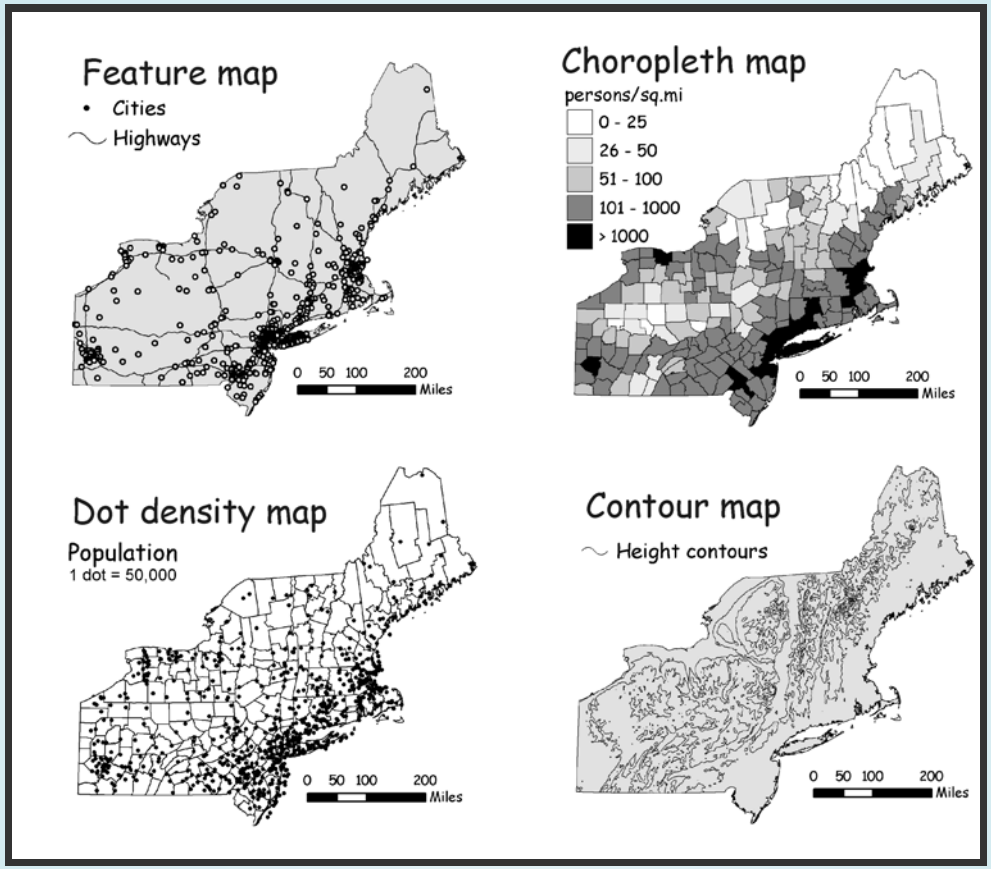


Bolstad 2012, Fig 4-4

TYPES OF MAPS

- Cartometric maps - represent the relative position of objects and thus may be suitable as a source of spatial data
- Feature maps - shows features such as points, lines, and polygons.
- Choropleth maps - depicts quantative information for areas.
- Dot density maps - dots represent values.
- Contour or isopleth maps - depicts common values as isolines.

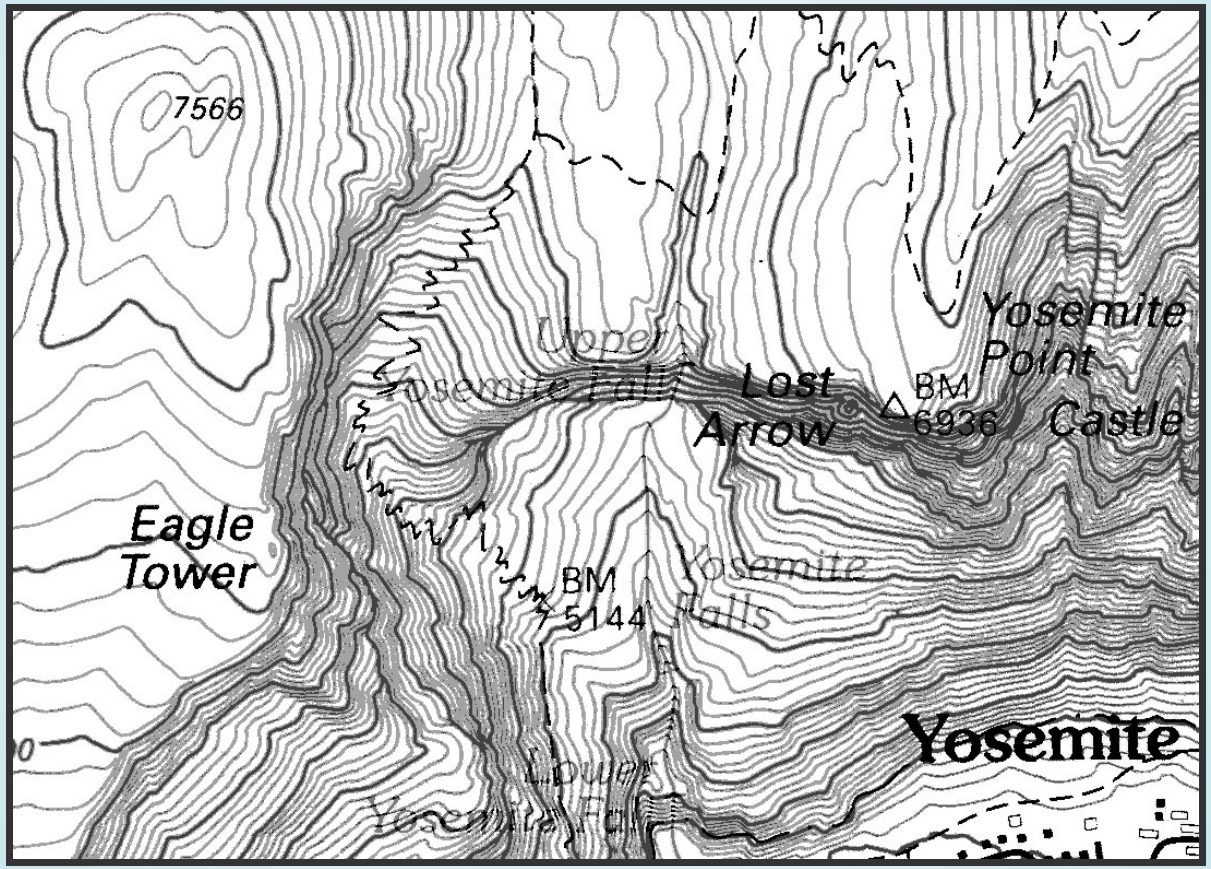
TYPES OF MAPS



Bolstad 2012, Fig 4-5

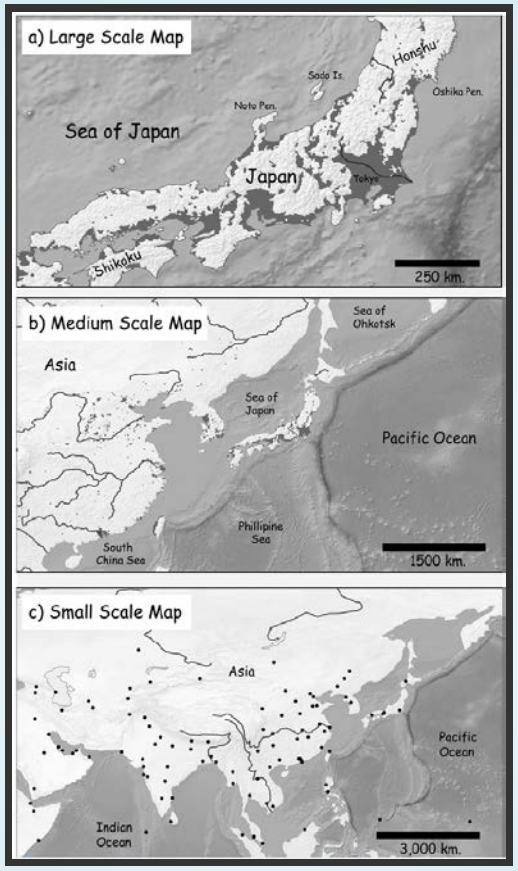
ISOLINES/CONTOURS

Isolines - lines of constant value



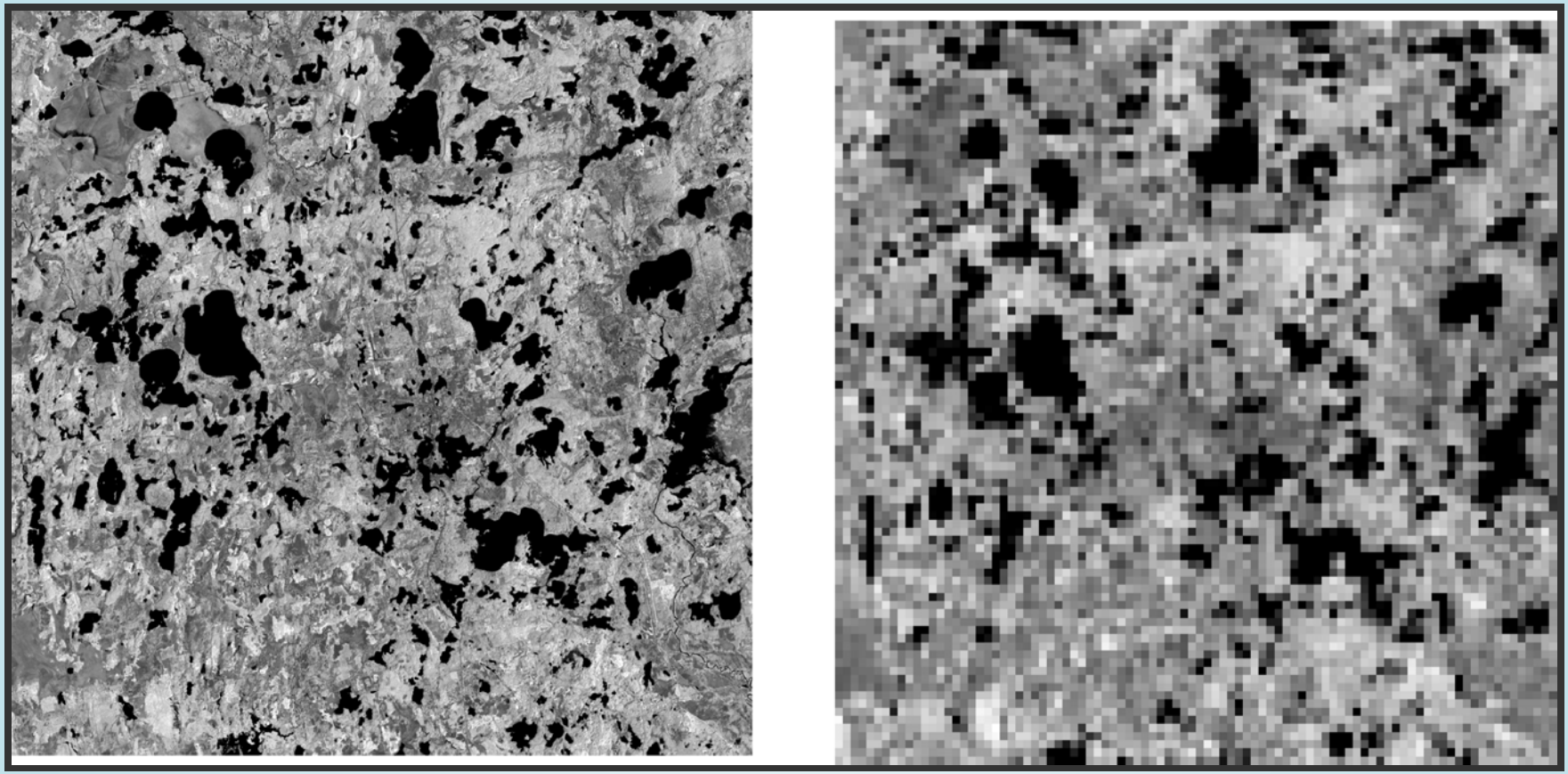
Bolstad 2012, Fig 4-6

MAP SCALE



Bolstad 2012, Fig 4-7

SPATIAL DETAIL

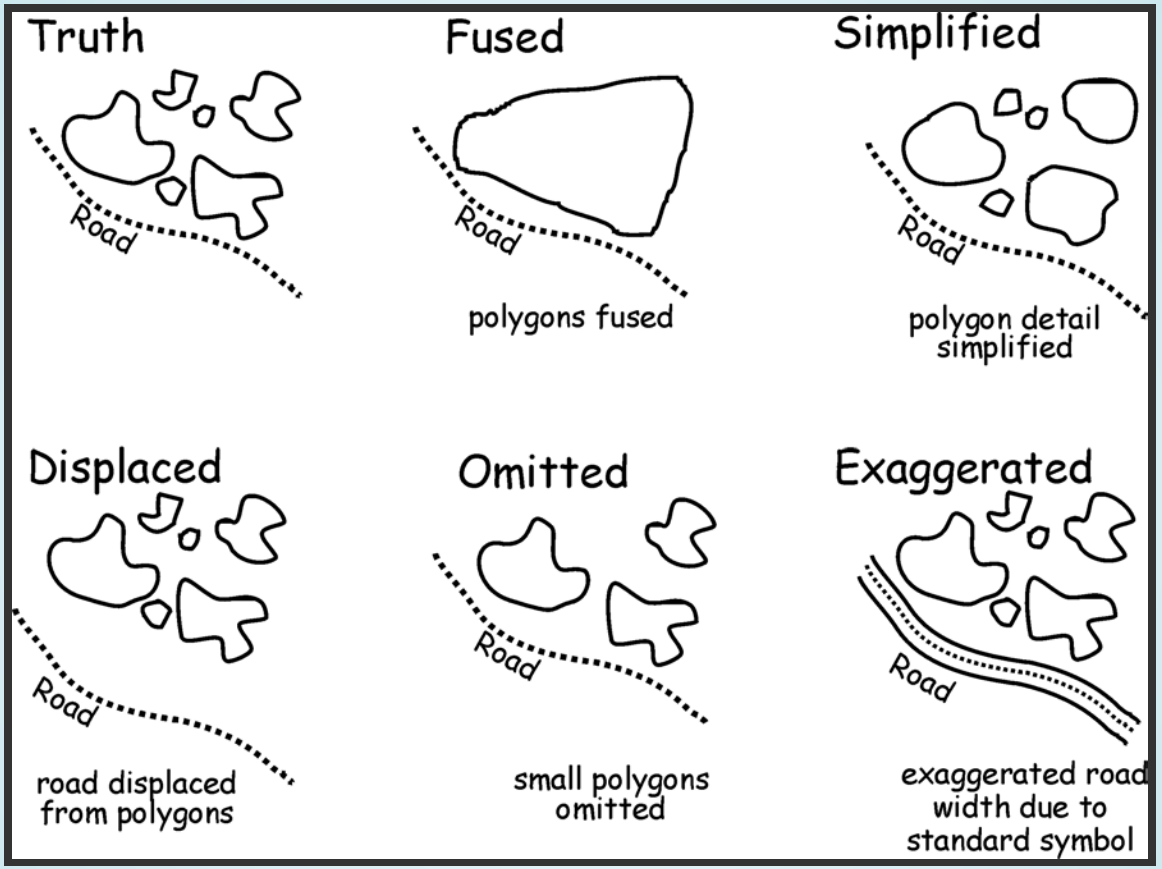


Bolstad 2012, Fig 4-8

MAP VS FEATURE GENERALIZATION

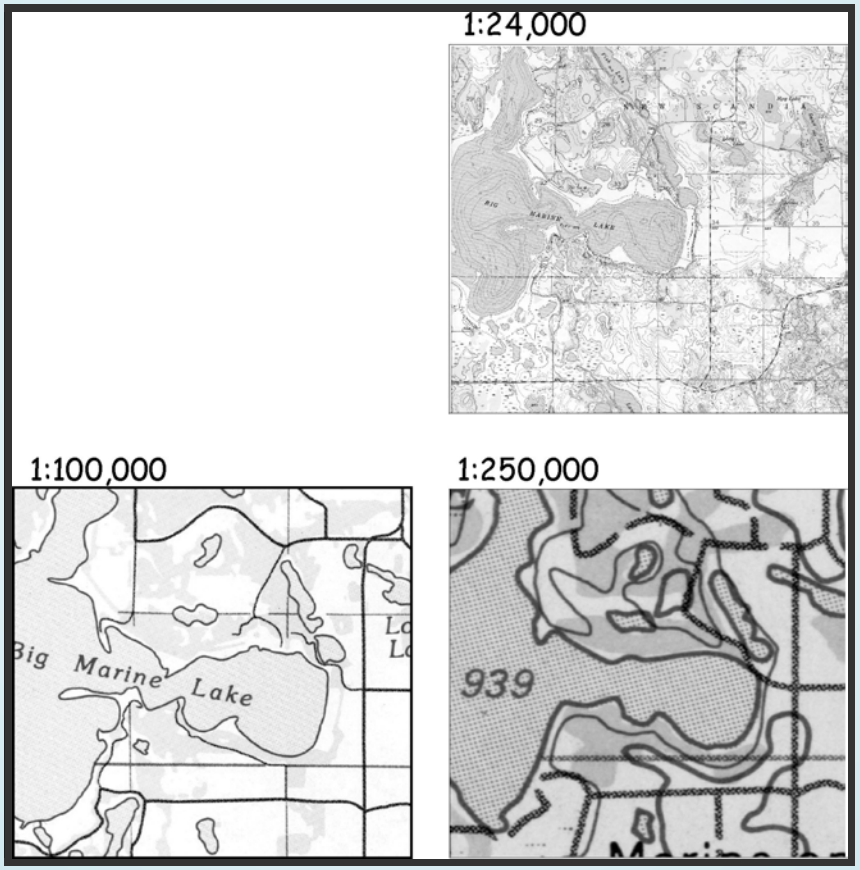
- Map generalization - the overall approximation of a landscape when represented on a map; the collection of feature generalizations.
- Feature generalization - approximation of entities when they are represented on a map.

TYPES OF GENERALIZATIONS



Bolstad 2012, Fig 4-9

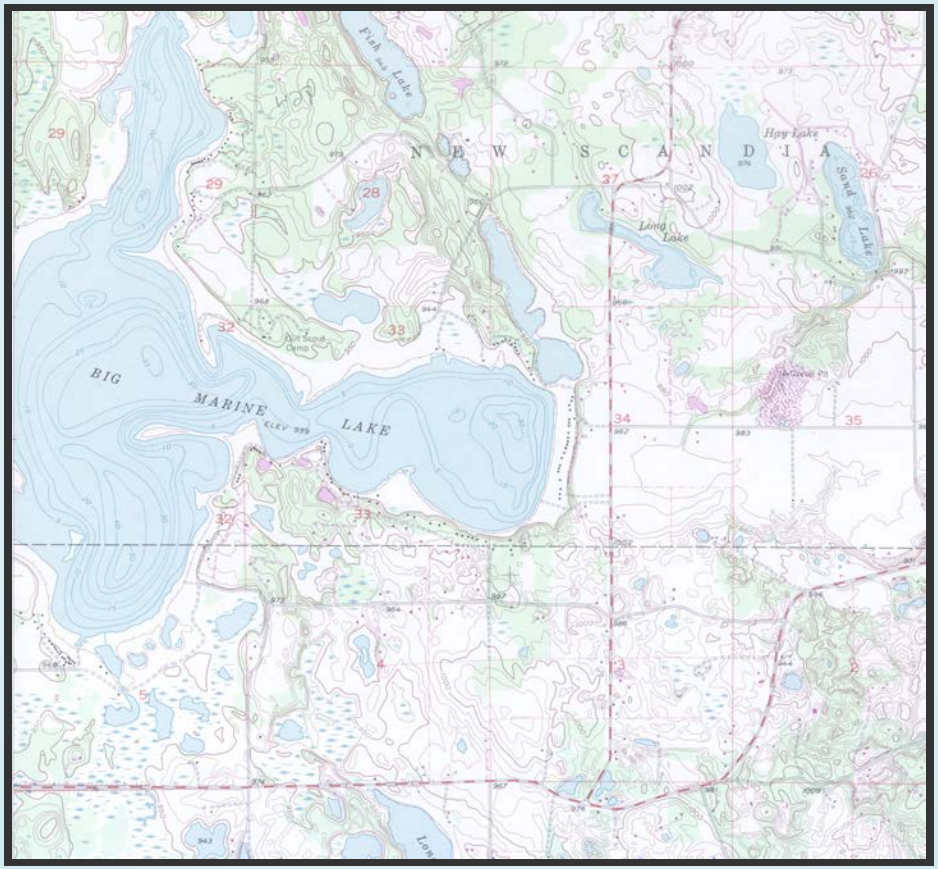
EXAMPLE OF GENERALIZATION



Bolstad 2012, Fig 4-10

EXAMPLE AT 24K

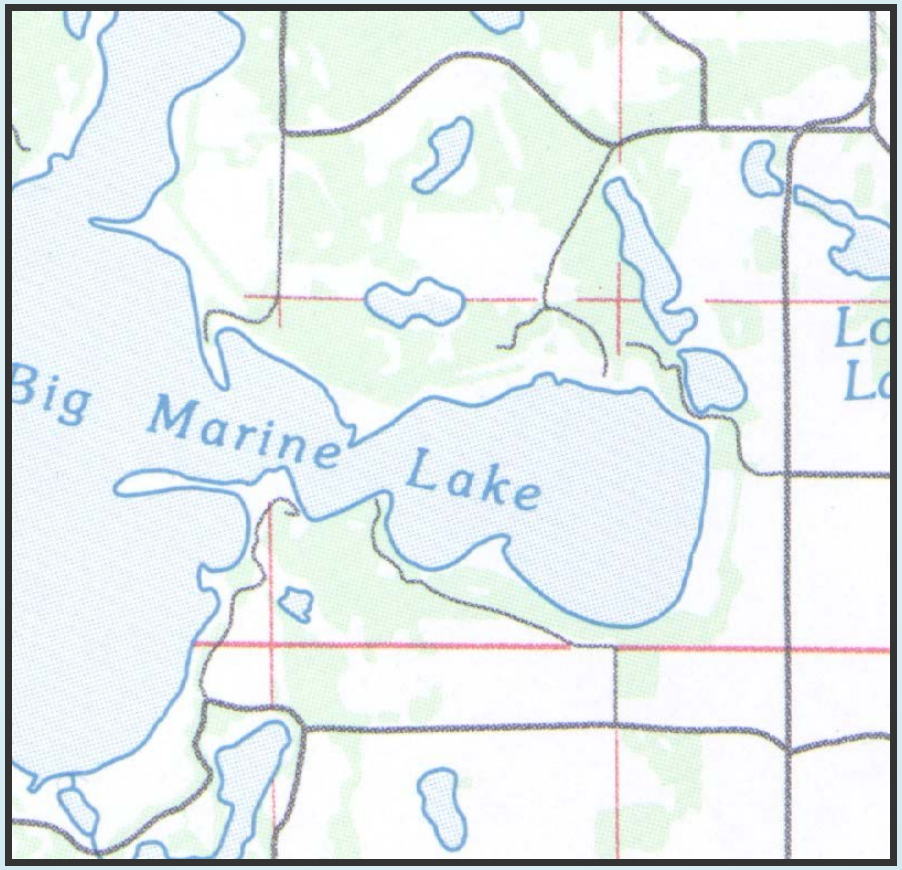
This lake is detailed at this large scale.



Bolstad 2012, Fig 4-10 (partial)

EXAMPLE AT 100K

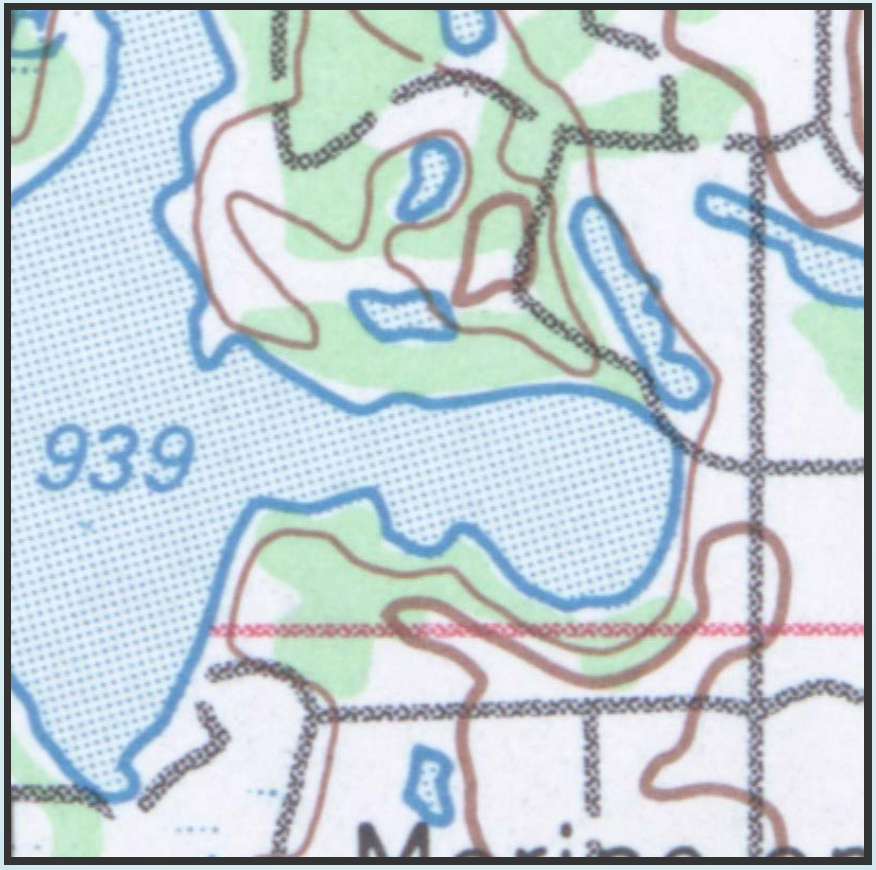
This lake is more generalized when drawn at medium scale.



Bolstad 2012, Fig 4-10 (partial)

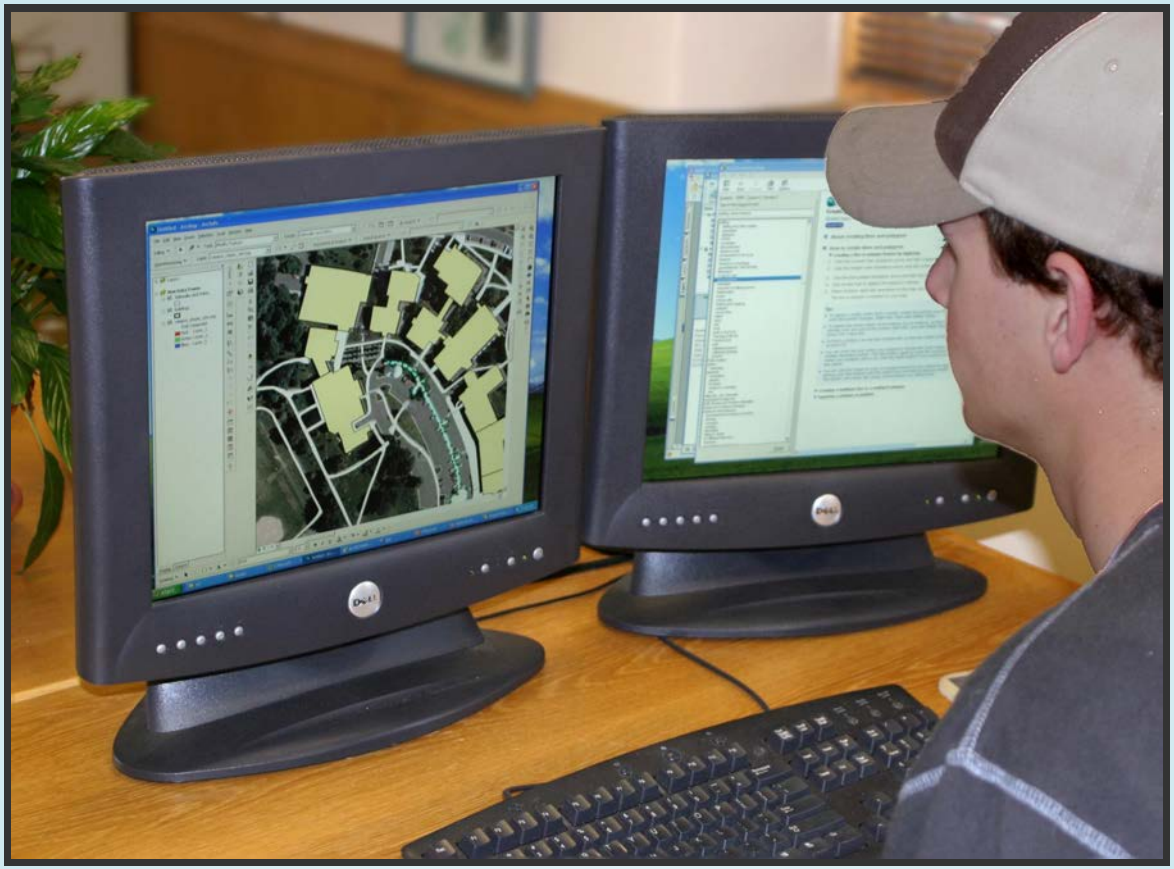
EXAMPLE AT 250K

This lake is even more generalized when drawn at small scale.



Bolstad 2012, Fig 4-10 (partial)

ON-SCREEN DIGITIZATION



Bolstad 2012, Fig 4-11

HARDCOPY DIGITIZATION

Bolstad 2012, Fig 4-12

CLOSE UP OF A DIGITIZING TOOL

Bolstad 2012, Fig 4-11old

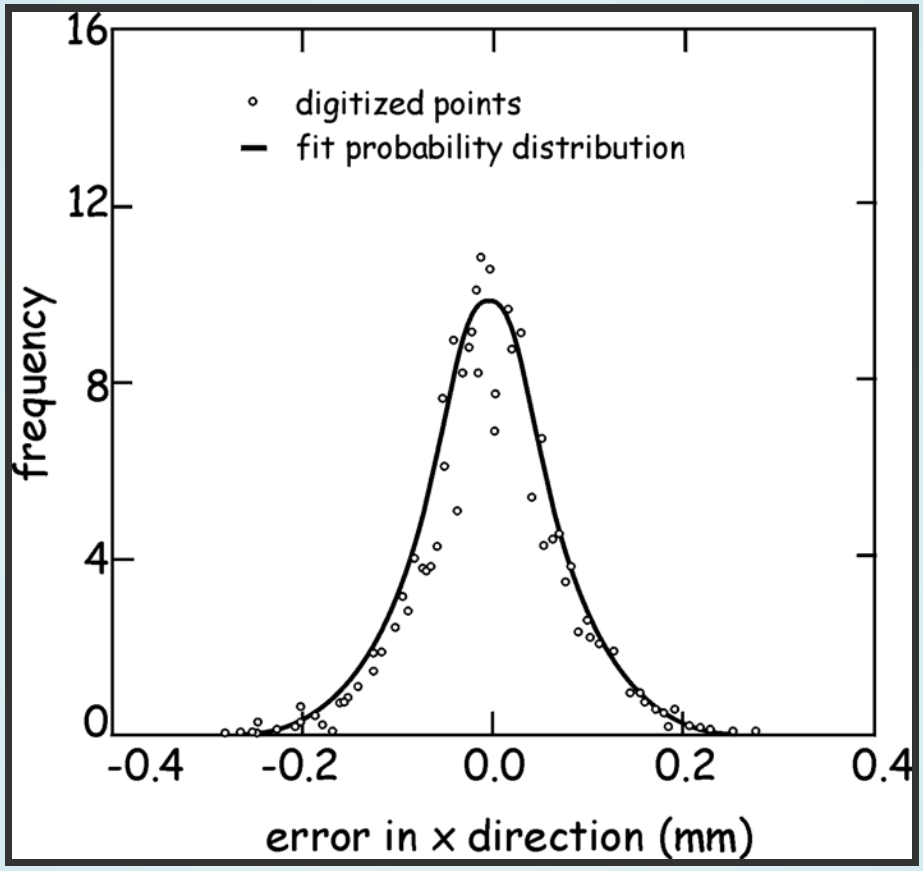
DIGITIZATION ERRORS

Table 4-1: The surface error caused by a one millimeter (0.039 inch) map error will change as map scale changes. Note the larger error at smaller map scales.

Map Scale	Error (m)	Error (ft)
1:24,000	24	79
1:50,000	50	164
1:62,500	63	205
1:100,000	100	328
1:250,000	250	820
1:1,000,000	1,000	3,281

Bolstad 2012, Table 4-1

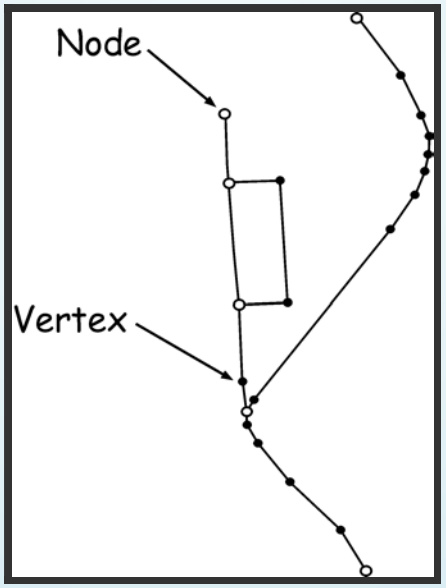
MEASURING ERROR



Bolstad 2012, Fig 4-13

NODES AND VERTICES

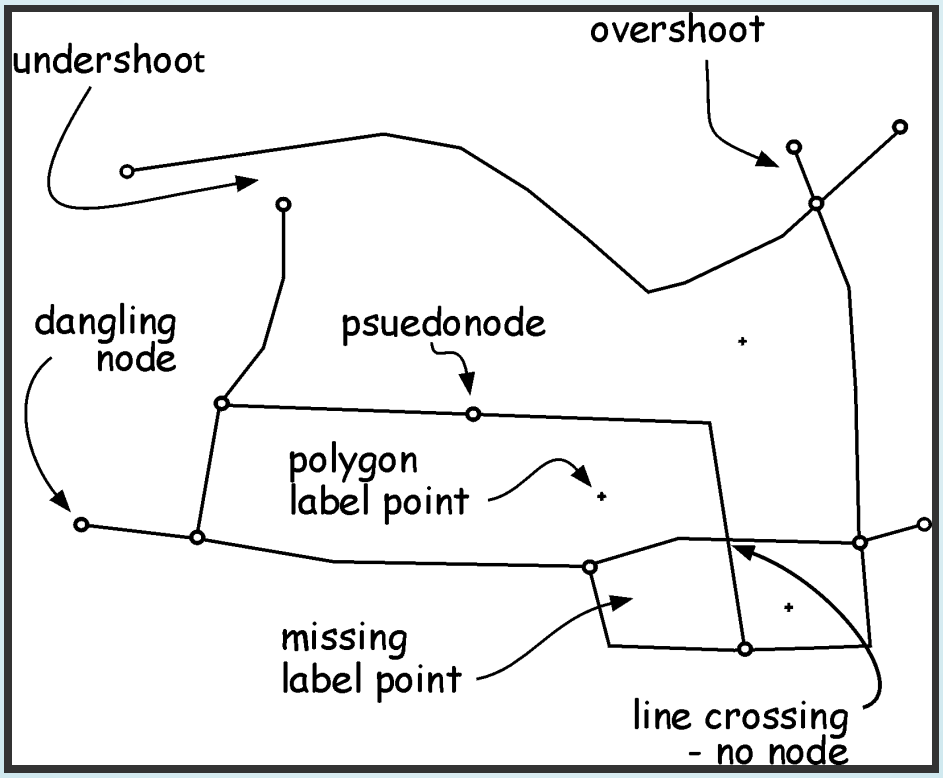
- Vertices - points in features, defining points, lines, or polygons.
- Nodes - the starting or ending vertices of lines.
- Vertices and nodes are often not differentiated.



Bolstad 2012, Fig 4-14

COMMON DIGITIZING ERRORS

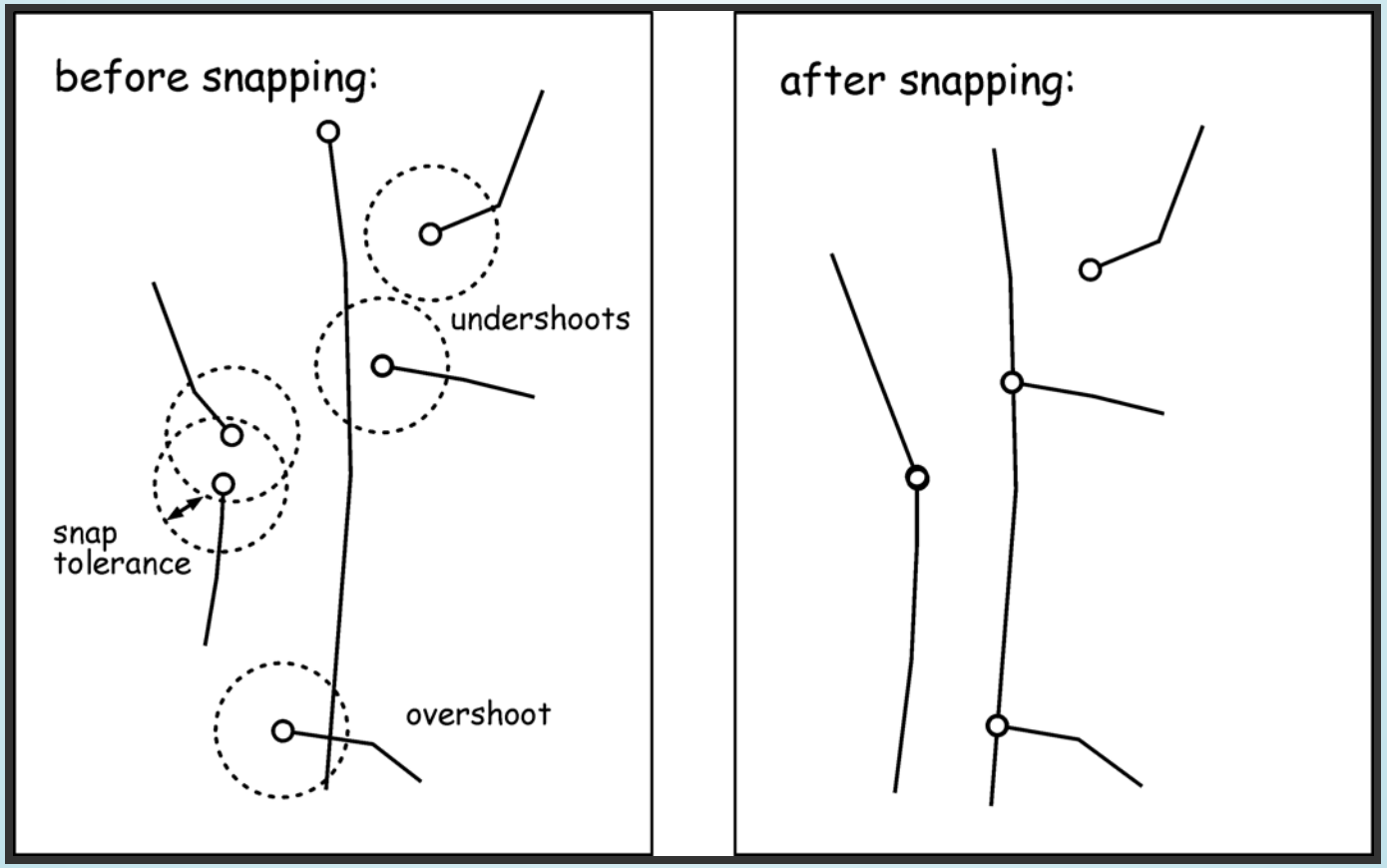
Remember the lesson on topology?



Bolstad 2012, Fig 4-15

SNAPPING

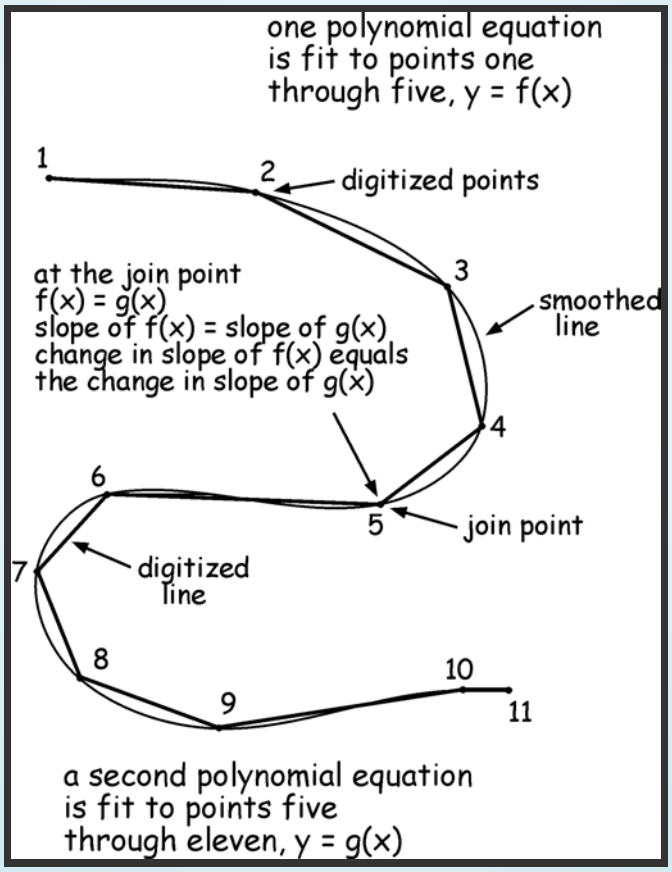
Whether or not a node or vertex snaps is dependent on an XY tolerance, a.k.a. snapping distance (e.g. snap if the node/vertex is within 1 meter)



Bolstad 2012, Fig 4-16

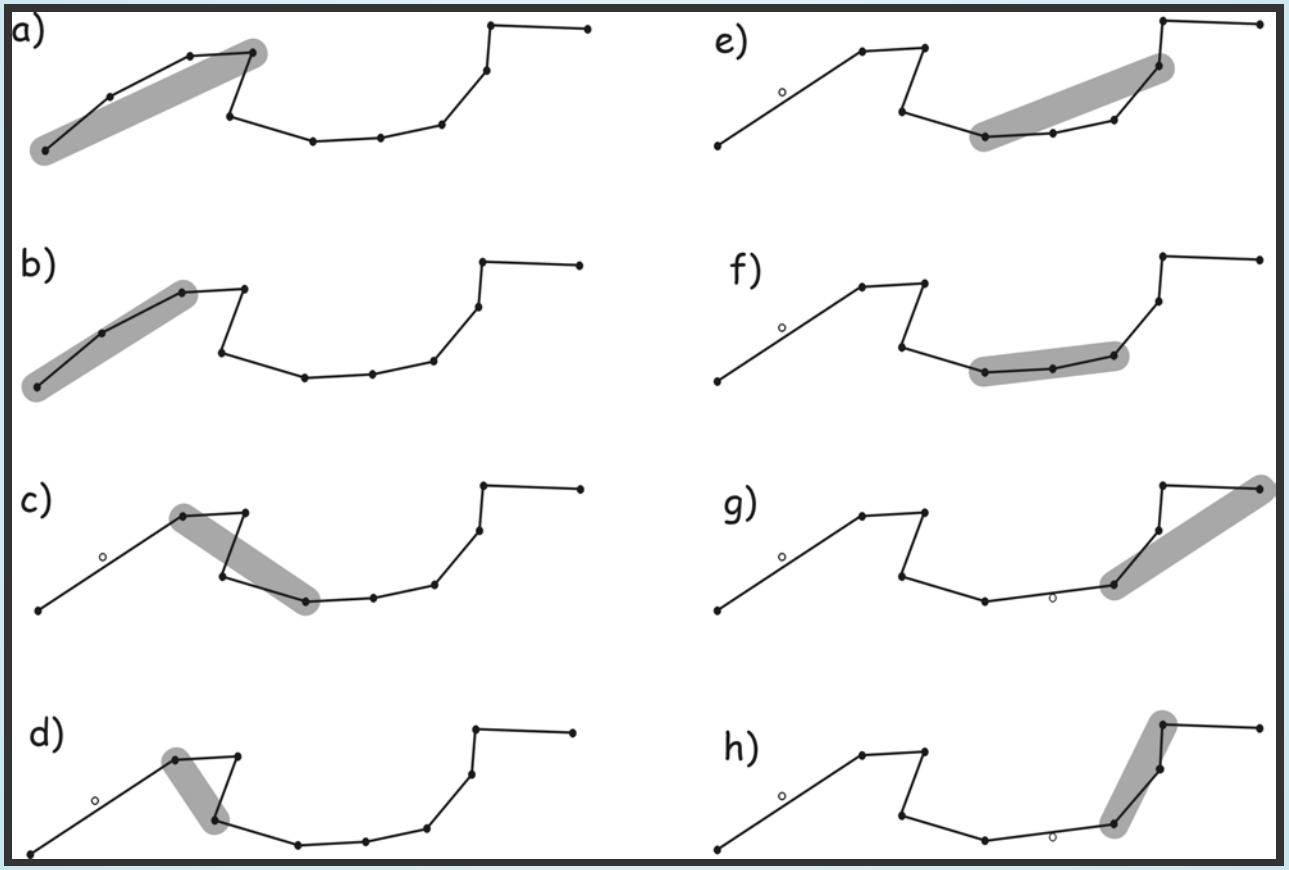
SMOOTHING LINES

- Spline - a smoothed line or surface created by joining multiple constrained polynomial functions.



Bolstad 2012, Fig 4-17

LANG METHOD FOR THINNING

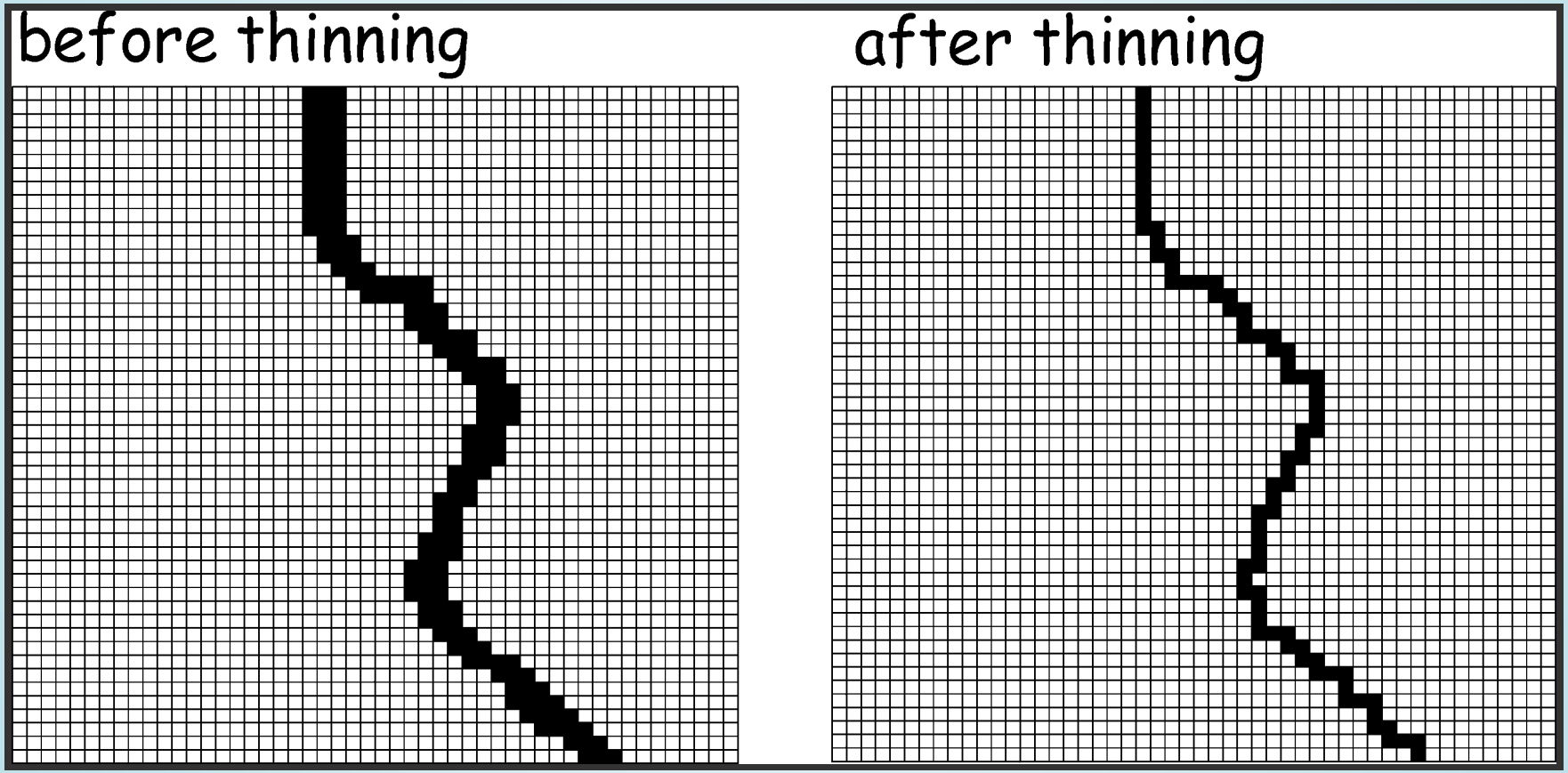


Bolstad 2012, Fig 4-18

MAP SCANNER

Bolstad 2012, Fig 4-19

SKELETONIZING FOR THINNING

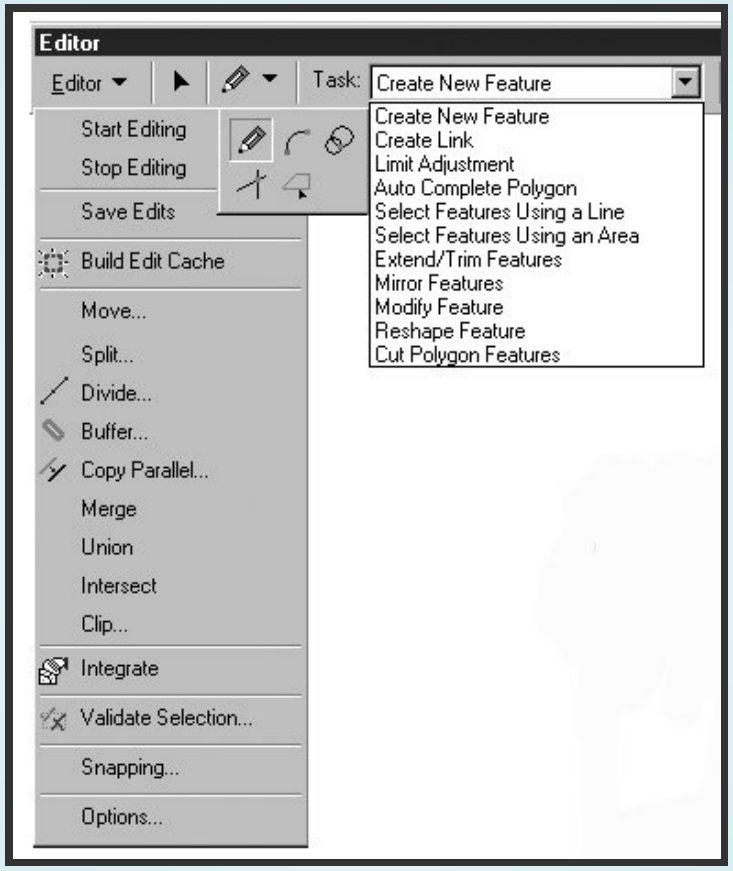


Bolstad 2012, Fig 4-20

ADJUSTING SCANNED DATA

Rubbersheeting - a technique to adjust groups of features in an area by fitting local equations to adjust the coordinates of features. Anchor points are used as control points and all other lines and points are adjusted.

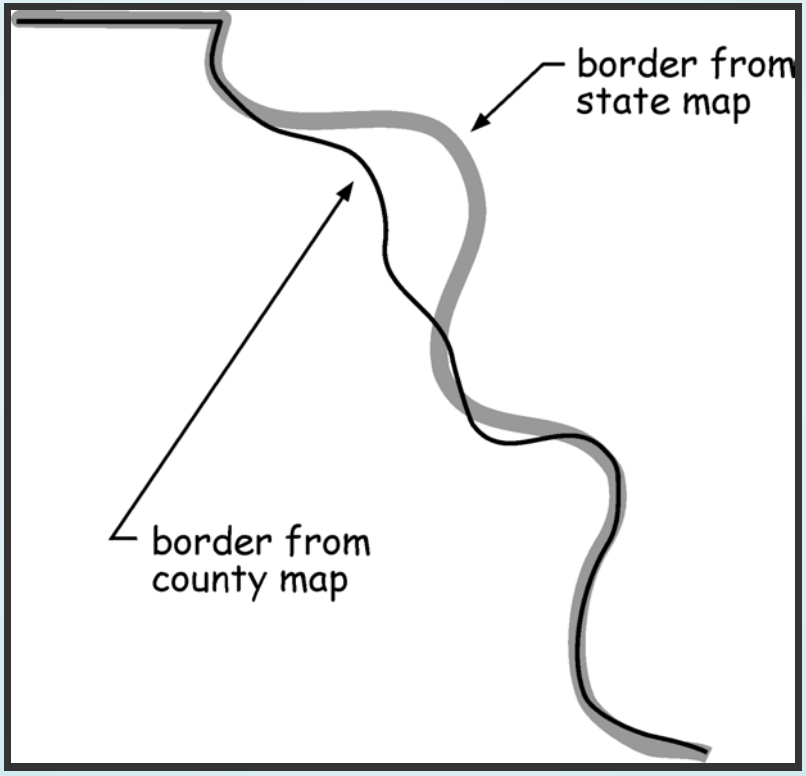
EDITING TOOLS IN GIS



Bolstad 2012, Fig 4-21

DIFFERENCES WITHIN DIFFERENT DATASETS

We saw this is Lesson 3 in Understanding GIS



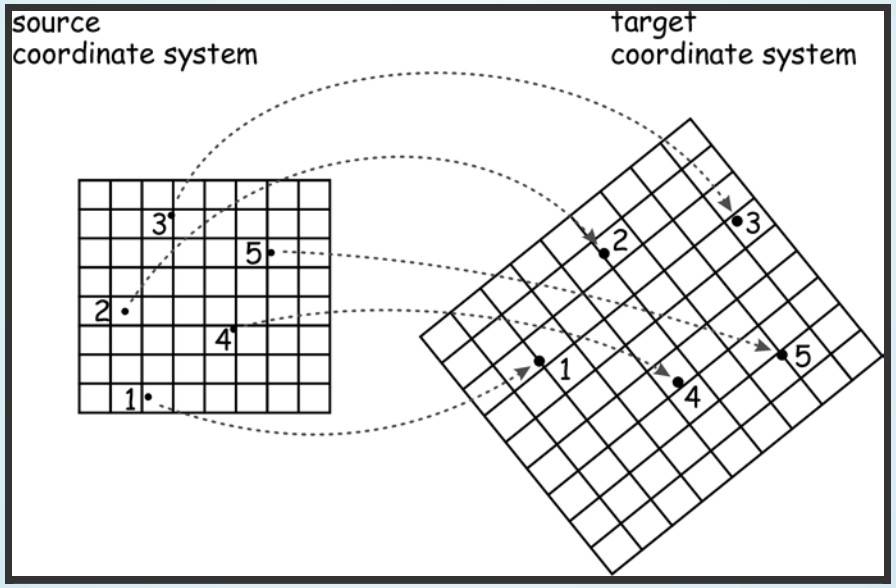
Bolstad 2012, Fig 4-22

COORDINATE TRANSFORMATION

Registration - the conversion of coordinate data to an earth-surface coordinate system. Generally, the fitting of cartographic data in one coordinate system to another. Registers data to a map coordinate system.

CONTROL POINTS FOR TRANSFORMATION

Control points - locations of known location in both layers and the map coordinate system.



Bolstad 2012, Fig 4-23

THE AFFINE TRANSFORMATION

$$E = T_E + a_1 x + a_2 y$$

$$N = T_N + b_1 x + b_2 y$$

Bolstad 2012, Eqs 4-1 and 4-2

$$500{,}083.4 = T_E + a_1(103.0) + a_2(-100.1) \quad (4.3)$$

$$4{,}903{,}683.5 = T_N + b_1(103.0) + b_2(-100.1) \quad (4.4)$$

Bolstad 2012, Eqs 4-3 and 4-4

ROOT MEAN SQUARE ERROR (RMSE)

- RMSE - a statistic that measures the difference between true and predicted data values for coordinate locations.

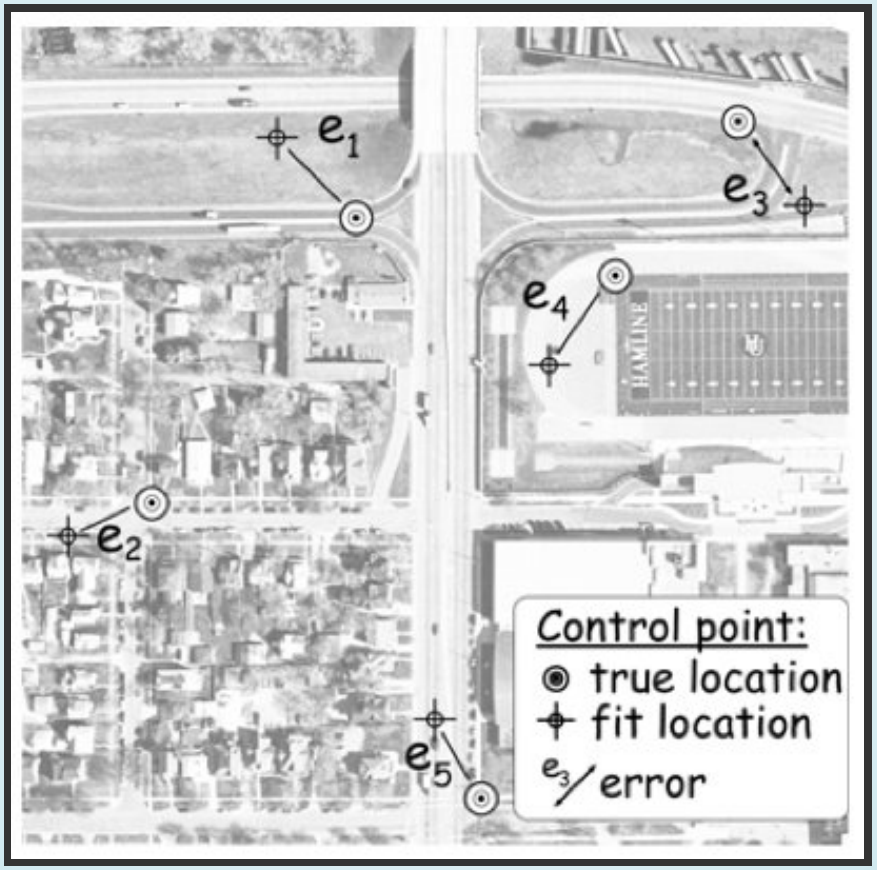
$$RMSE = \sqrt{\frac{e_1^2 + e_2^2 + e_3^2 \ldots + e_n^2}{n}} \qquad (4.5)$$

Bolstad 2012, Eq 4-5

$$e = \sqrt{(x_t - x_d)^2 + (y_t - y_d)^2} \qquad (4.6)$$

Bolstad 2012, Eq 4-6

CONTROL POINTS AND ERROR



Bolstad 2012, Fig 4-24

OTHER COORDINATE TRANSFORMATIONS

$$E = T_E + cx - dy \qquad (4.7)$$

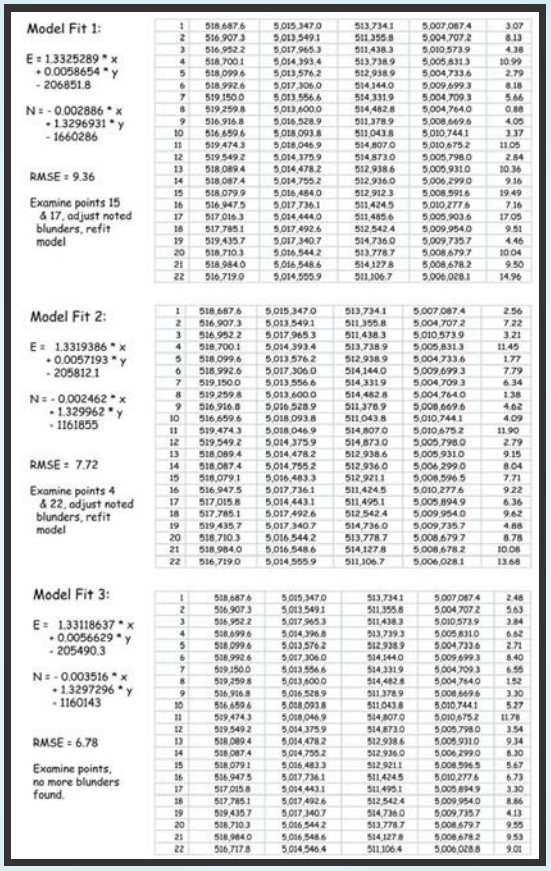
$$N = T_N + dx + cy \qquad (4.8)$$

Bolstad 2012, Eqs 4-7 and 4-8

$$E = b_1 + b_2x + b_3y + b_4x^2 + b_5y^2 + b_6xy \qquad (4.9)$$

Bolstad 2012, Eq 4-9

ITERATIVE FITTING



Model Fit 1:

E = 1.3325289 * x + 0.0058654 * y - 206851.8

N = - 0.002886 * x + 1.3296931 * y - 1660286

RMSE = 9.36

Examine points 15 & 17, adjust noted blunders, refit model

1	518,687.6	5,015,347.0	513,734.1	5,007,087.4	3.07
2	516,907.3	5,013,549.1	511,355.8	5,004,707.2	8.13
3	516,952.2	5,017,965.3	511,438.3	5,010,573.9	4.38
4	518,700.1	5,014,393.4	513,738.9	5,005,831.3	10.99
5	518,099.6	5,013,576.2	512,938.9	5,004,733.6	2.79
6	518,992.6	5,017,306.0	514,144.0	5,009,699.3	8.18
7	519,150.0	5,013,556.6	514,331.9	5,004,709.3	5.66
8	519,259.8	5,013,600.0	514,482.8	5,004,764.0	0.88
9	516,916.8	5,016,528.9	511,378.9	5,008,669.6	4.05
10	516,659.6	5,018,093.8	511,043.8	5,010,744.1	3.37
11	519,474.3	5,018,046.9	514,807.0	5,010,675.2	11.05
12	519,549.2	5,014,375.9	514,873.0	5,005,798.0	2.84
13	518,089.4	5,014,478.2	512,938.6	5,005,931.0	10.36
14	518,087.4	5,014,755.2	512,936.0	5,006,299.0	9.16
15	518,079.9	5,016,484.0	512,912.3	5,008,591.6	19.49
16	516,947.5	5,017,736.1	511,424.5	5,010,277.6	7.16
17	517,016.3	5,014,444.0	511,485.6	5,005,903.6	17.05
18	517,785.1	5,017,492.6	512,542.4	5,009,954.0	9.51
19	519,435.7	5,017,340.7	514,736.0	5,009,735.7	4.46
20	518,710.3	5,016,544.2	513,778.7	5,008,679.7	10.04
21	518,984.0	5,016,548.6	514,127.8	5,008,678.2	9.50
22	516,719.0	5,014,555.9	511,106.7	5,006,028.1	14.96

Model Fit 2:

E = 1.3319386 * x + 0.0057193 * y - 205812.1

N = - 0.002462 * x + 1.329962 * y - 1161855

RMSE = 7.72

Examine points 4 & 22, adjust noted blunders, refit model

1	518,687.6	5,015,347.0	513,734.1	5,007,087.4	2.56
2	516,907.3	5,013,549.1	511,355.8	5,004,707.2	7.22
3	516,952.2	5,017,965.3	511,438.3	5,010,573.9	3.21
4	518,700.1	5,014,393.4	513,738.9	5,005,831.3	11.45
5	518,099.6	5,013,576.2	512,938.9	5,004,733.6	1.77
6	518,992.6	5,017,306.0	514,144.0	5,009,699.3	7.79
7	519,150.0	5,013,556.6	514,331.9	5,004,709.3	6.34
8	519,259.8	5,013,600.0	514,482.8	5,004,764.0	1.38
9	516,916.8	5,016,528.9	511,378.9	5,008,669.6	4.62
10	516,659.6	5,018,093.8	511,043.8	5,010,744.1	4.09
11	519,474.3	5,018,046.9	514,807.0	5,010,675.2	11.90
12	519,549.2	5,014,375.9	514,873.0	5,005,798.0	2.79
13	518,089.4	5,014,478.2	512,938.6	5,005,931.0	9.15
14	518,087.4	5,014,755.2	512,936.0	5,006,299.0	8.04
15	518,079.1	5,016,483.3	512,921.1	5,008,596.5	7.71
16	516,947.5	5,017,736.1	511,424.5	5,010,277.6	9.22
17	517,015.8	5,014,443.1	511,495.1	5,005,894.9	6.36
18	517,785.1	5,017,492.6	512,542.4	5,009,954.0	9.62
19	519,435.7	5,017,340.7	514,736.0	5,009,735.7	4.88
20	518,710.3	5,016,544.2	513,778.7	5,008,679.7	8.78
21	518,984.0	5,016,548.6	514,127.8	5,008,678.2	10.08
22	516,719.0	5,014,555.9	511,106.7	5,006,028.1	13.68

Model Fit 3:

E = 1.33118637 * x + 0.0056629 * y - 205490.3

N = - 0.003516 * x + 1.3297296 * y - 1160143

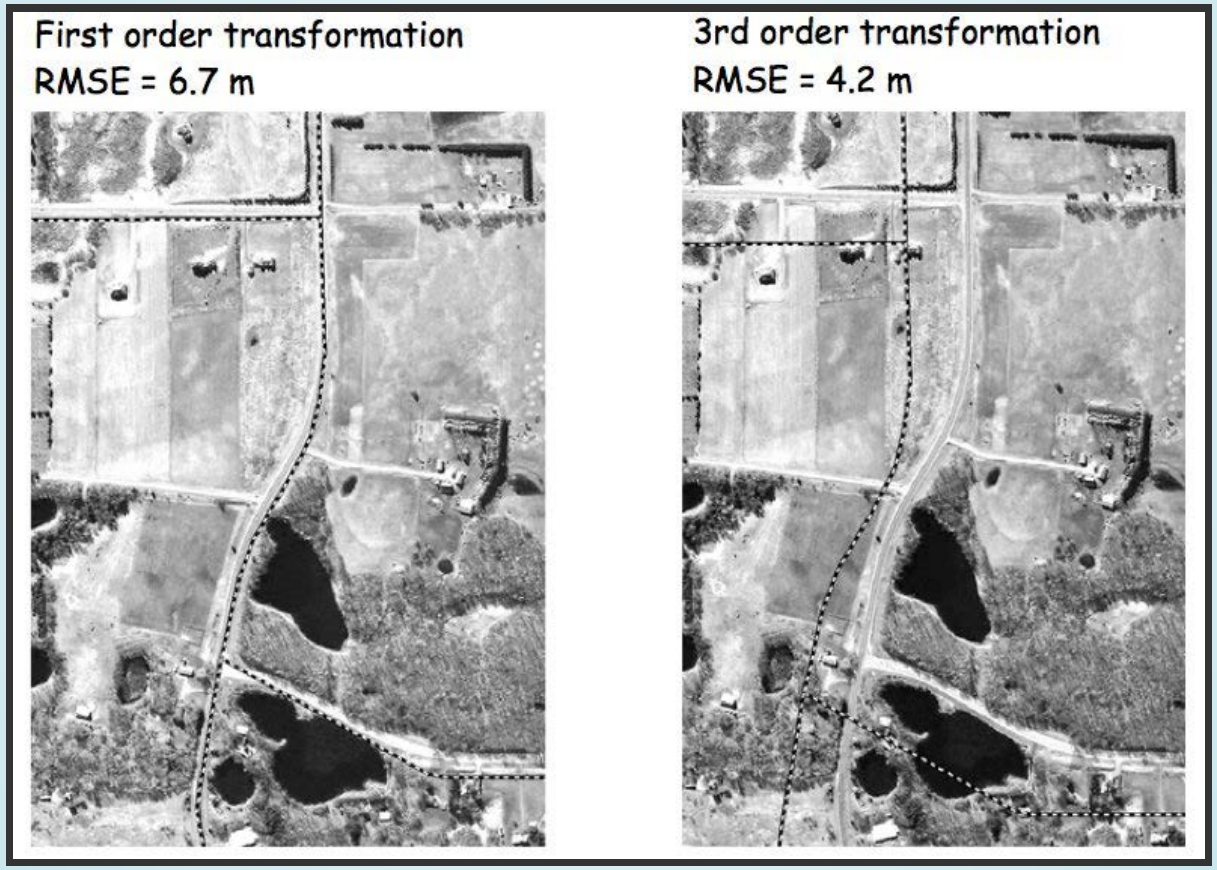
RMSE = 6.78

Examine points, no more blunders found.

1	518,687.6	5,015,347.0	513,734.1	5,007,087.4	2.48
2	516,907.3	5,013,549.1	511,355.8	5,004,707.2	5.63
3	516,952.2	5,017,965.3	511,438.3	5,010,573.9	3.84
4	518,699.6	5,014,396.8	513,739.3	5,005,831.0	6.62
5	518,099.6	5,013,576.2	512,938.9	5,004,733.6	2.71
6	518,992.6	5,017,306.0	514,144.0	5,009,699.3	8.40
7	519,150.0	5,013,556.6	514,331.9	5,004,709.3	6.55
8	519,259.8	5,013,600.0	514,482.8	5,004,764.0	1.52
9	516,916.8	5,016,528.9	511,378.9	5,008,669.6	3.30
10	516,659.6	5,018,093.8	511,043.8	5,010,744.1	5.27
11	519,474.3	5,018,046.9	514,807.0	5,010,675.2	11.78
12	519,549.2	5,014,375.9	514,873.0	5,005,798.0	3.54
13	518,089.4	5,014,478.2	512,938.6	5,005,931.0	9.34
14	518,087.4	5,014,755.2	512,936.0	5,006,299.0	8.30
15	518,079.1	5,016,483.3	512,921.1	5,008,596.5	5.67
16	516,947.5	5,017,736.1	511,424.5	5,010,277.6	6.73
17	517,015.8	5,014,443.1	511,495.1	5,005,894.9	3.30
18	517,785.1	5,017,492.6	512,542.4	5,009,954.0	8.86
19	519,435.7	5,017,340.7	514,736.0	5,009,735.7	4.13
20	518,710.3	5,016,544.2	513,778.7	5,008,679.7	9.55
21	518,984.0	5,016,548.6	514,127.8	5,008,678.2	9.53
22	516,717.8	5,014,546.4	511,106.4	5,006,028.8	9.01

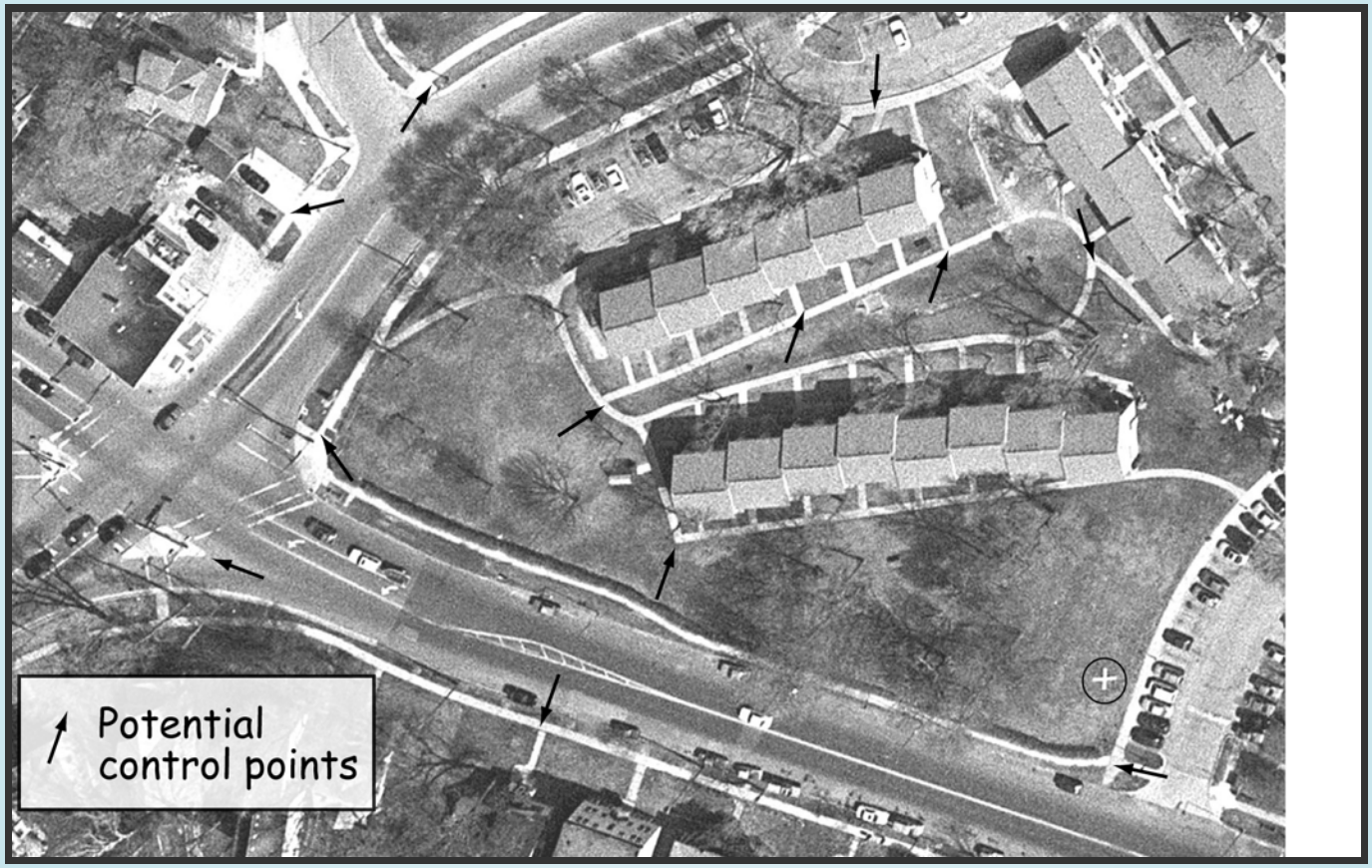
Bolstad 2012, Fig 4-25

RMSE BETWEEN DIFFERENT TRANSFORMATIONS



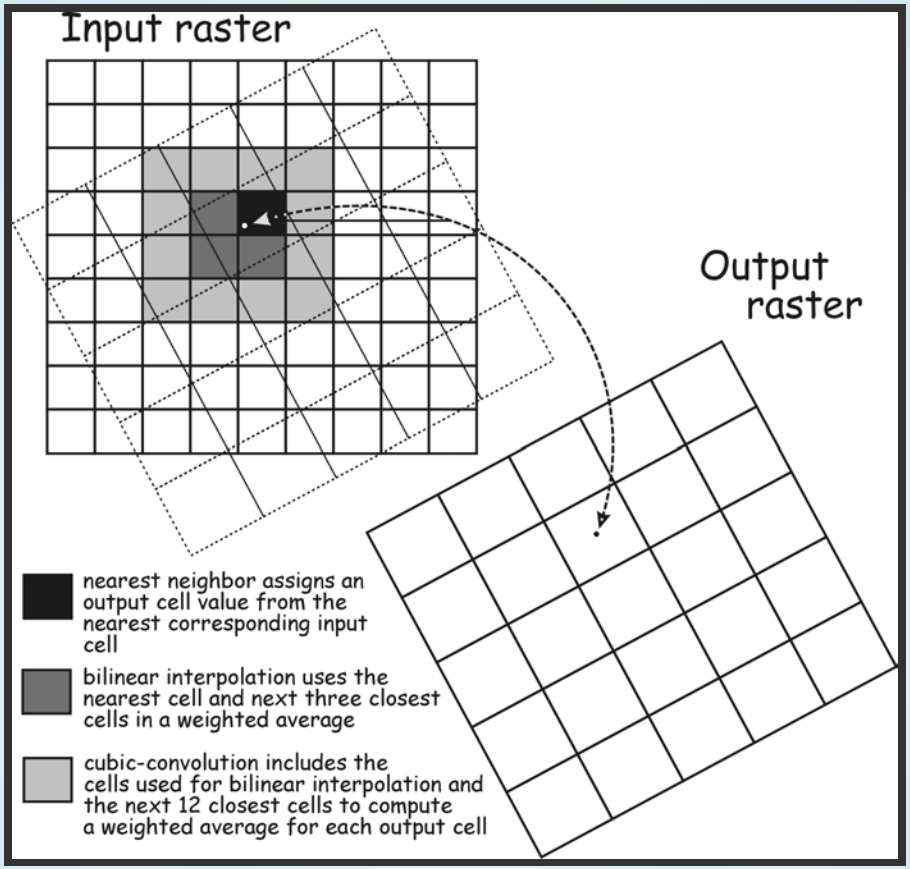
Bolstad 2012, Fig 4-26

POTENTIAL CONTROL POINTS



Bolstad 2012, Fig 4-28

RASTER RESAMPLING

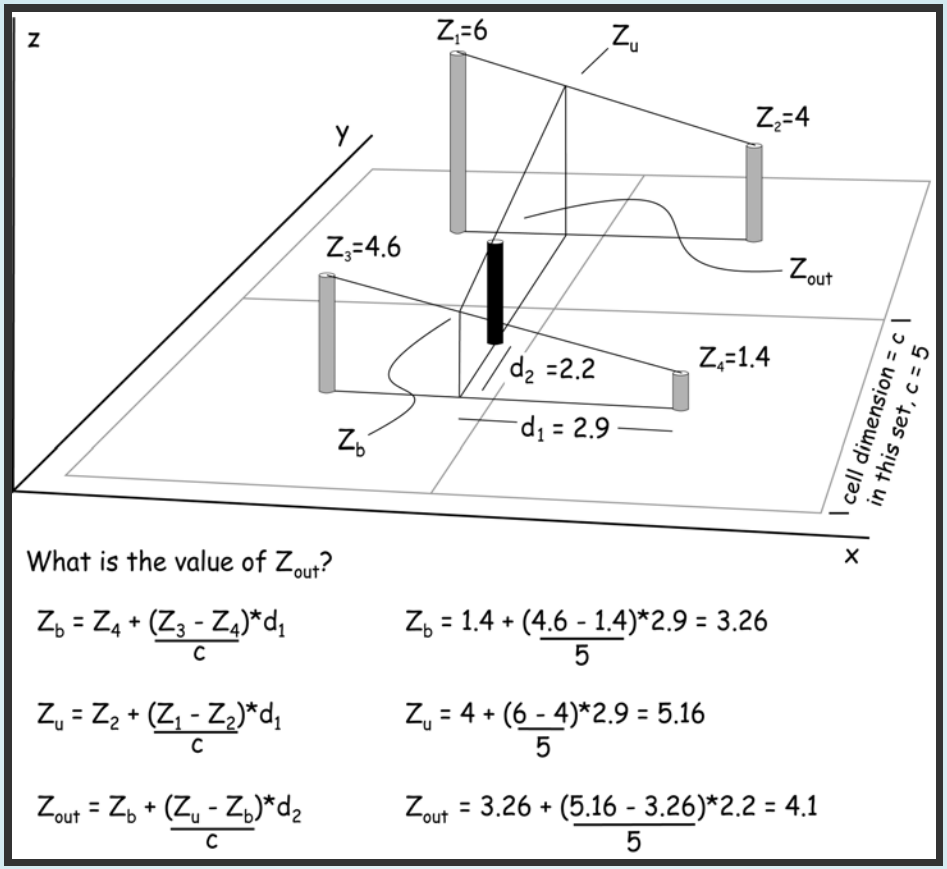


Bolstad 2012, Fig 4-30

RESAMPLING METHODS

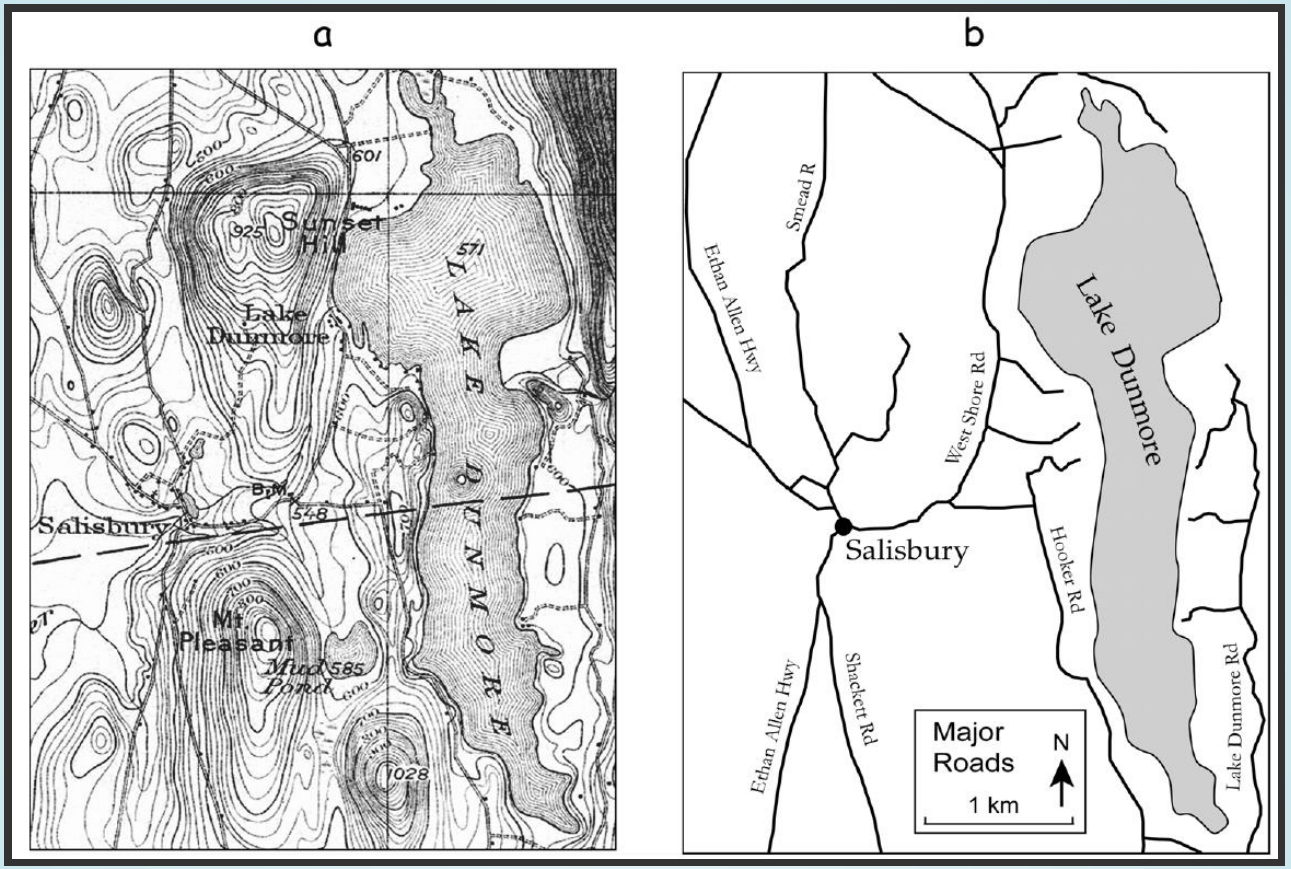
- Nearest neighbor - takes value of nearest cell.
- Bilinear interpolation - distance based averaging of the four nearest cells.
- Cubic convolution - weighted average of 16 nearest cells.

BILINEAR INTERPOLATION



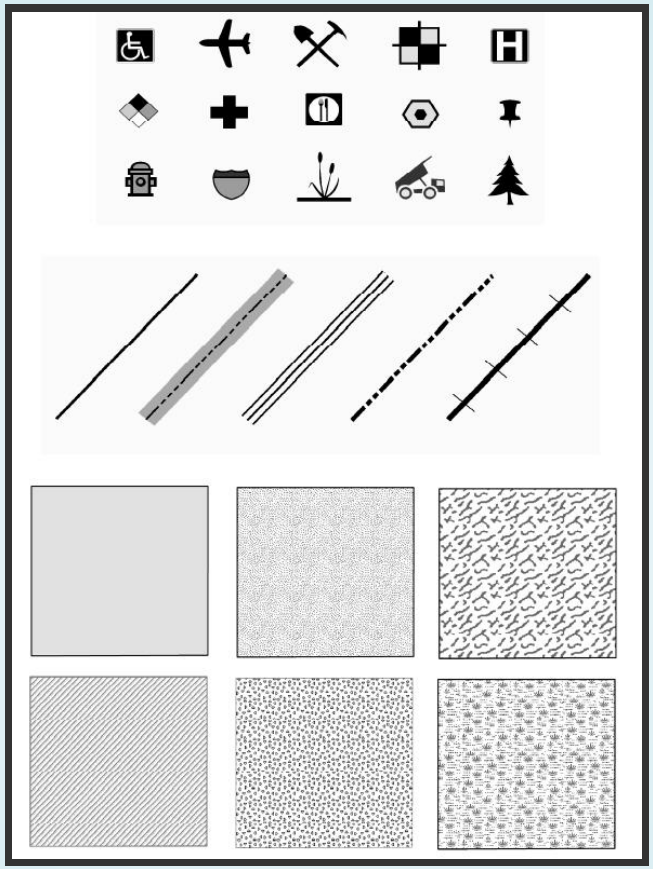
Bolstad 2012, Fig 4-31

MAPS HAVE THEMES



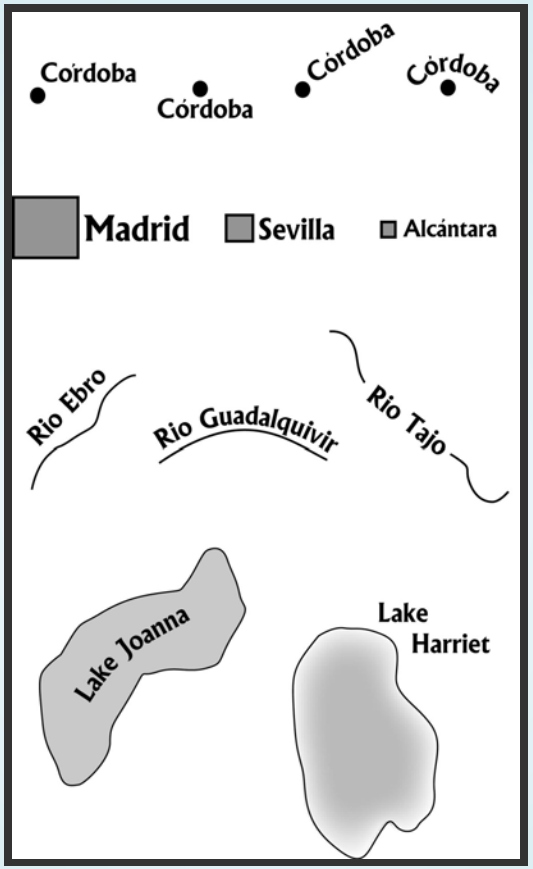
Bolstad 2012, Fig 4-32

SYMBOLOGY



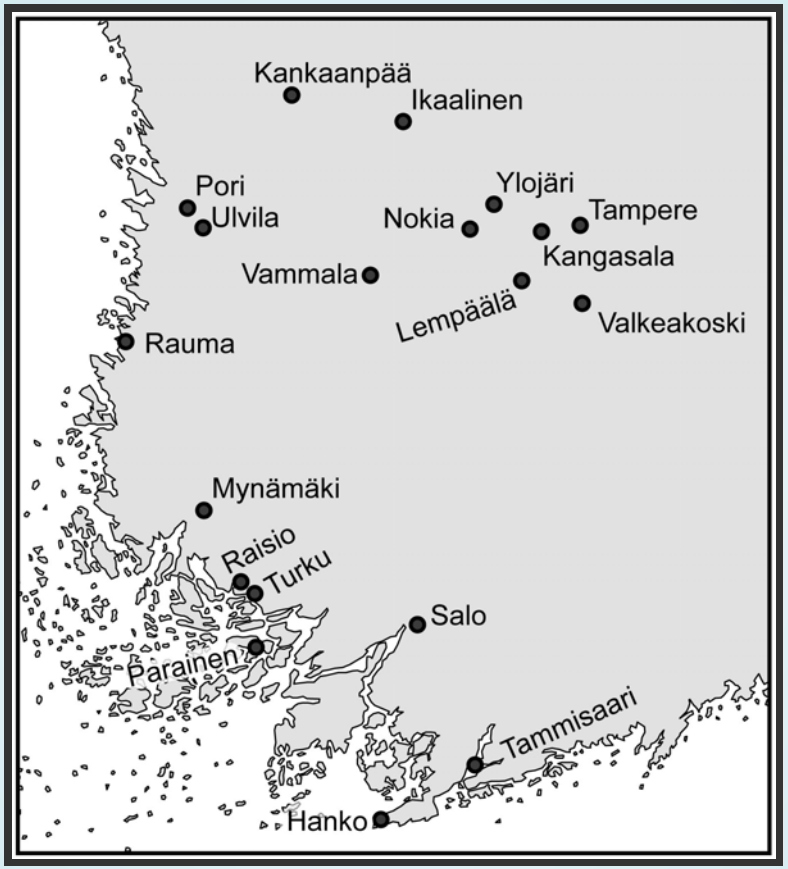
Bolstad 2012, Fig 4-33

LABELS



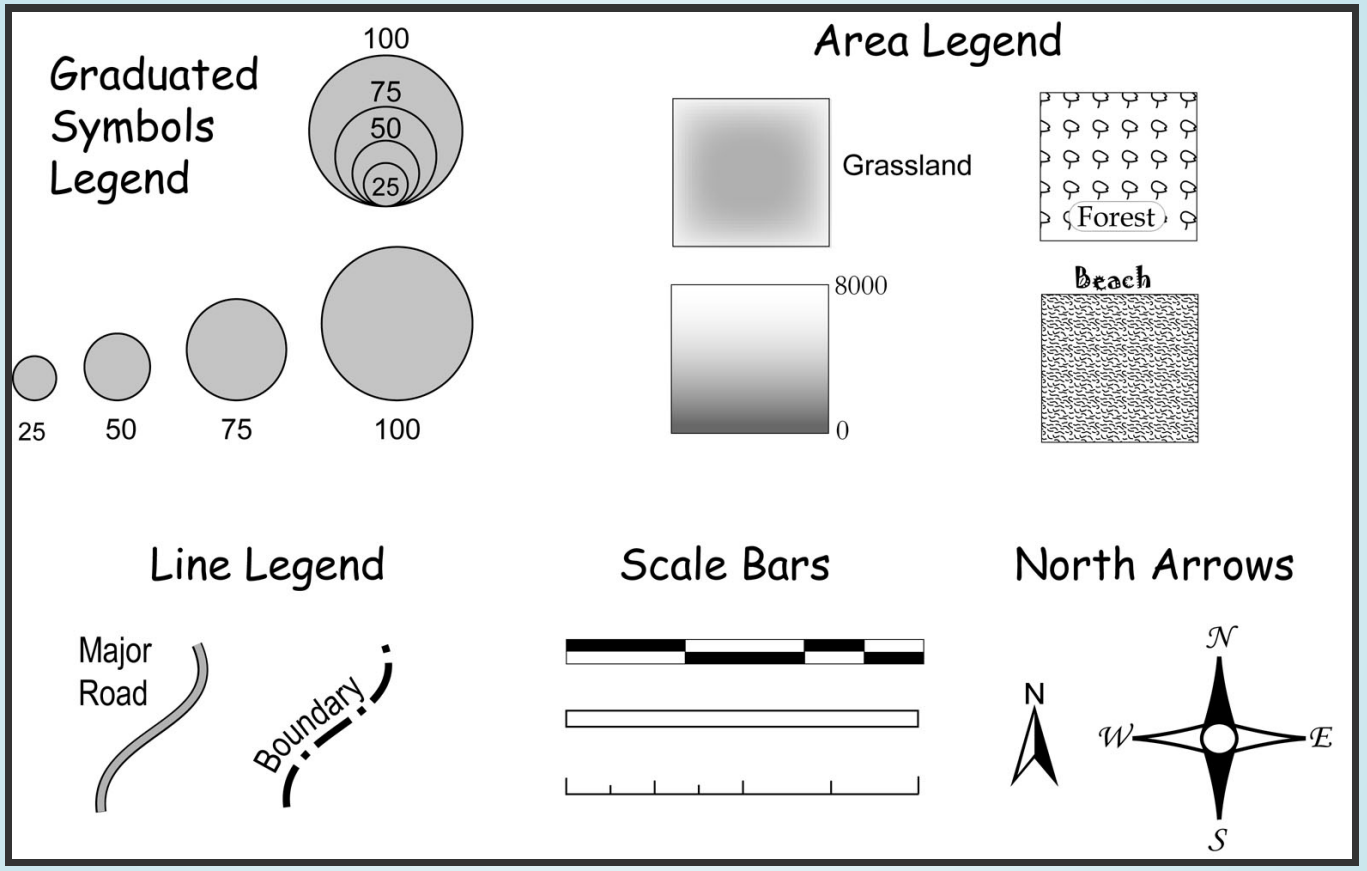
Bolstad 2012, Fig 4-34

LABEL PLACEMENT



Bolstad 2012, Fig 4-35

MORE MAP ELEMENTS



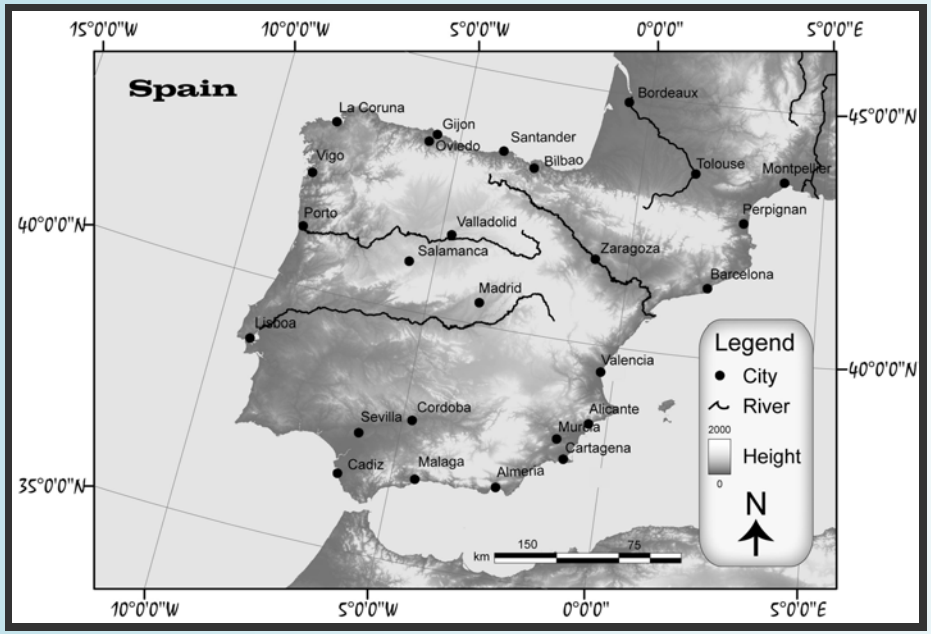
Bolstad 2012, Fig 4-36

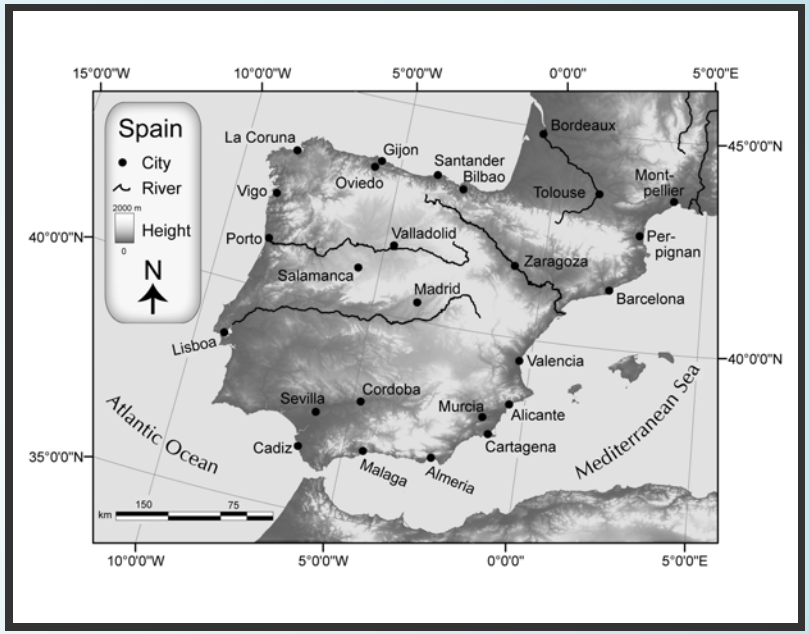
MORE MAP ELEMENTS

- Data area or pane (a.k.a. view extent, or data frame in ArcMap)
- Neatline - a frame surrounding a map element
- Inset - a data frame placed within the borders of another data frame
- Scalebars - indicates real-world distances on a map
- Legends - a key that describes the symbology of feature classes in the map
- North arrow - an arrow that points north (may be geographic, grid, or magnetic north)

BAD MAP, GOOD MAP

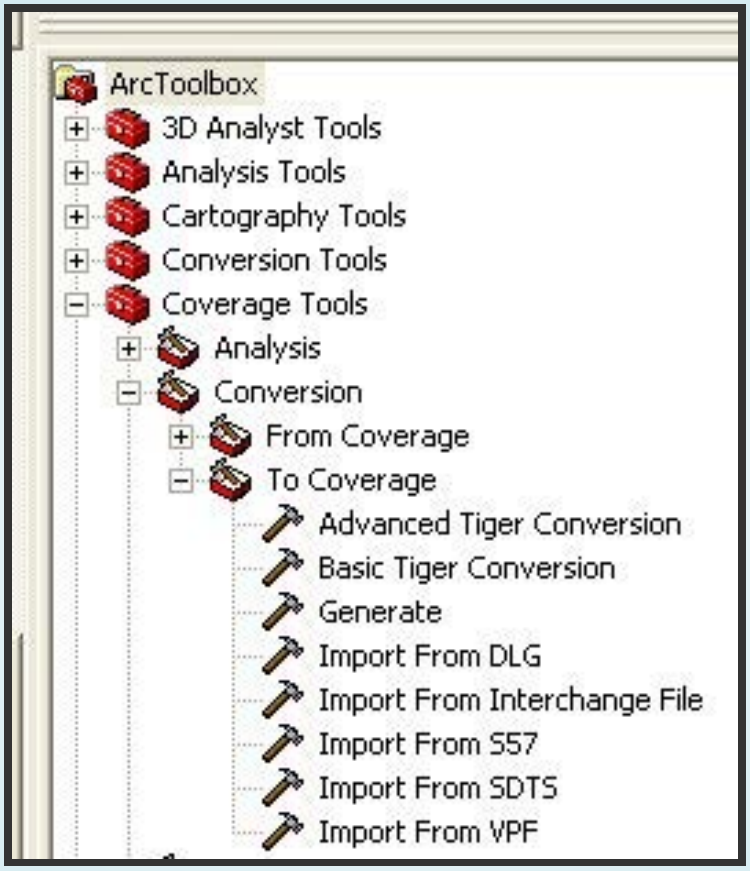
Let's talk





Bolstad 2012, Fig 4-37

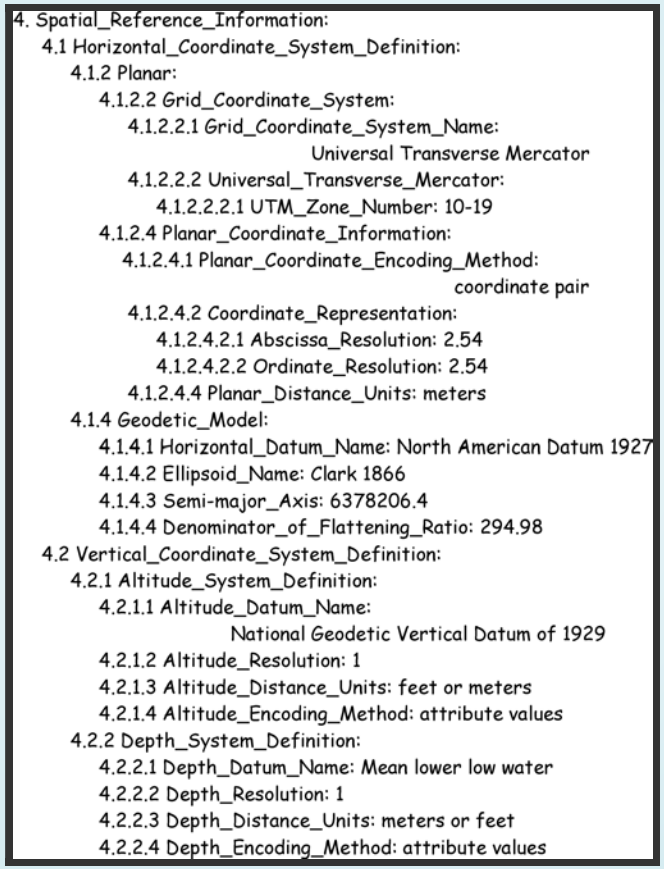
FILE FORMAT CONVERSIONS



Bolstad 2012, Fig 4-38

METADATA EXAMPLE

Metadata - data about data.



Bolstad 2012, Fig 4-39