A Tool for Estimating Flood Frequency of New Hampshire Streams

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Why Flood-Frequency Data

- Mitigation of flood hazards and flood insurance mapping
- Design of bridges, culverts, and other infrastructure in the riverine environment
- Operation of flood control structures
- Stream stability and restoration
- Last NH study done in mid-1970s

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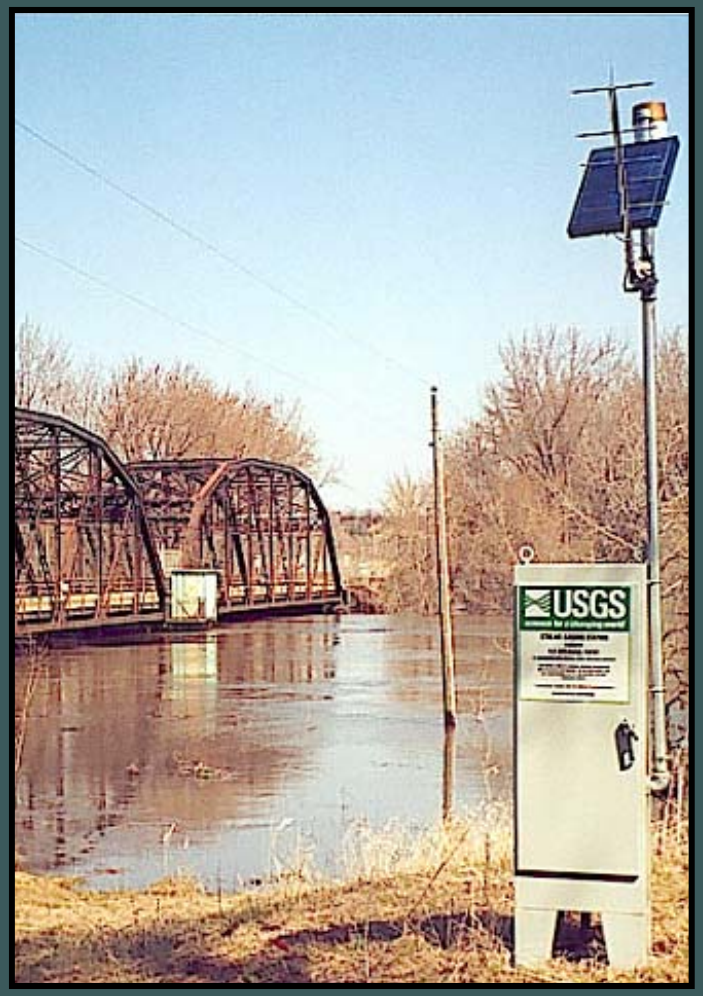
Flood-Frequency Determination

- Flow-frequency determinations require historical streamflow data from streamgages
- It is not practical to gage all streams
- Estimates of flow-frequency are often needed for ungaged streams



Flood Flow Frequency Determination on Ungaged Streams

- Relate flow-frequency data at streamgages to the characteristics of the gage's drainage basin using regression analysis
- Common basin characteristics include:
  - Drainage area
  - Storage in lakes or wetlands
  - Basin slope
  - Elevation
  - Precipitation
  - Channel length or slope
  - Land use
  - Basin shape or orientation
  - Soils or surficial geology

- The result is a set regression equations to estimate flood flow frequency using basin characteristics of an ungaged location

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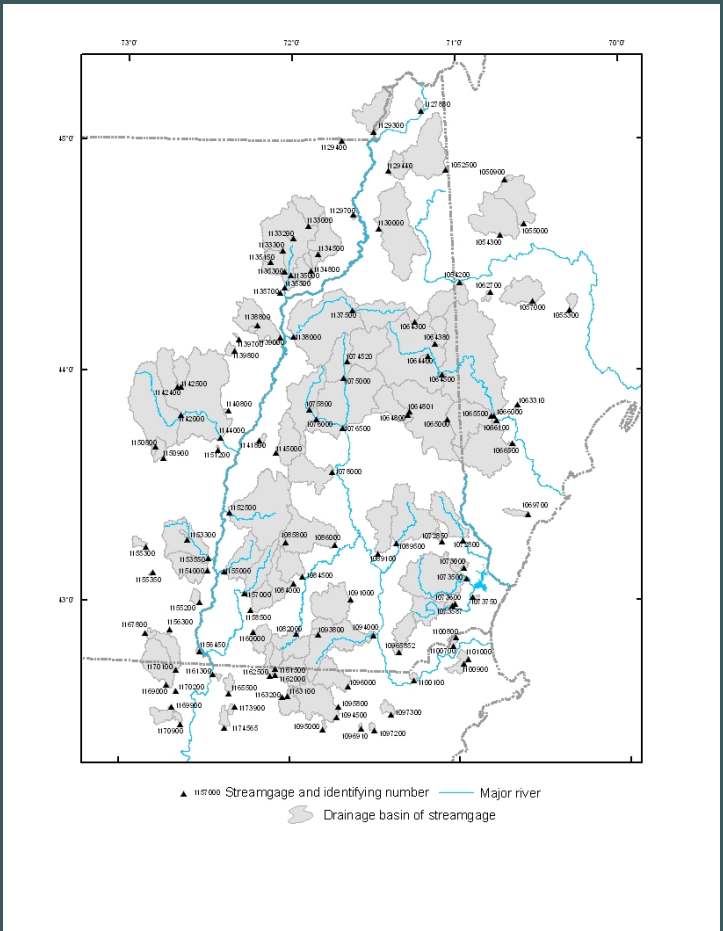
Streamgage data used to develop the equations

- Annual Peakflow data from 117 streamgages were used
  - Gages adjacent to New Hampshire were included
  - Drainage areas: 0.7 to 1,290 mi^2
  - Rural drainage basins
  - Unregulated peakflows (up to 103 ac-ft/mi^2 usable storage allowed)
  - Minimum of 10 years of data

- The magnitude of the 2-, 5-, 10- 25-, 50-, 100-, and 500-year was computed for each streamgage using the Log-Pearson type 3 distribution



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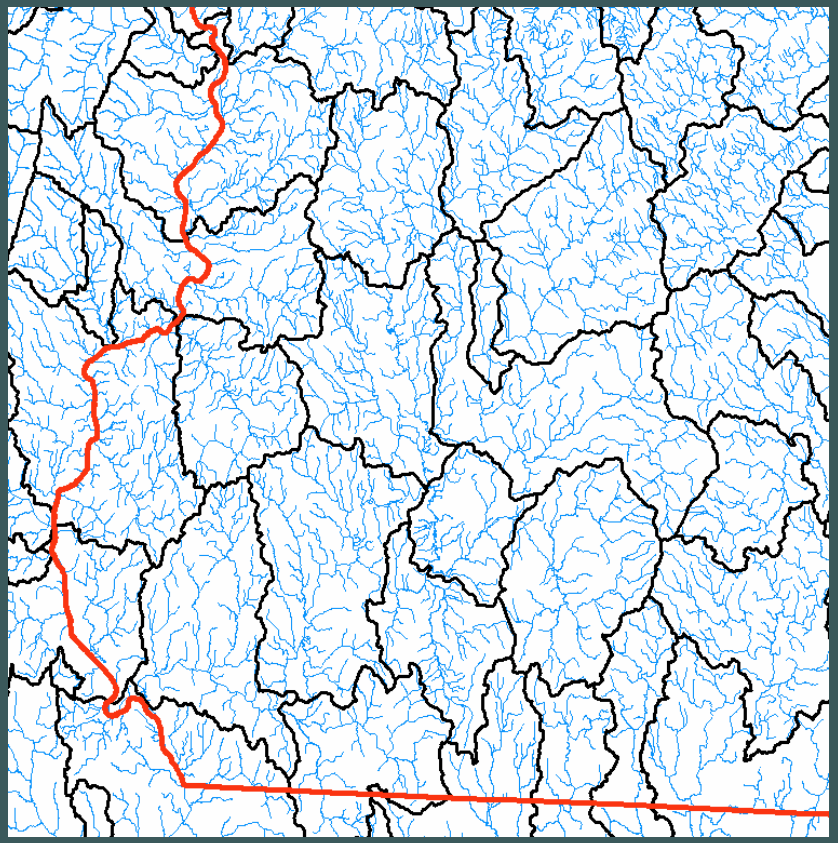
Basin Characteristics

- Drainage area computations based on USGS 30-meter DEM
- DEM hydrologically corrected using National Hydrography Dataset and Watershed Boundary Dataset

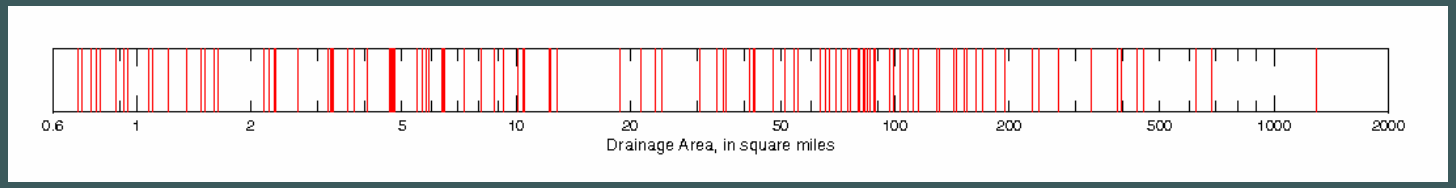


Basin Characteristics

- All basin characteristics were determined using ESRI's ArcHydro
- 110 basin characteristics for the 117 streamgages
- Basin characteristics included:

  - Drainage area
  - Mean elevation
  - Mean basin slope
  - Percent of basin with a slope > 30%
  - Annual and monthly precipitation
  - Annual and monthly temperature
  - Percent wetland cover
  - Percent forest cover
  - Percent agricultural land
  - Percent impervious
  - Percent tree canopy
  - Mean permeability
  - Percent hydric soils
  - Mean annual runoff
  - Mean annual snowfall
  - Percent of basin above X feet
  - Population density
  - Housing unit density
  - Longest flow path
  - Main channel slope
  - Rainfall intensity—$I_{2,24}$
  - Sinuosity of main channel
  - Basin perimeter
  - Basin Length
  - Elongation ratio and other shape factors
  - Stream density

Basin Characteristics



Basin characteristics narrowed down

- Correlation data and stepwise linear regression was used to determine the variable that best explained peak flow frequency
- Generalized Least Squares used to determine the final basin basin characteristics and determine the regression equations
- Drainage area, basinwide mean of average April precipitation, percentage of the basin covered by wetlands, and main channel slope had generated the least amount of error

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Regression Equations

$$Q_2=2.60A^{0.958}P^{1.50}10^{-0.0245(W)}S^{0.205}$$
$$Q_5=3.23A^{0.929}P^{1.73}10^{-0.0245(W)}S^{0.211}$$
$$Q_{10}=3.88A^{0.912}P^{1.83}10^{-0.0247(W)}S^{0.211}$$
$$Q_{25}=4.99A^{0.892}P^{1.90}10^{-0.0250(W)}S^{0.207}$$
$$Q_{50}=5.96A^{0.879}P^{1.94}10^{-0.0252(W)}S^{0.203}$$
$$Q_{100}=7.13A^{0.867}P^{1.98}10^{-0.0254(W)}S^{0.198}$$
$$Q_{500}=10.6A^{0.841}P^{2.03}10^{-0.0259(W)}S^{0.183}$$

A=Drainage Area, square miles
P=Basinwide mean of the average April precipitation, inches (PRISM)
W=Pecentage of the basin with wetland land cover (2001 NLCD)
S=Channel slope between points 10- and 85-percent up the main channel (channel extended to the drainage boundary), feet per mile

Regression Equations

Accuracy and Limitations

- Unregulated streams / natural flow conditions
- Non-urban watersheds
- Limits of basin characteristics used to develop equations
  - Drainage area, 0.7 - 1,290 square miles
  - Average April precipitation, 2.79 – 6.23 inches
  - Percent basin covered by wetlands, 0 – 21.8 %
  - Main channel slope, 5.43 – 543 ft/mile
  - Highly recommend using StreamStats to avoid bias

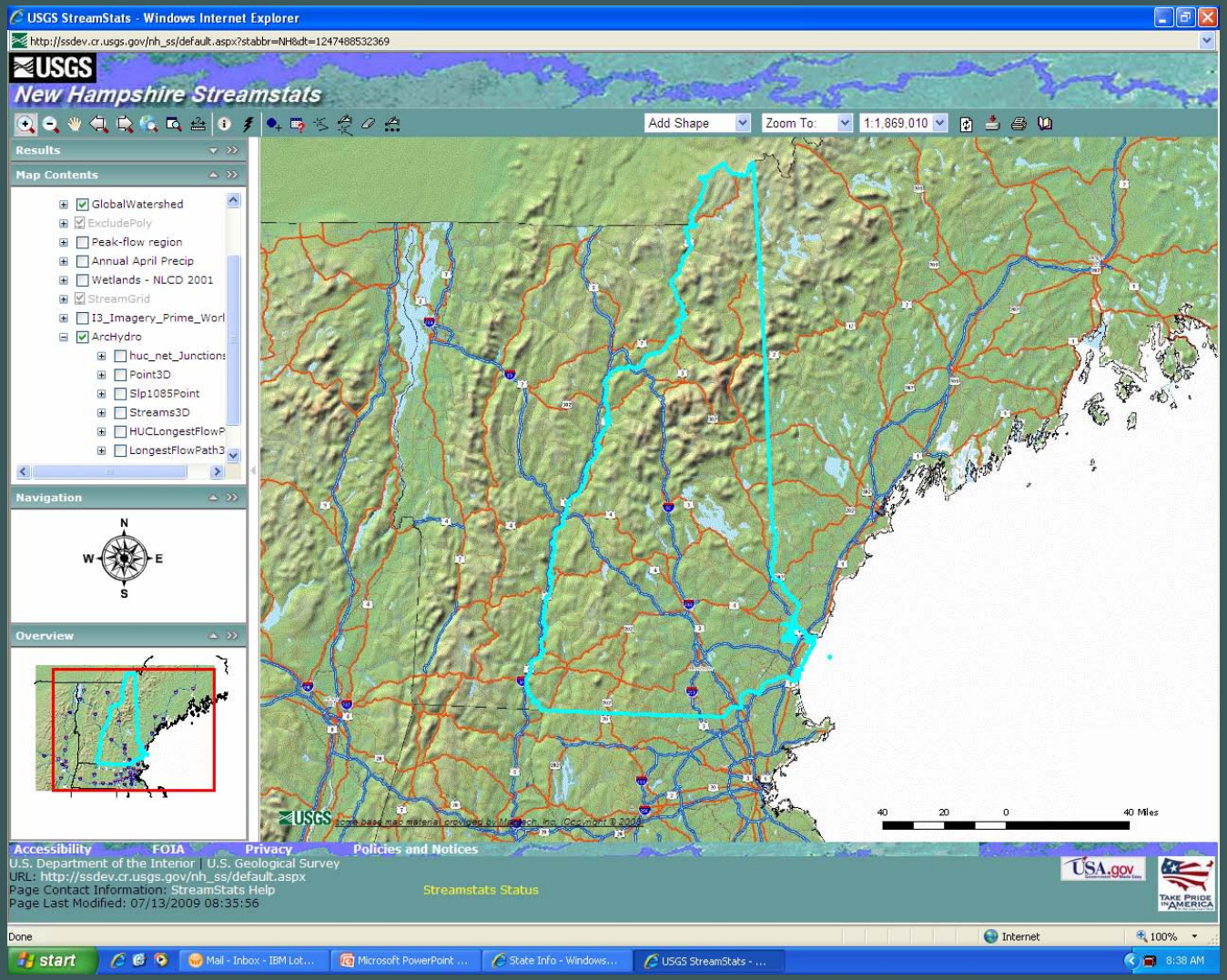
Regression Equations

Accuracy and Limitations
Average standard error of prediction

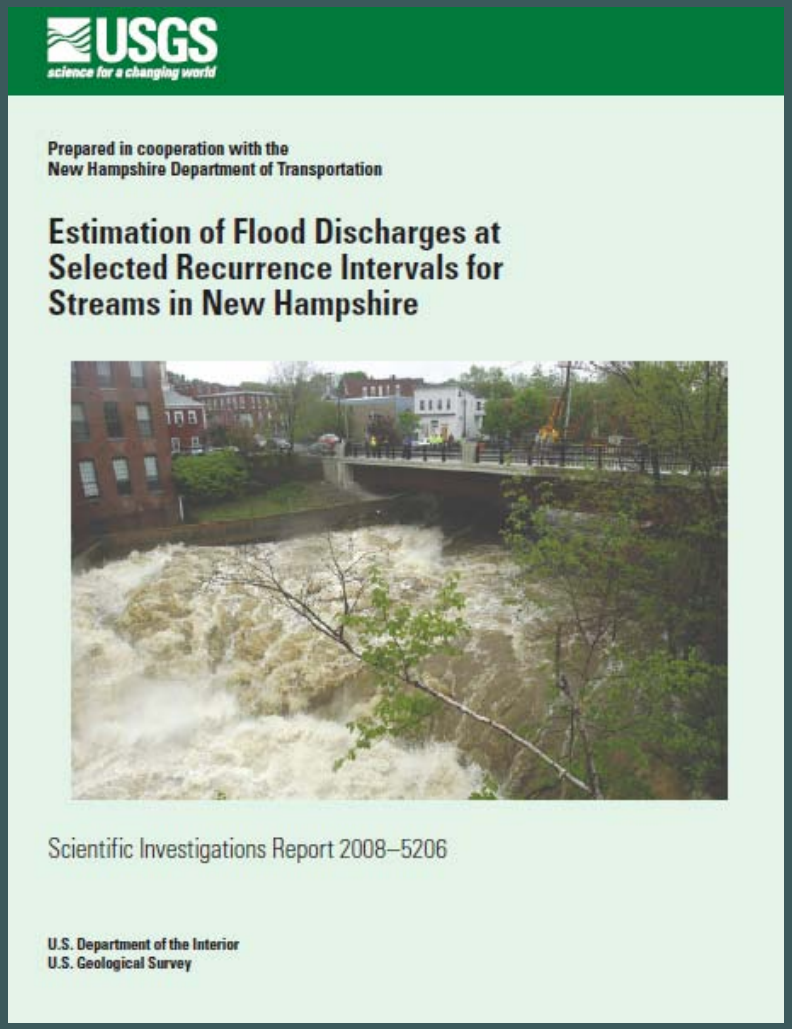
Recurrence interval	percent
2-year	-25.5 to 34.3
5-year	-26.2 to 35.5
10-year	-27.1 to 37.1
25-year	-28.4 to 39.6
50-year	-29.7 to 42.2
100-year	-31.1 to 45.2
500-year	-34.4 to 52.4

NH StreamStats

http://water.usgs.gov/osw/streamstats/new_hampshire.html



Report is online at:
http://pubs.usgs.gov/sir/2008/5206



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