The lag time of river response to urbanization in eastern Pennsylvania

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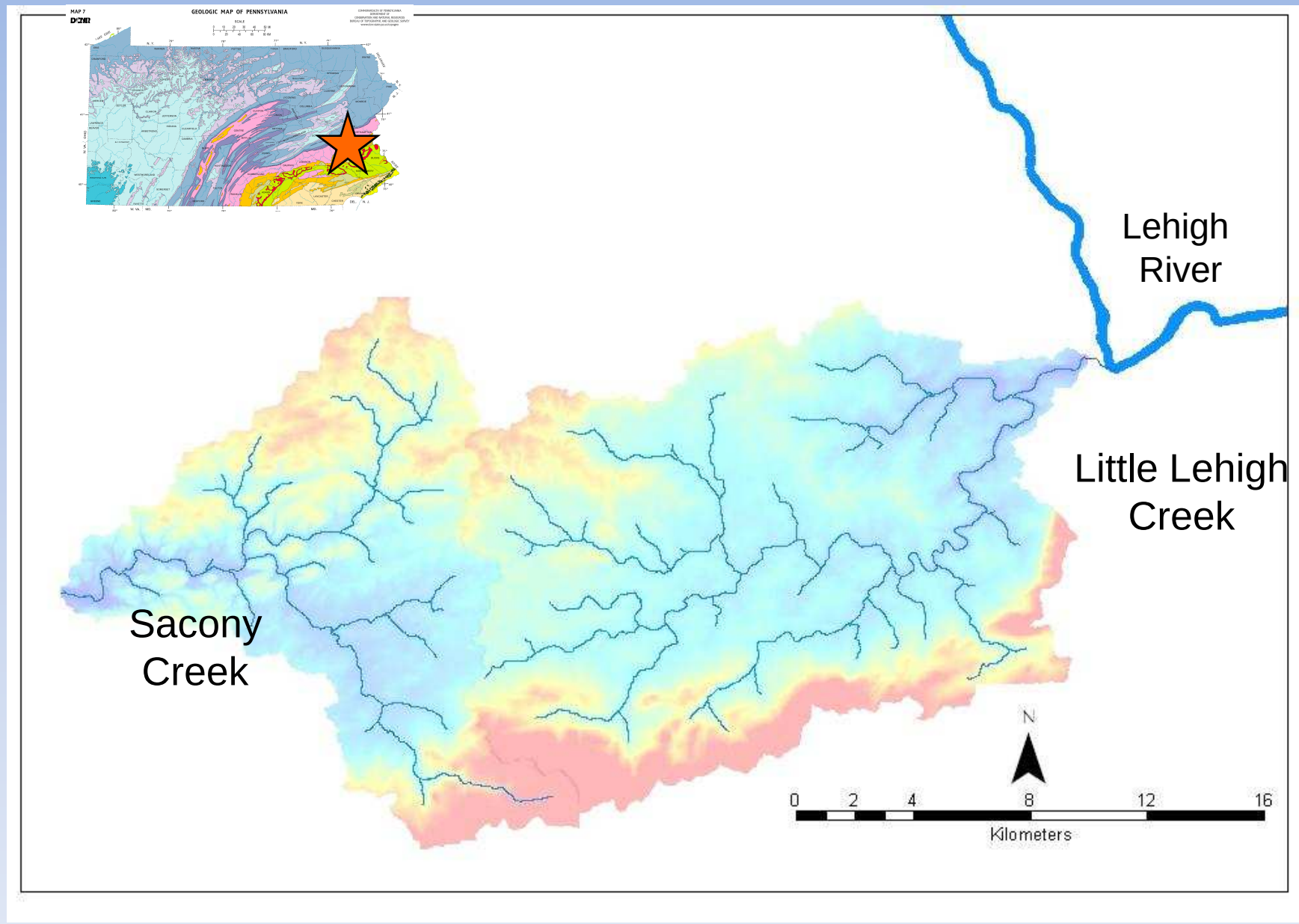
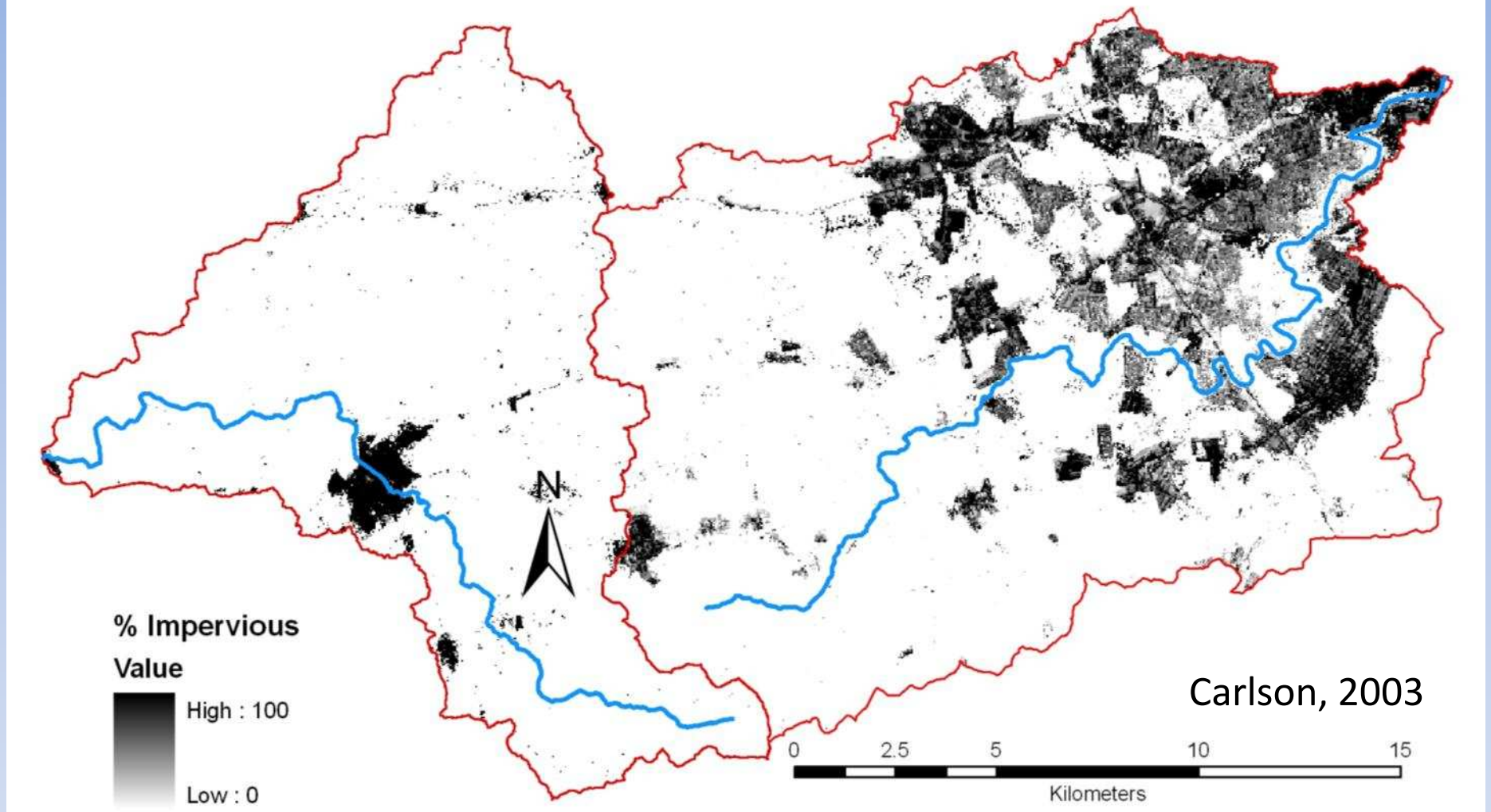
Objective

- To quantify the time lag between urbanization and stream response
- Background studies: two comparable watersheds
  - Bedrock lithology
  - Relief
  - Climatic variables
  - Size

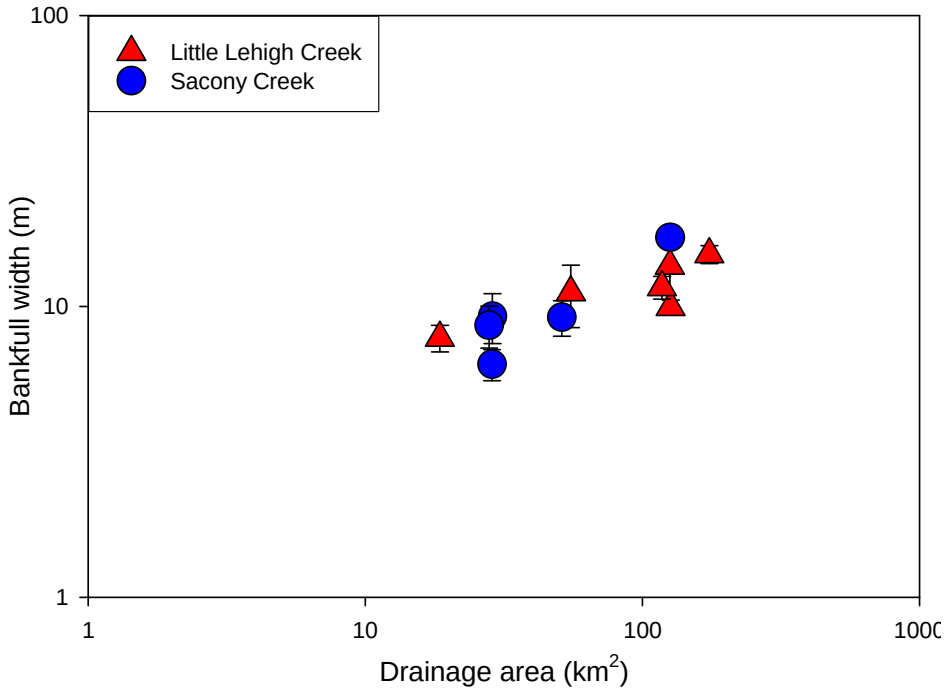

GEOLOGIC MAP OF PENNSYLVANIA
Lehigh River
Little Lehigh Creek
Sacony Creek
N
0 2 4 8 12 16
Kilometers

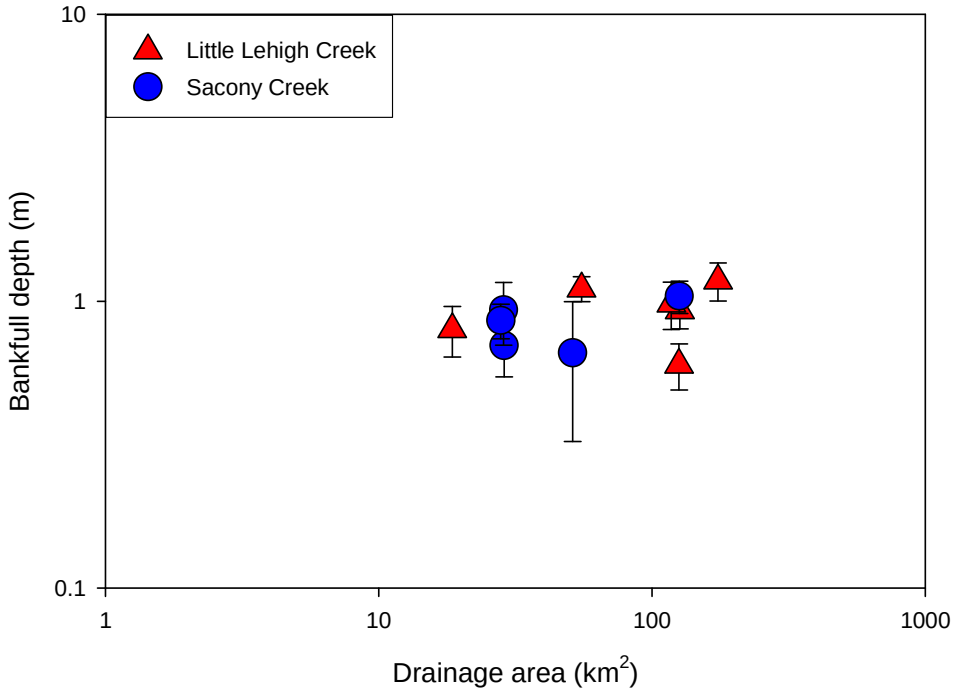


Percent Impervious, 2001:

Different land use creates different discharges

If urbanized stream has higher peak discharges, then modern channel morphology should reflect that.

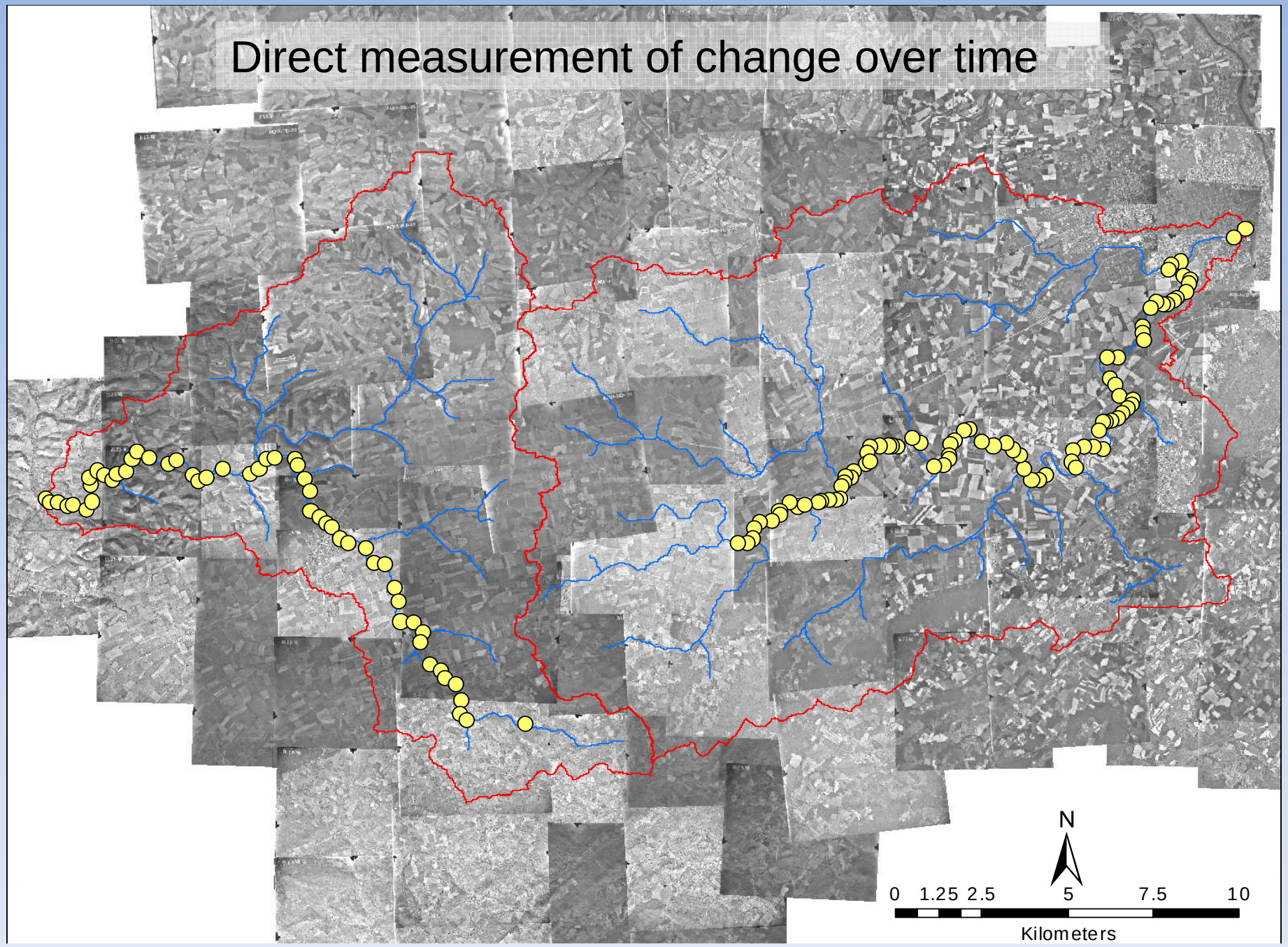


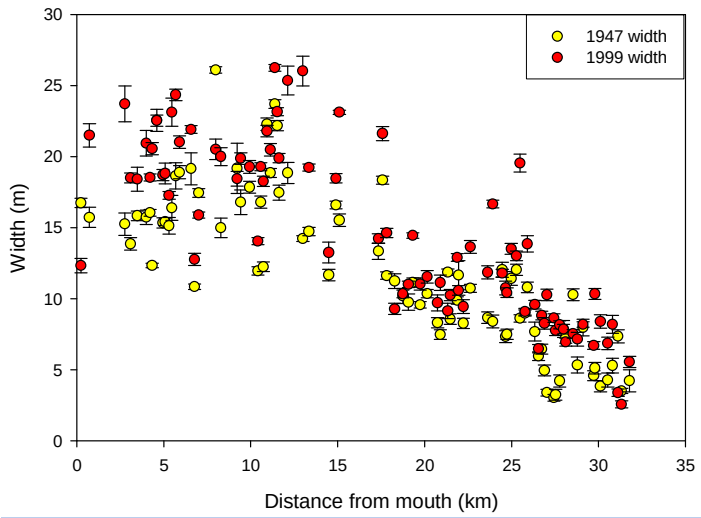


But, too much inherent variability within a reach to separate the channels.

So…

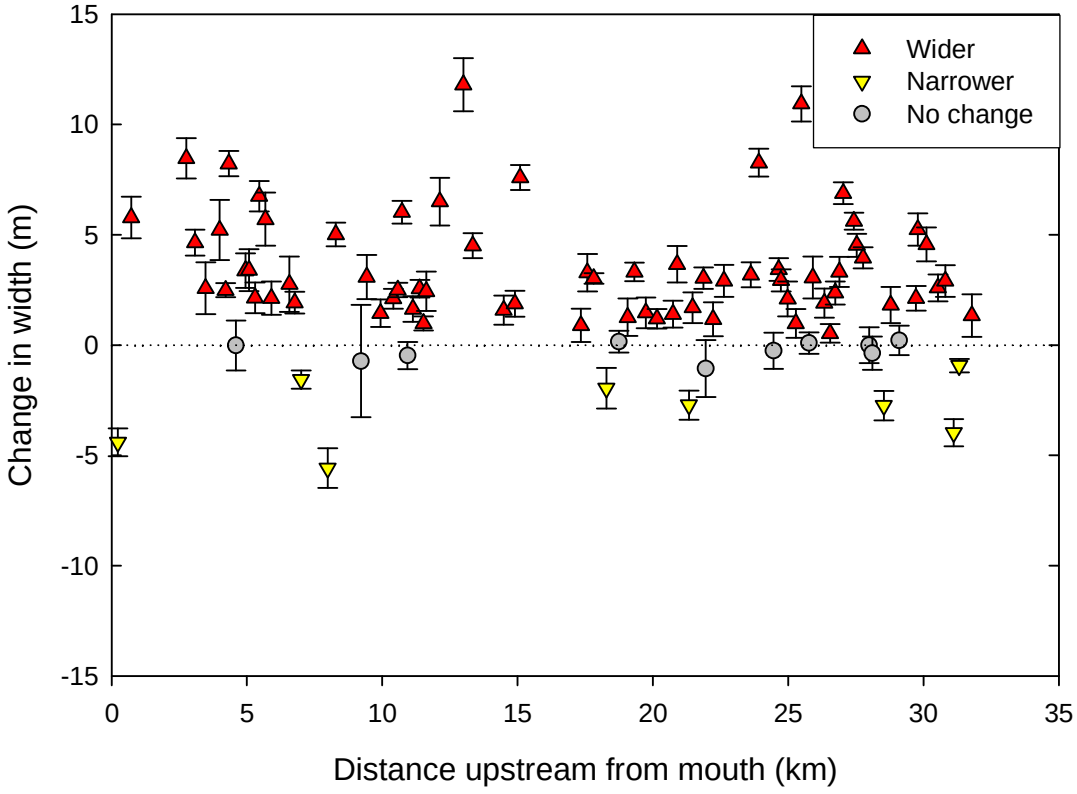
Direct measurement of change over time

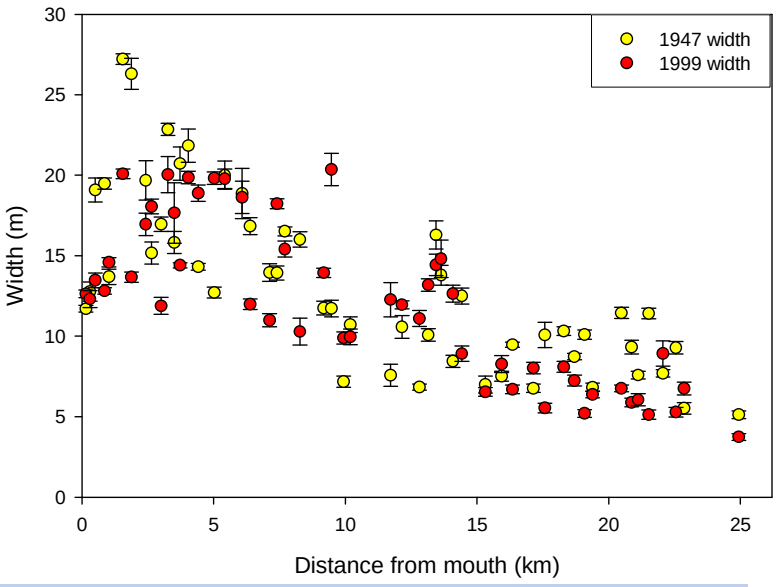




Little Lehigh Creek

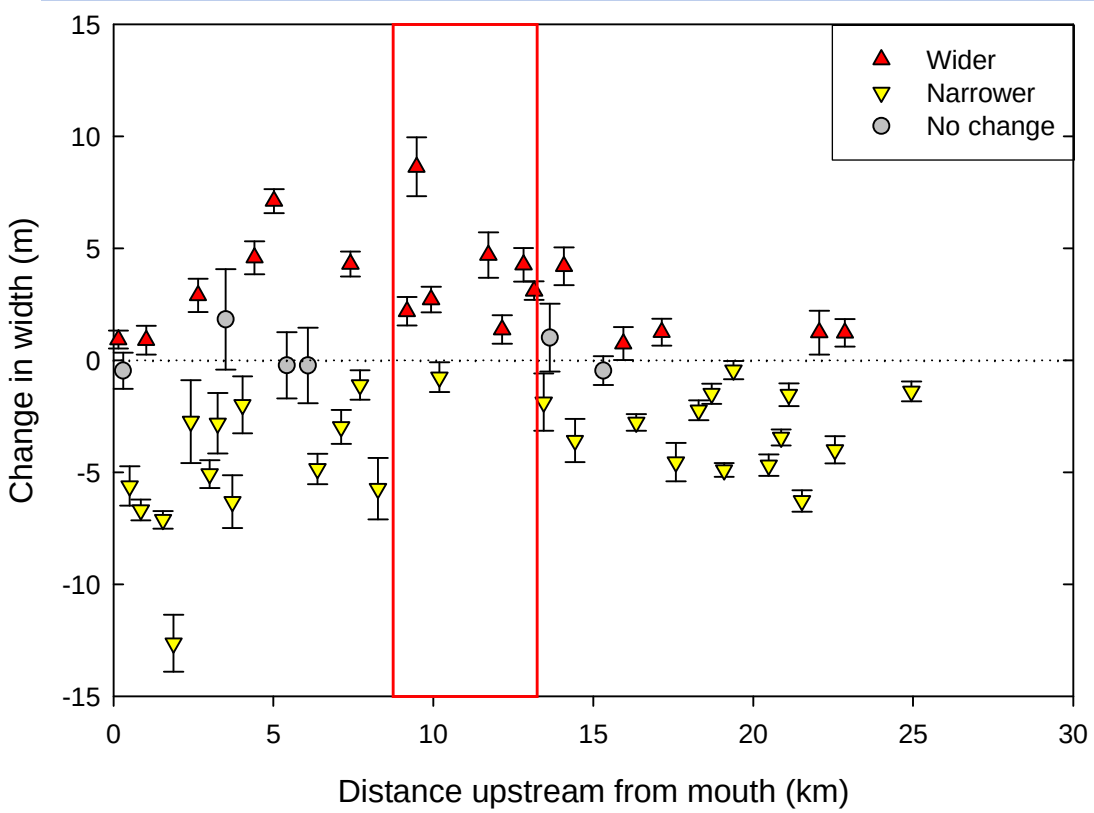
- Most widths are wider from 1947 to 1999 in Little Lehigh Creek
- % widening increases upstream



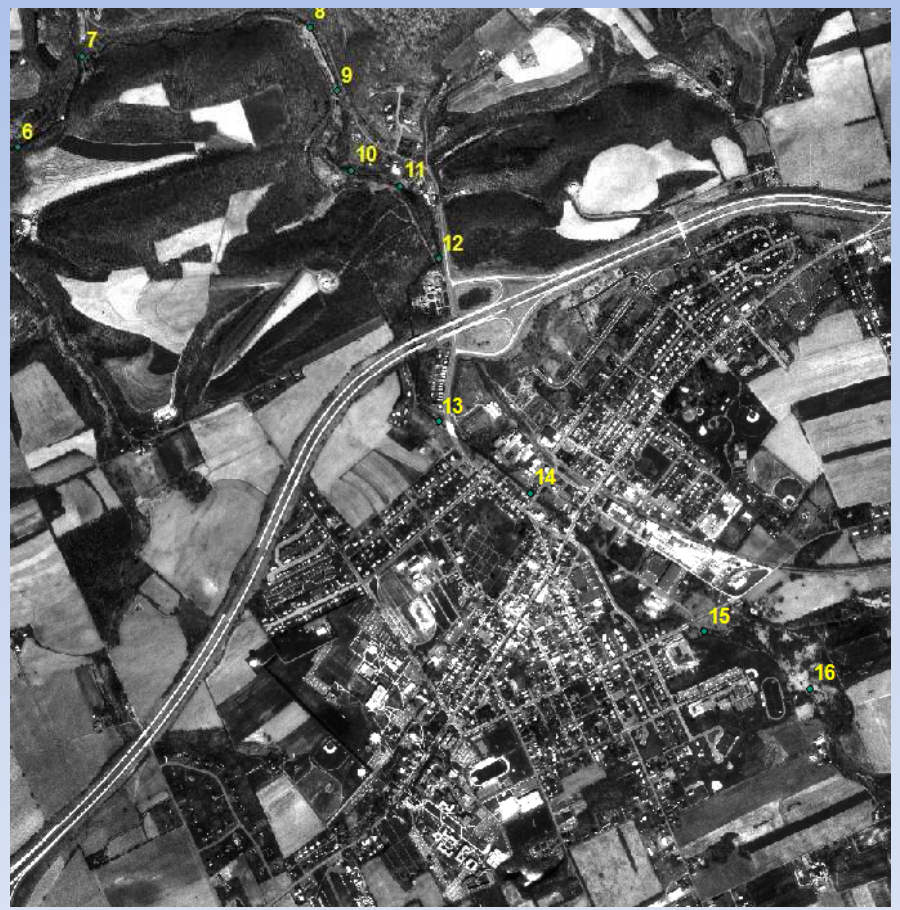


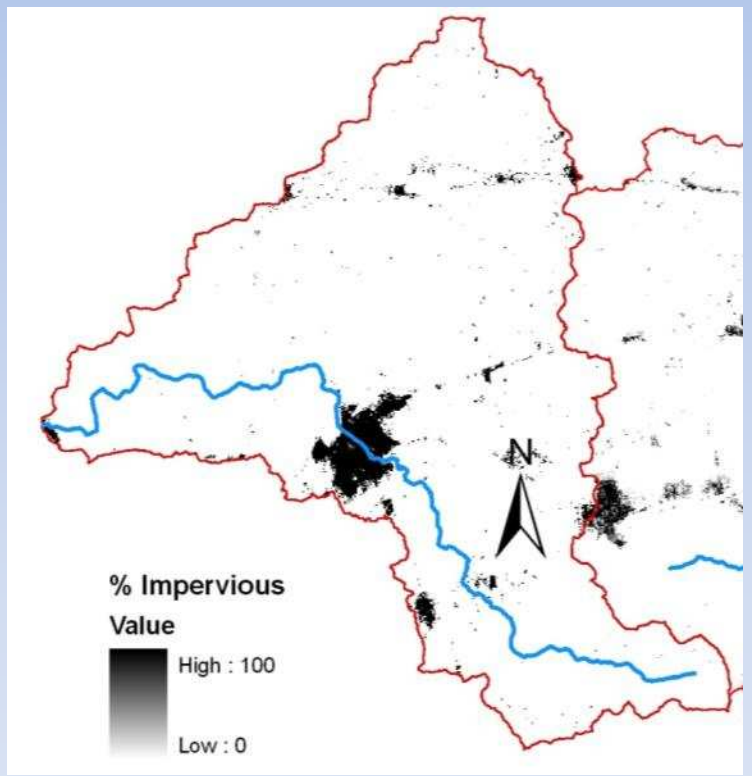
Sacony Creek

- 1946 to 1999 widths are evenly spread among wider, narrower, and no change.



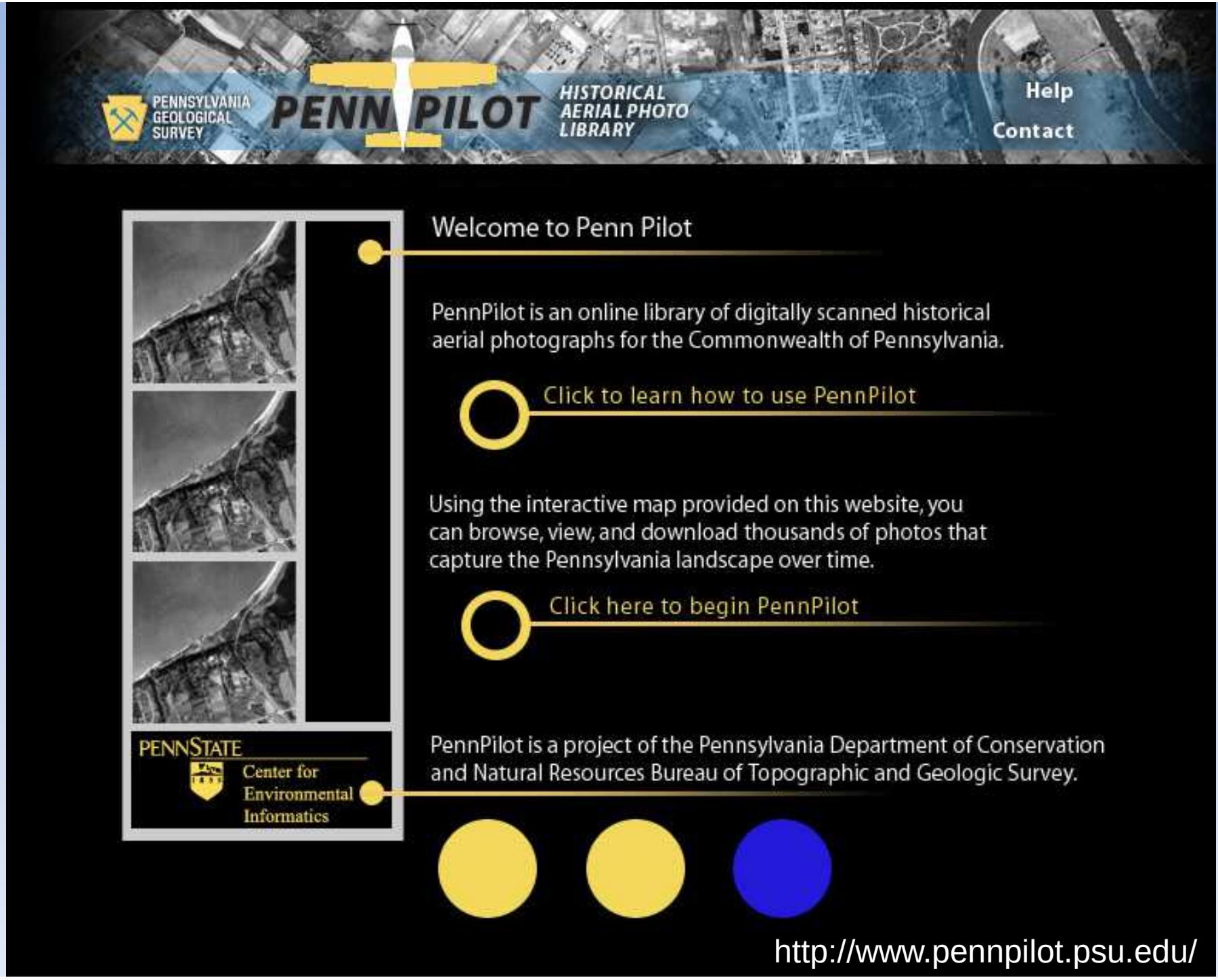
Only section to consistently widen is downstream of the only urbanized area





Objectives

- Improve on 1946 to 1999 measurements.
- What is the response time between urban growth and stream response?
- Is there a threshold for land use change or is the response linear?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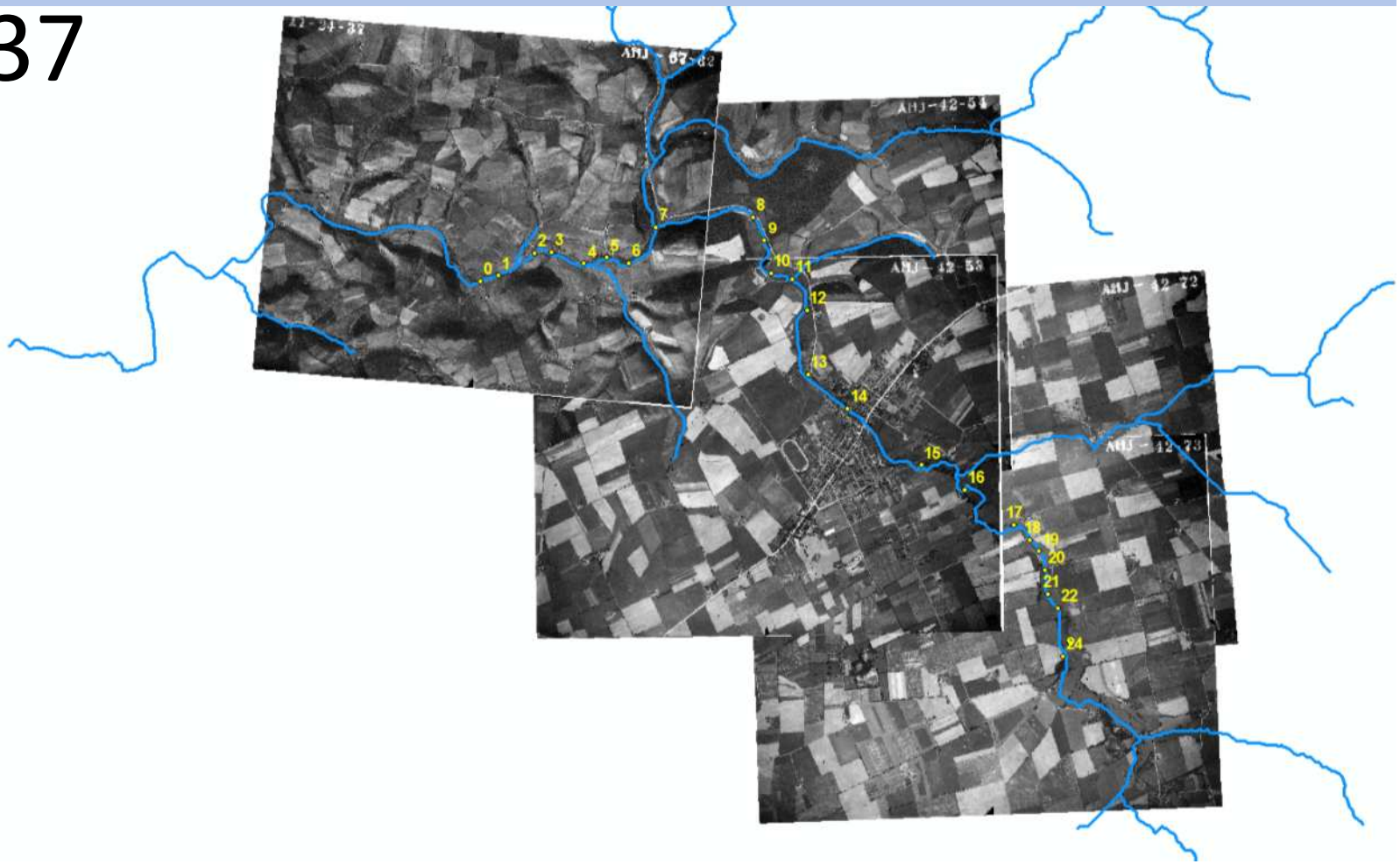
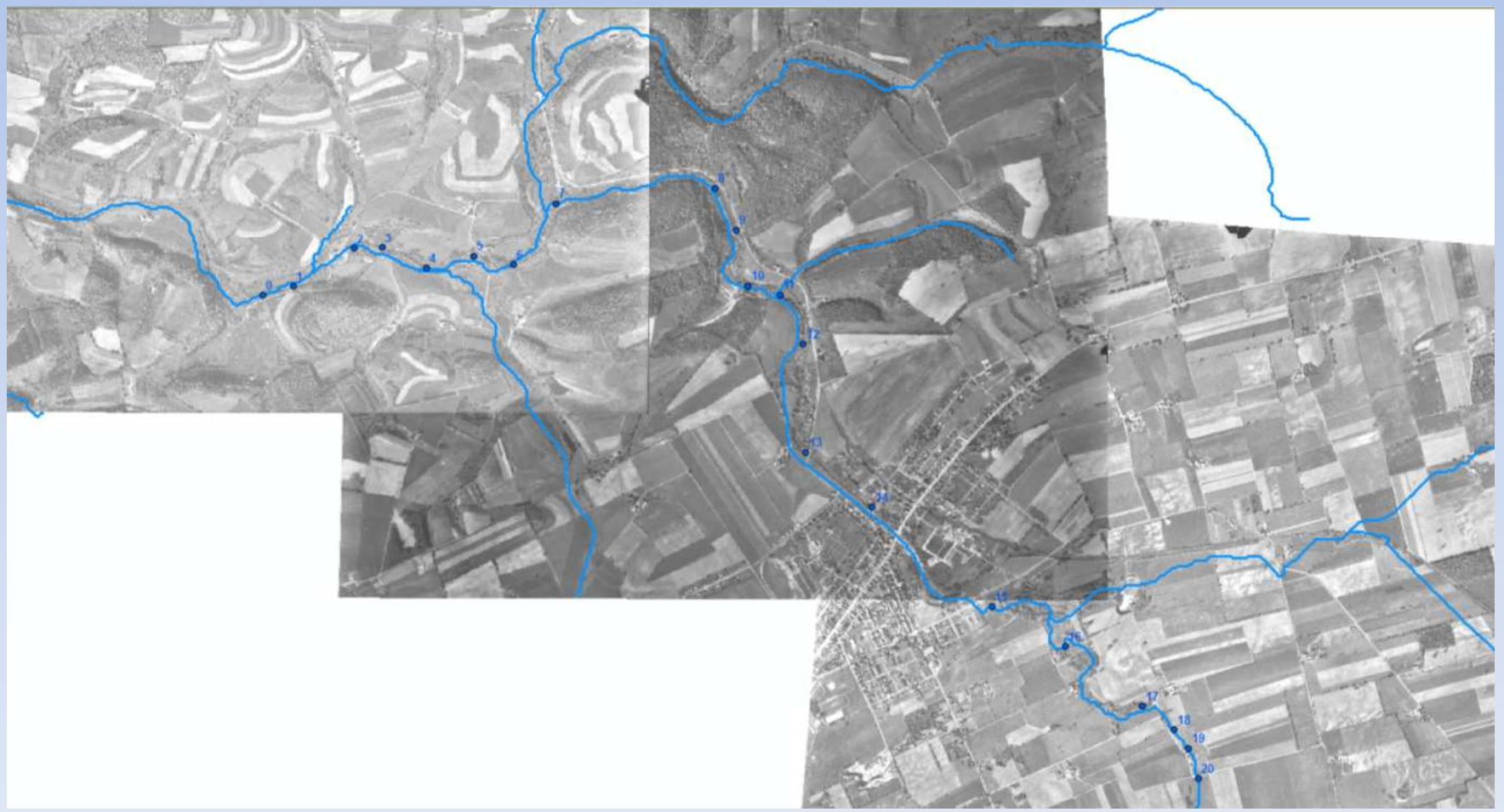
Georeferencing the photographs

- Use road layers
- RMS error of < 0.0001
- 1937

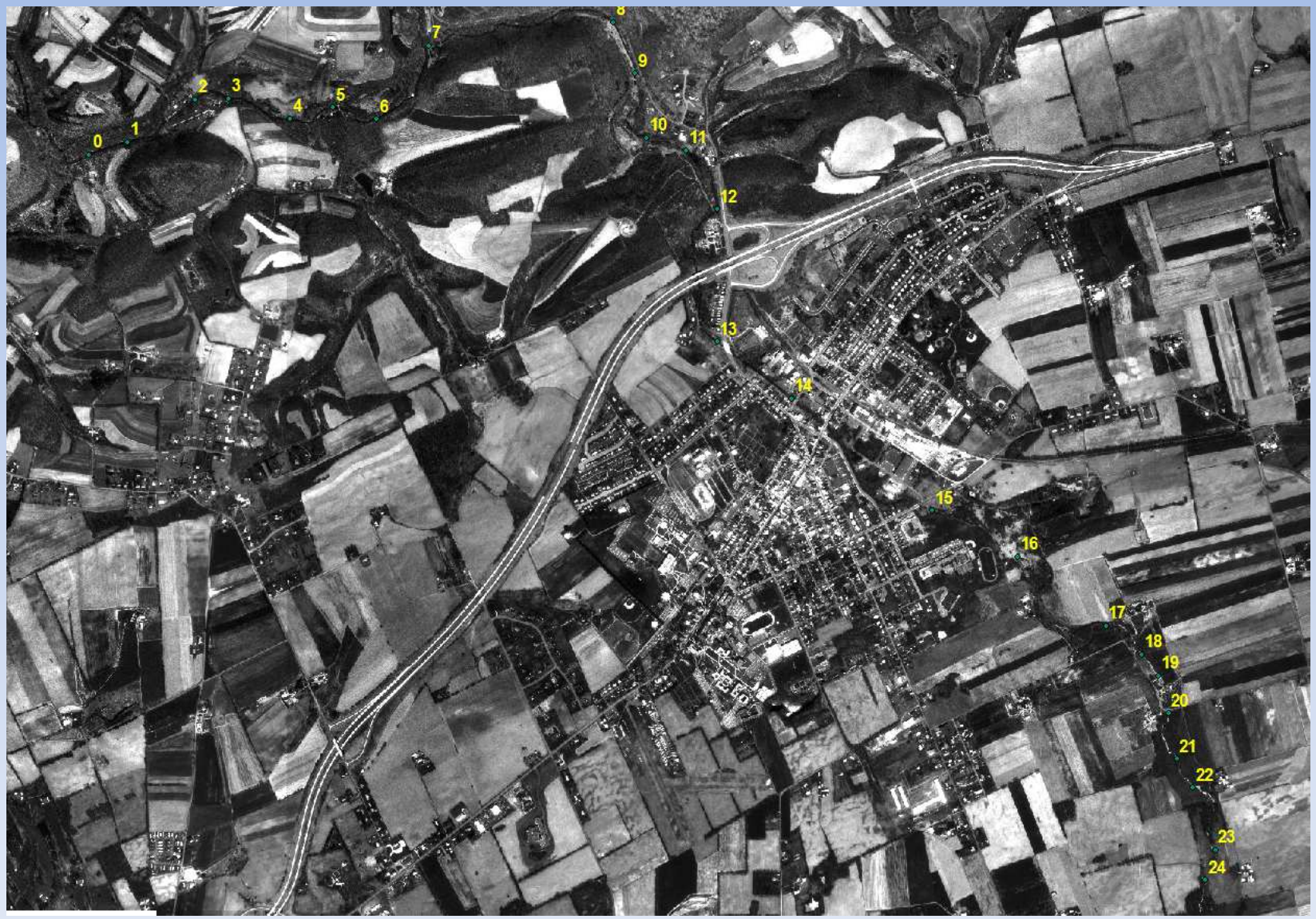


Repeat the process for following decades: 1958



1971

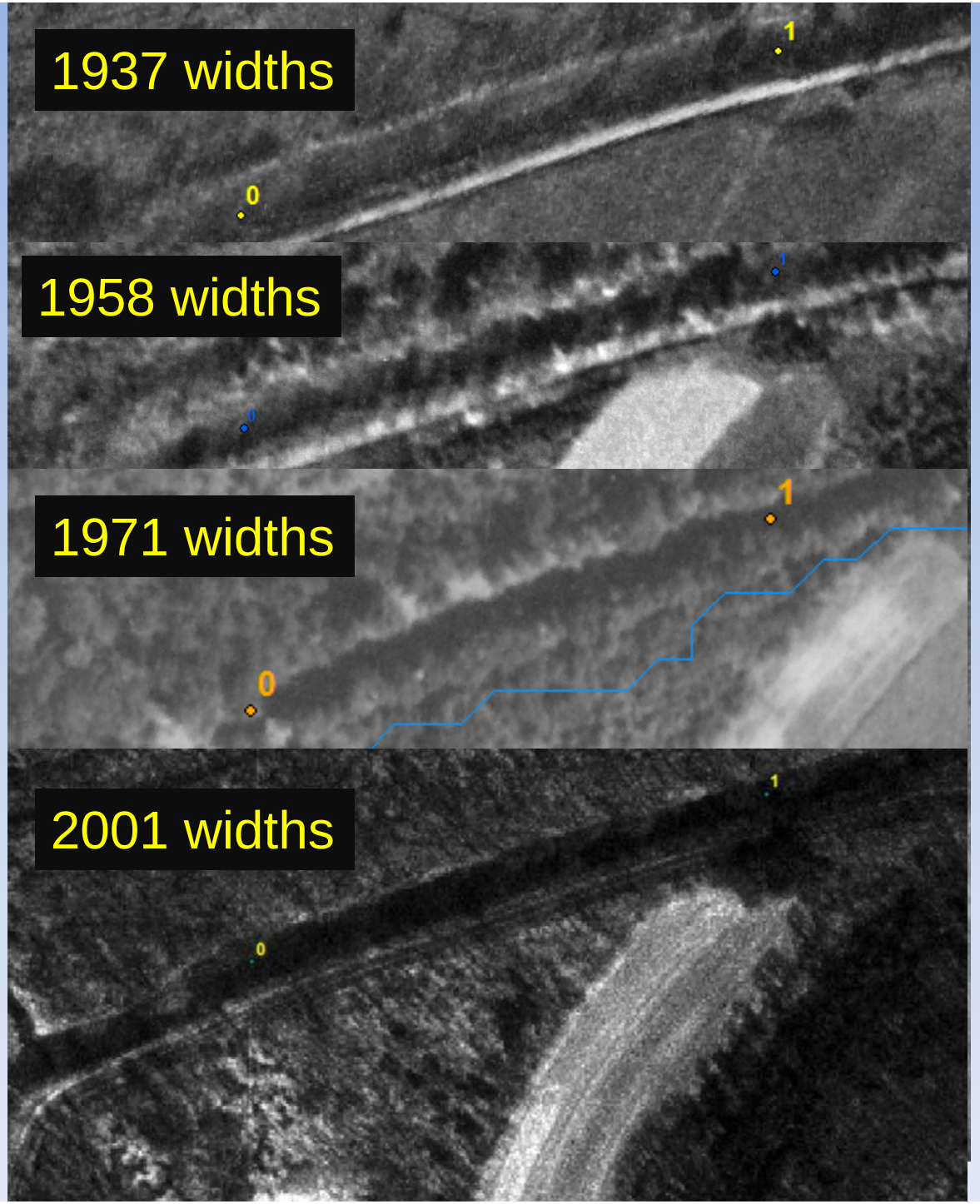
2001 already georeferenced



Methodology

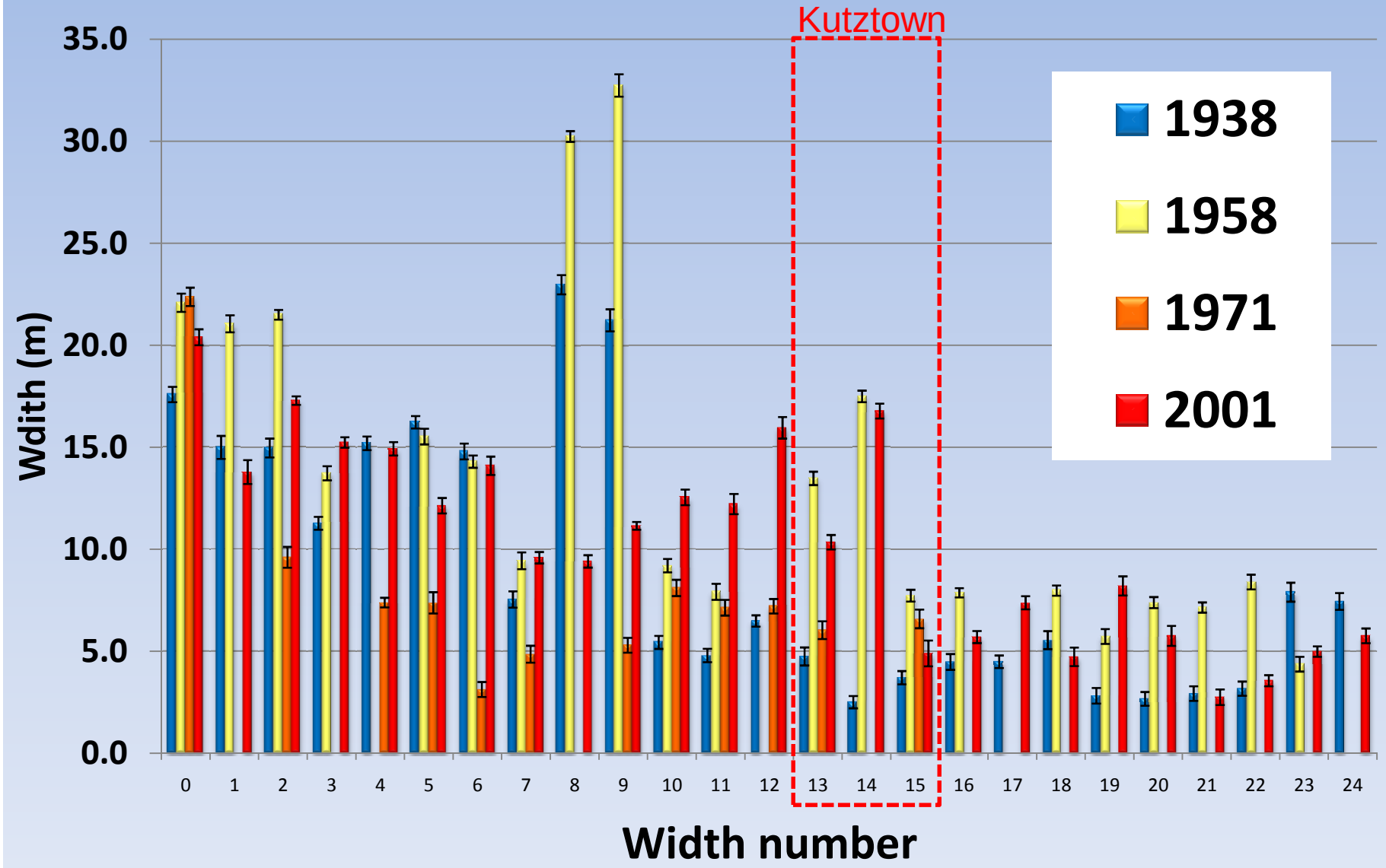
- Georeferenced aerial photographs
  - 1937, 1958, 1971, 2001
- Establish points for discrete width measurements
  - Contrast with averaged width measurements (channel area divided by channel length)
    - Digital Shoreline Analysis system (DSAS)
  - Interpolate channel widths between unseen points
  - Changes in downstream drainage area
- Must establish same location every year

- OK
- OK
- BAD
- OK
- Result: Not every year represented

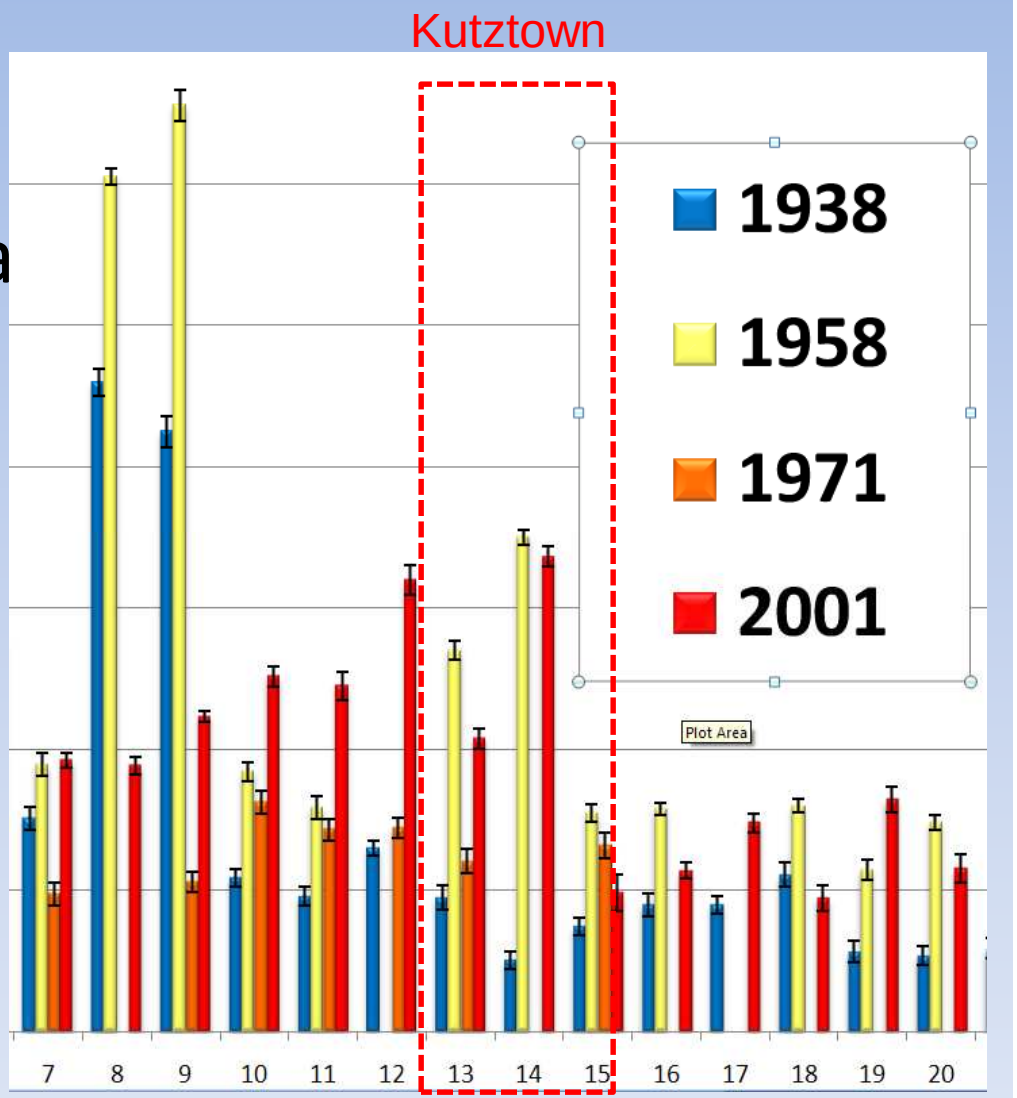


Each width measured 10x per year
16 total cross-sections established

Width results

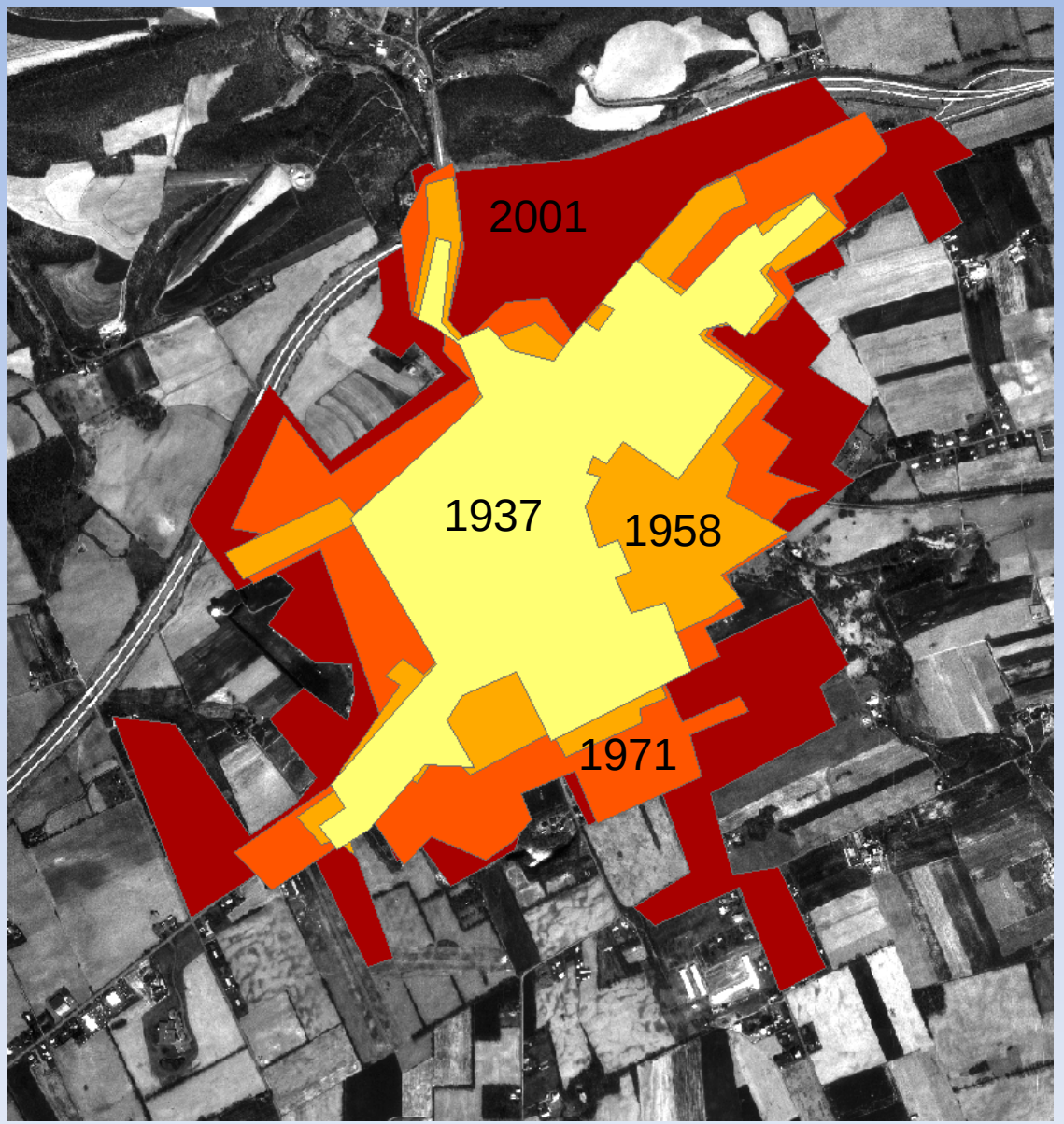


- Consistent widening downstream (2.5 km) of growing urban area
- Cross-sections 8 & 9: relic dam

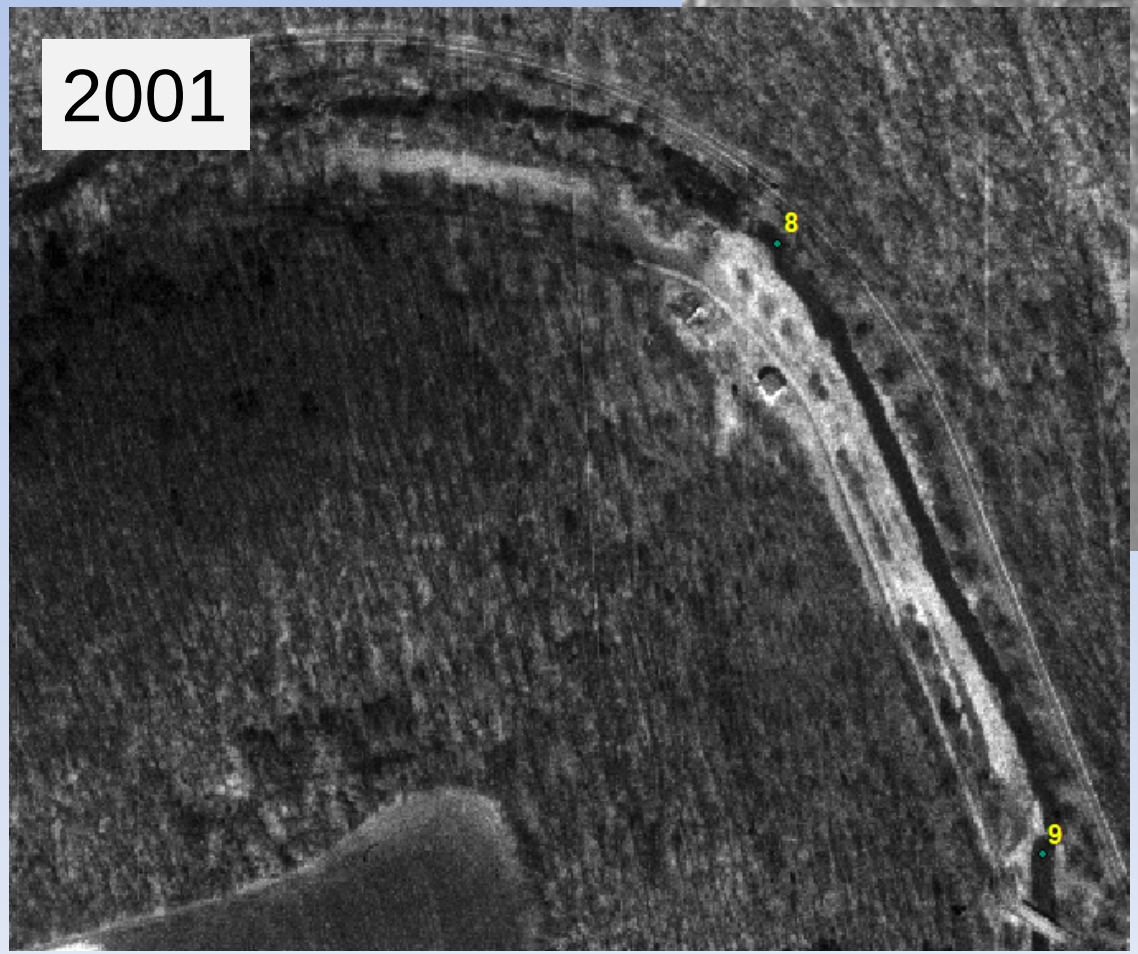


Expanding urbanized area

- 1937: 1.4 km^2
- 1958 : 2.0 km^2
- 1971 : 3.0 km^2
- 2001 : 4.8 km^2

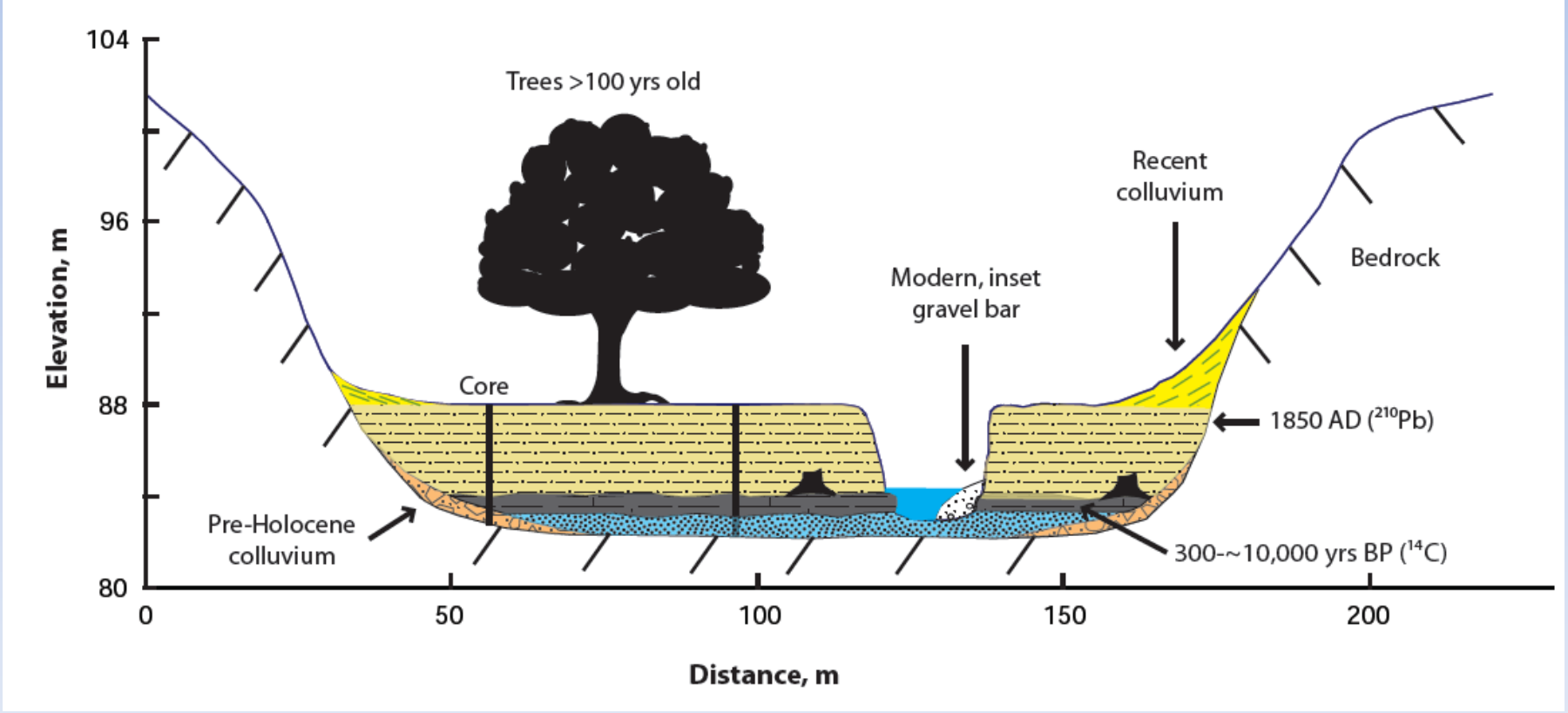


Relic dam

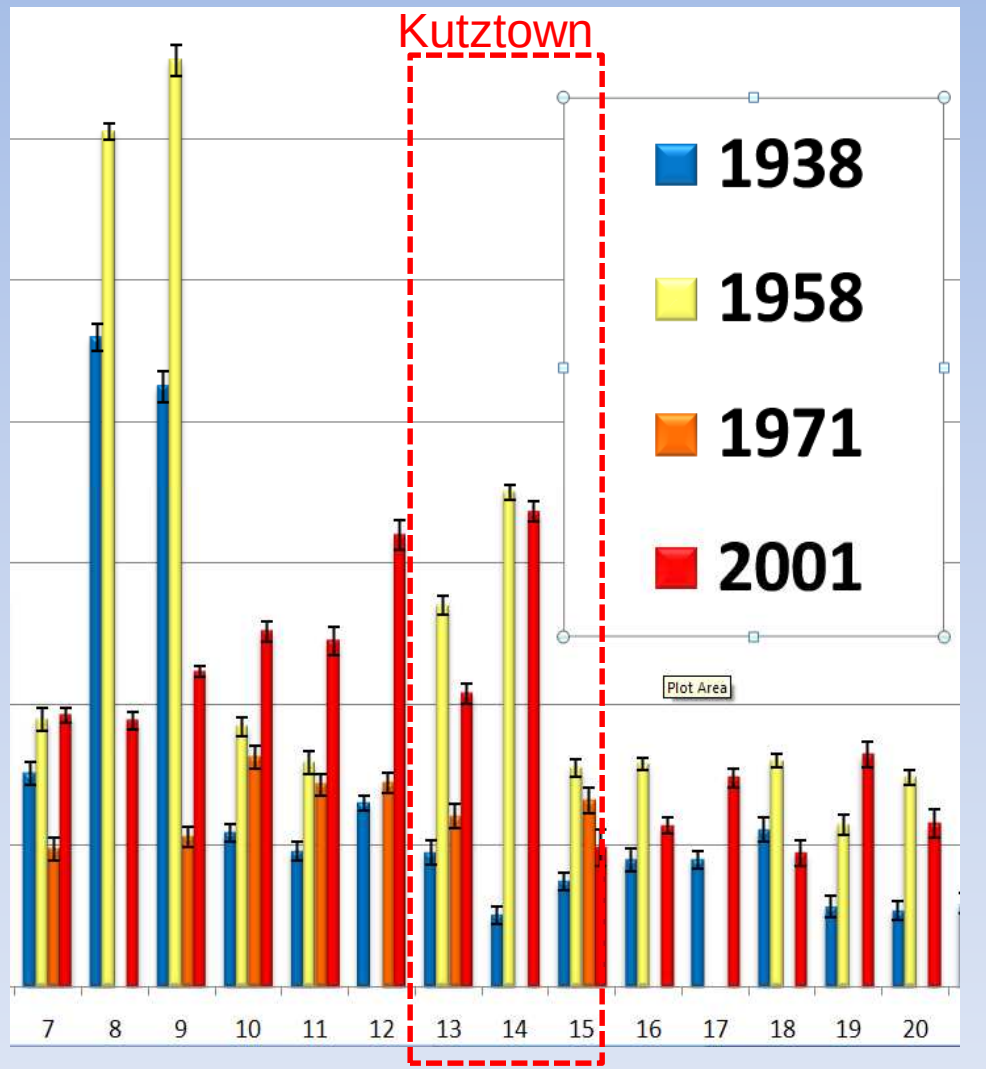


Influence of old dams: source of sediment; unstable & widening channels

- Walter and Merritts, 2008, Science, Vol. 319. no. 5861, pp. 299 – 304

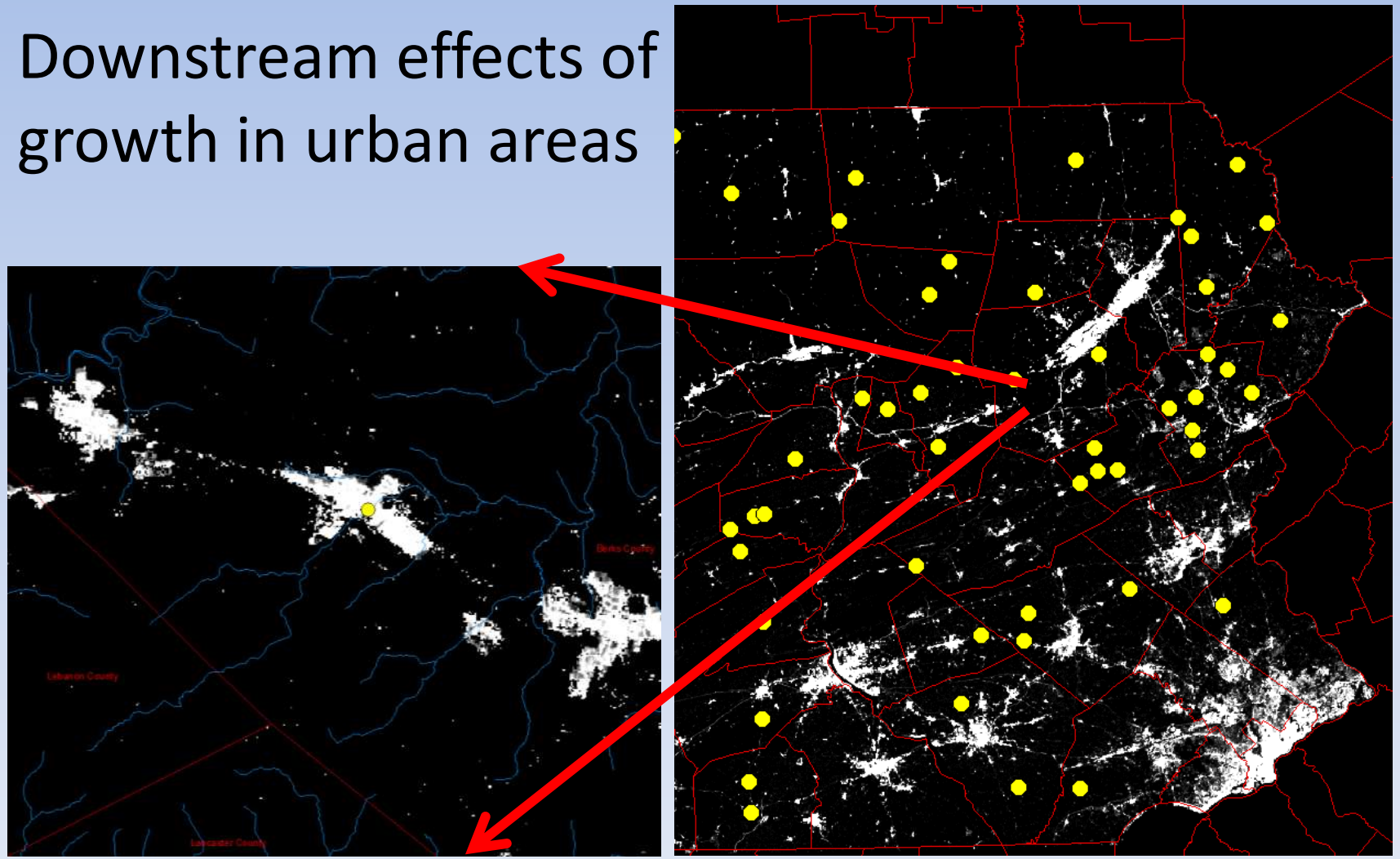


- Consistent widening downstream (2.5 km) of growing urban area
- Short response time
- Linear response?
- Response of streams is a combination of relic dams/sediment storage and modern land use



Future work

- Downstream effects of growth in urban areas



Future work

- Process to classify land use from B&W historic aerial photographs
  - Currently time-consuming
  - Coarse resolution