SEDIMENT SOURCES and SEDIMENT LOADINGS

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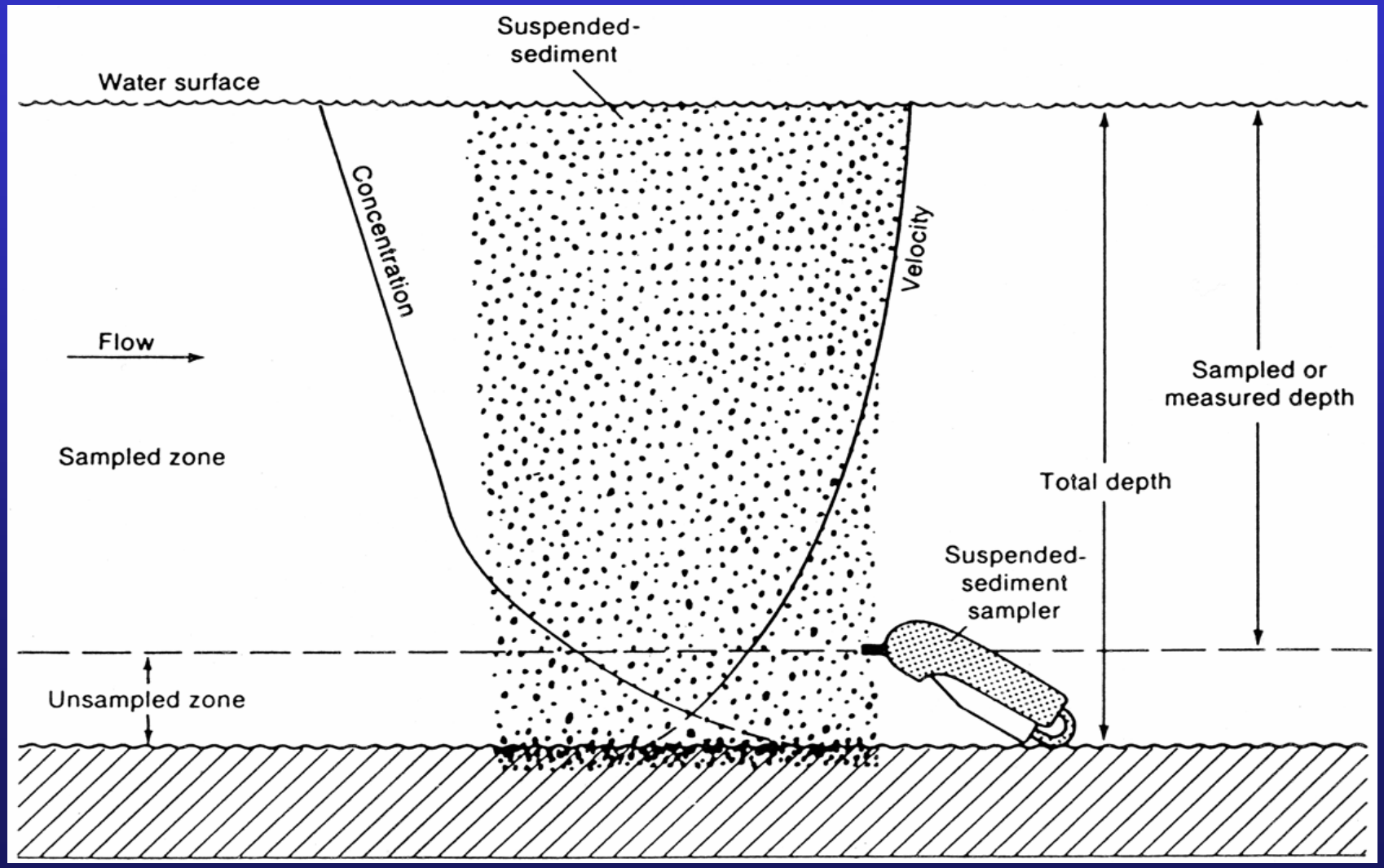
Outline of Talk

- Factors affecting sediment loadings
- Sediment yields
- Concept of sediment fingerprinting
- Examples from the Chesapeake Bay

suspended sediment versus bedload



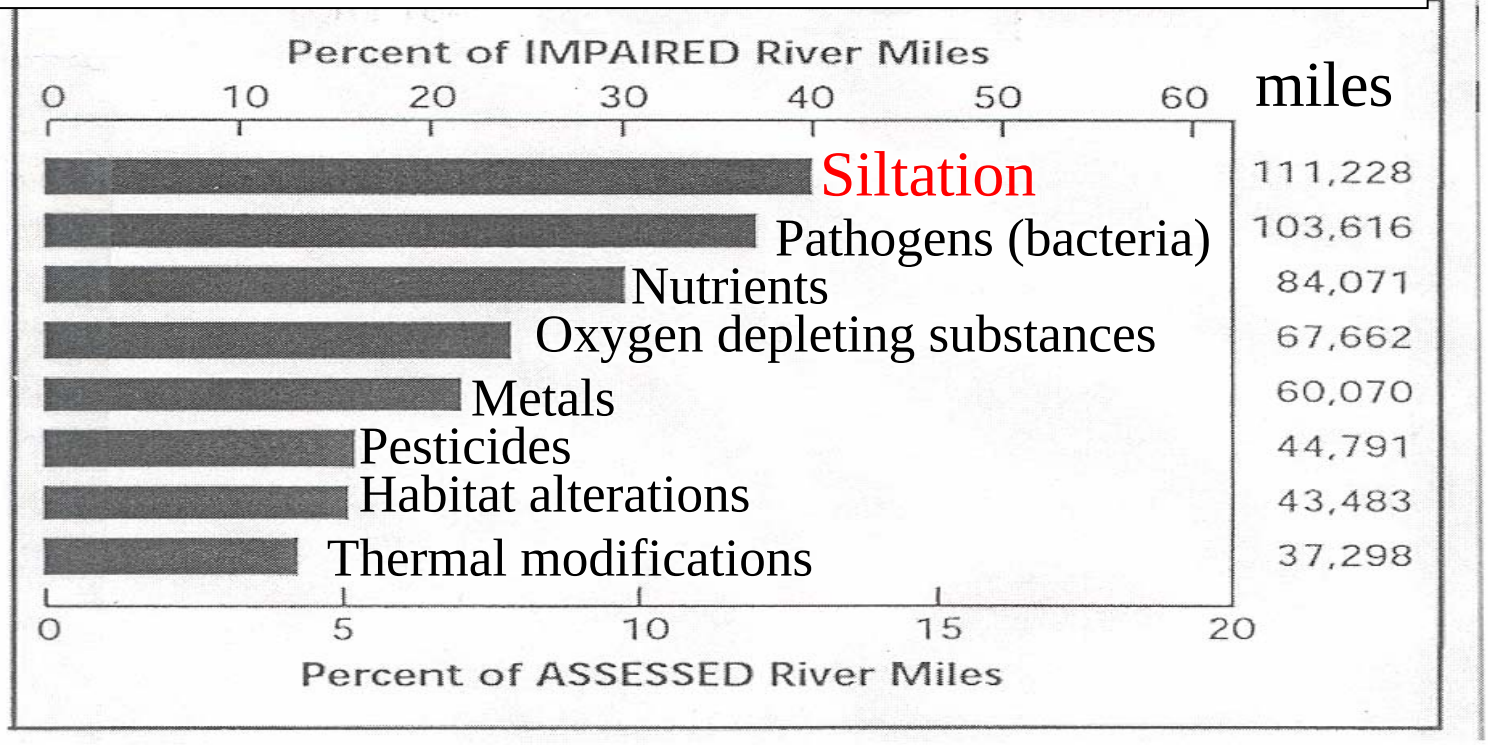
Impacts of Suspended Sediment

- Habitat – burial, light attenuation, channel morphology changes
- Water supply – taste, odor, blocking intakes, reservoir sedimentation
- Infrastructure – sedimentation, flooding
- Water quality – solid transport of contaminants bound to sediment

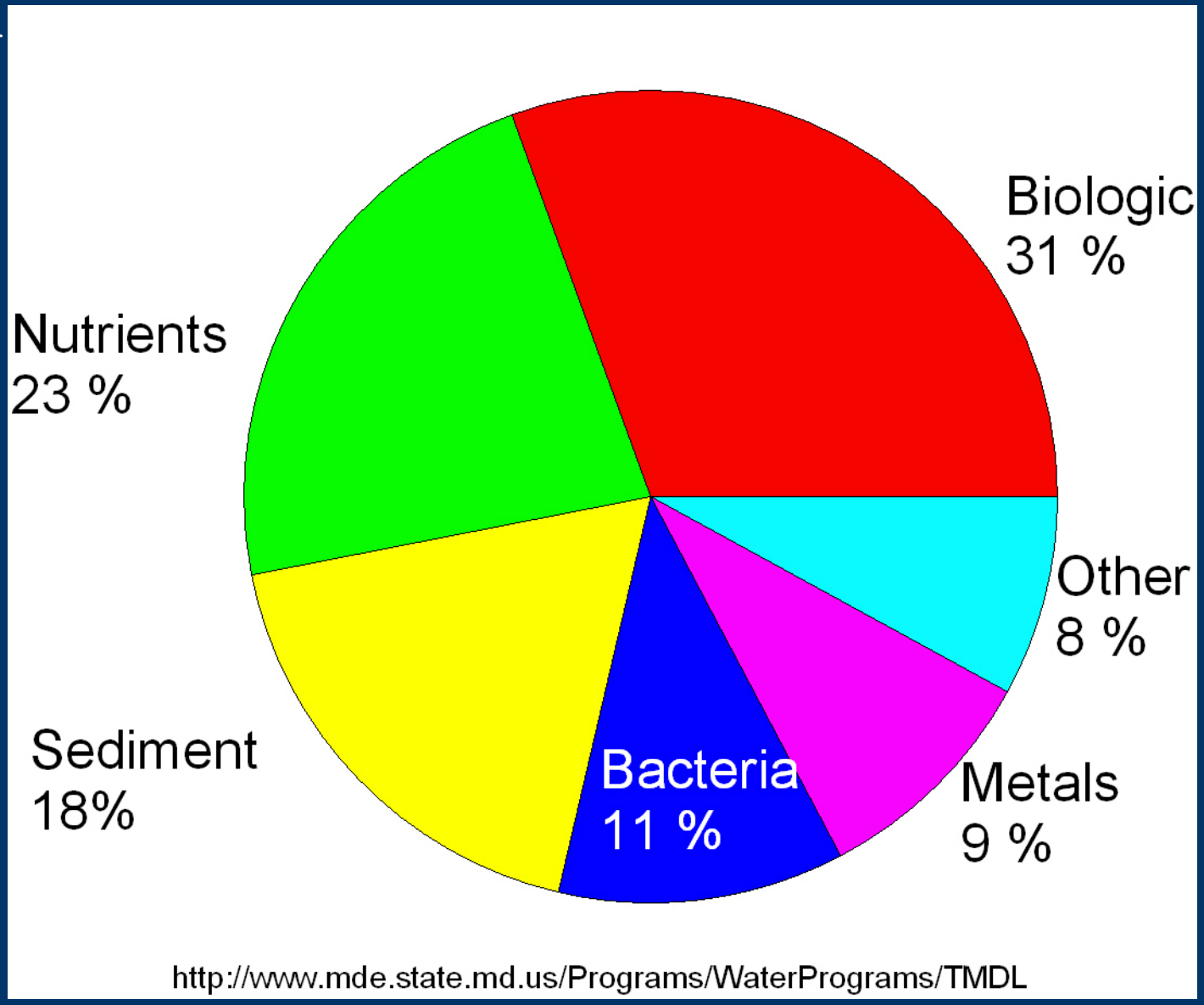
The EPA's 1998 National Water Quality Inventory Report to Congress lists sediment (siltation) as the leading pollutant impairing rivers and streams.

Leasing Pollutants and Sources

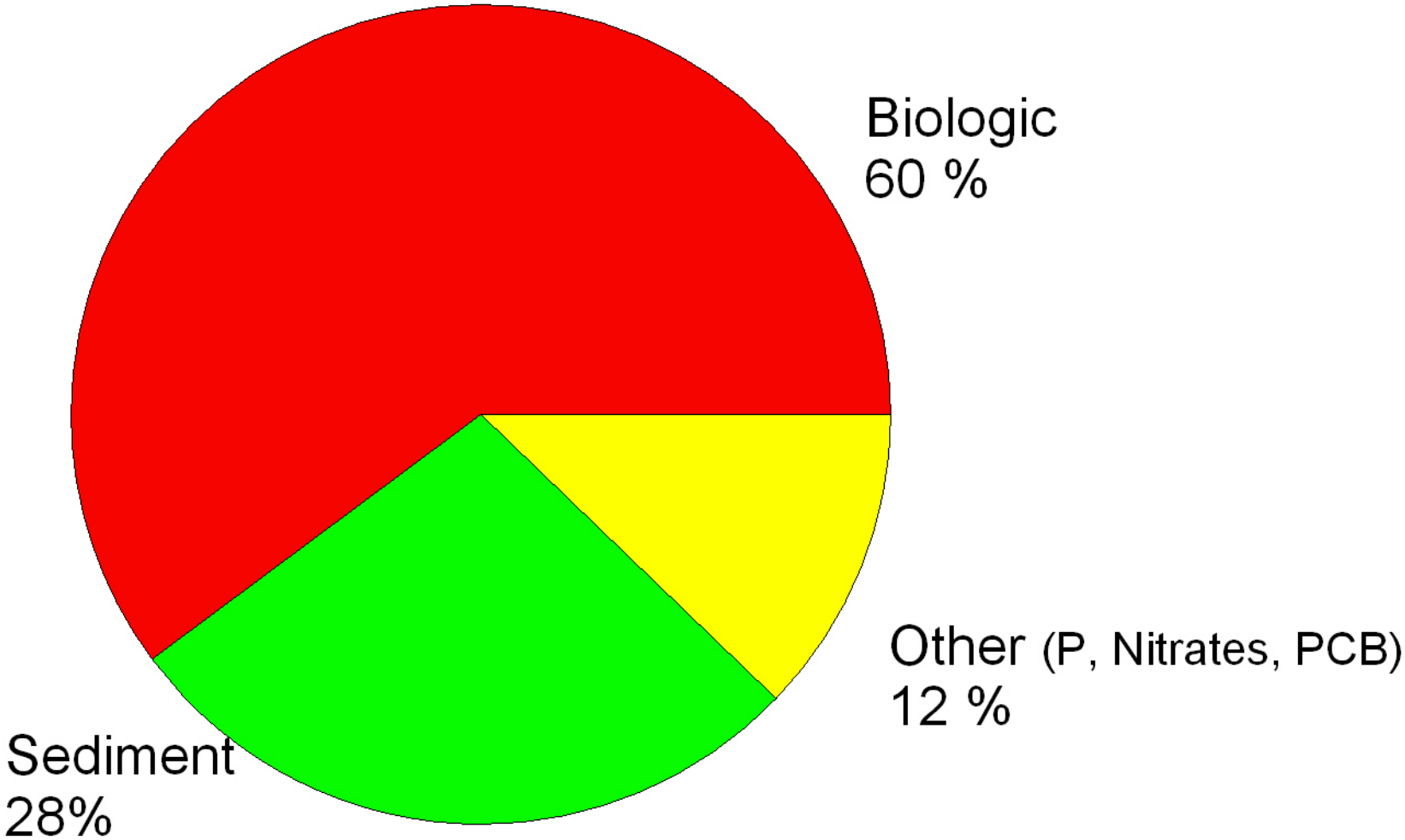
Impairing Assessed Rivers and Streams



2002 Maryland 303d list



2004 Virginia summary of impairments
303D List
94 waterbodies



http://www.deq.state.va.us/tmdl/tmdlrpts.html

FACTORS AFFECTING SEDIMENT LOADINGS

Upland versus channel corridor

<u>Upland</u> – land use (cropland, construction, pasture, mining)

bed, l

ed, br

tural

BMPs – dams, vegetation, restored, till vs no till

HISTORY

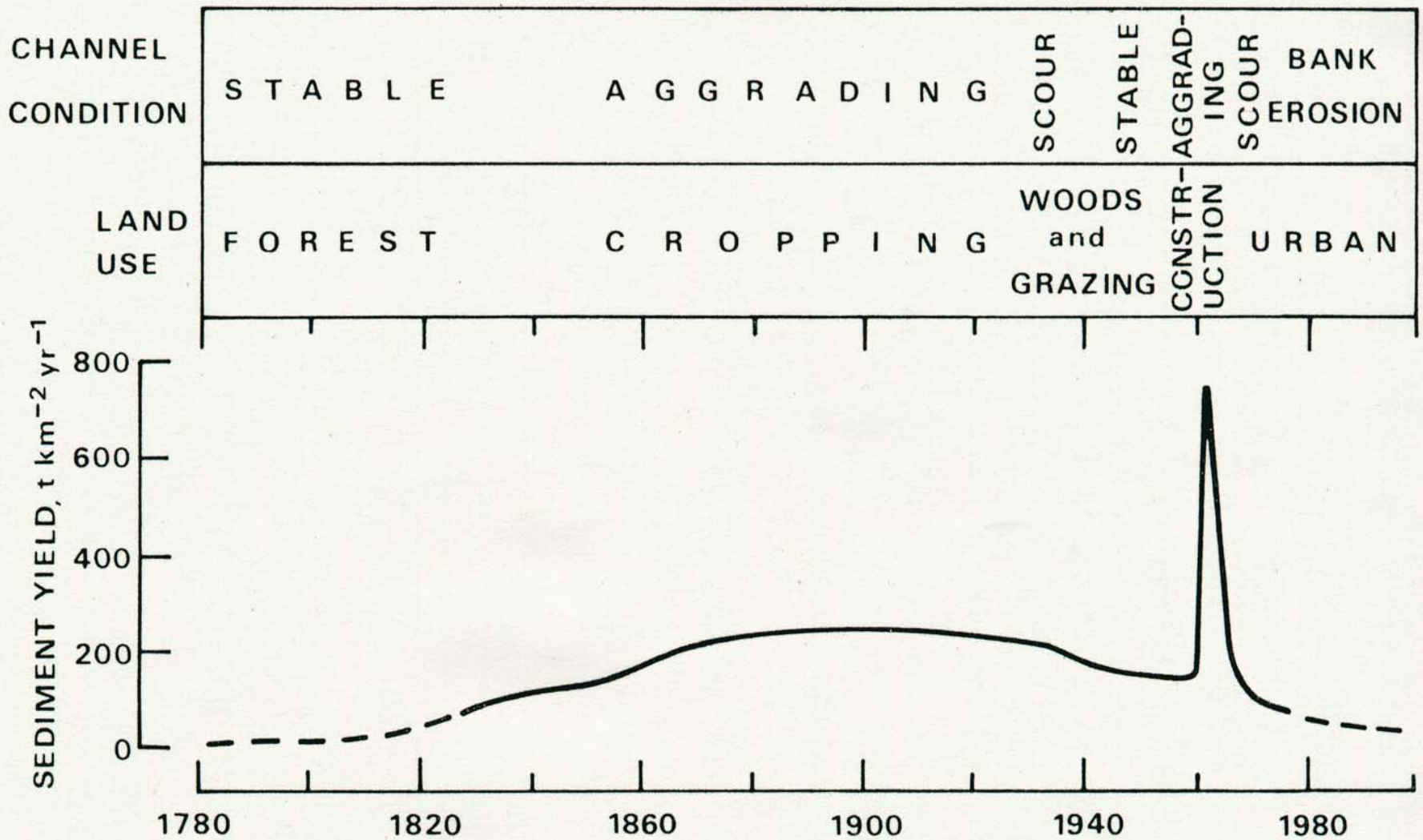


Fig 5.9 Variation in sediment yield over time, Piedmont region, USA (after Wolman, 1967).

Sediment Storage and Residence Time

Trimble (1975) – 90% of eroded sediment

in the Southern Piedmont is still in storage

(hillslopes and valley)

Costa (1975) – 86% of sediment is still in storage

in Maryland Piedmont

Identifying sediment sources

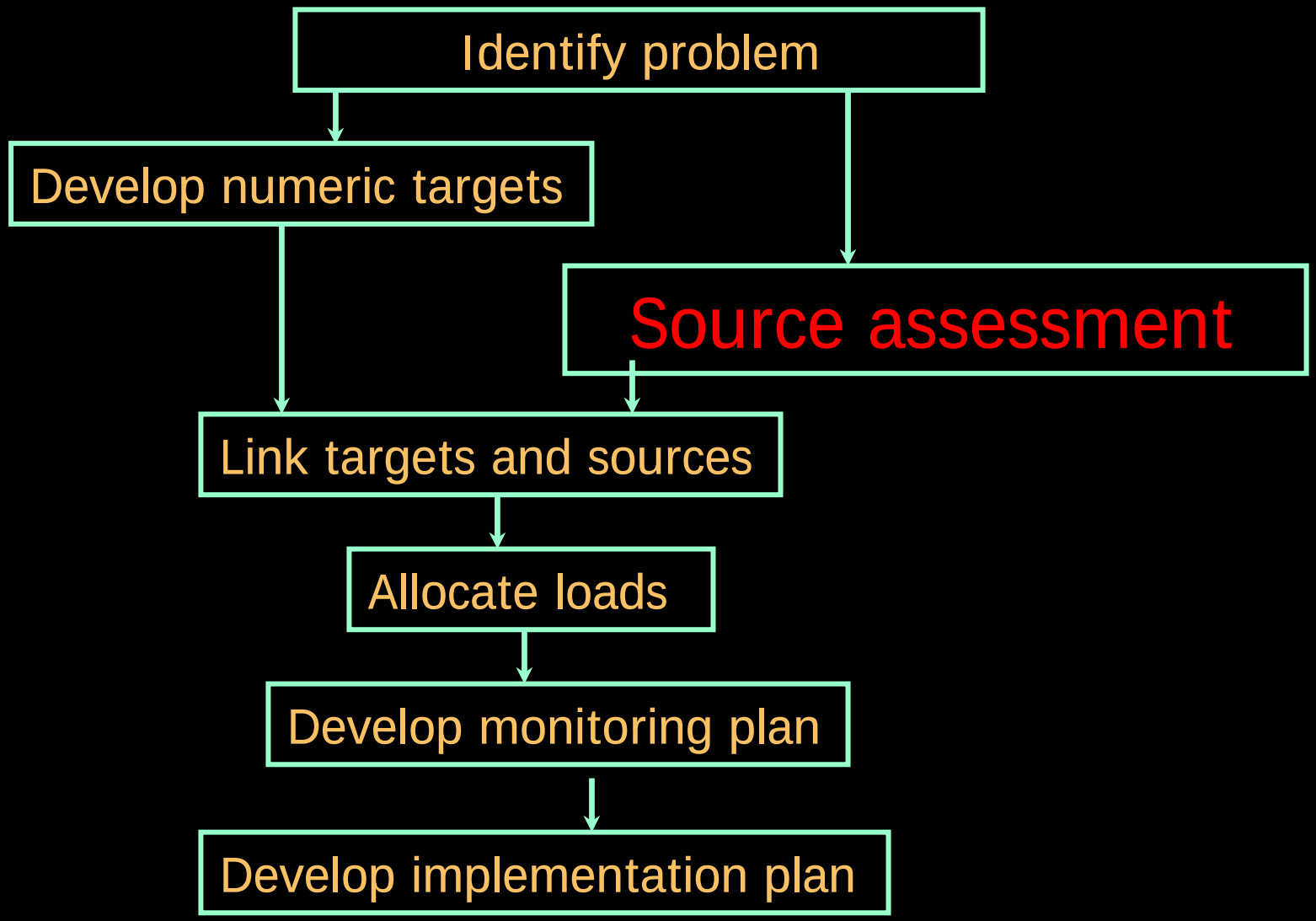
1. <u>Direct measurement</u>

- field measurements of erosion (upland and channel)
- Fluvial sediment data
- Provenance

2. <u>Indirect measurement</u>

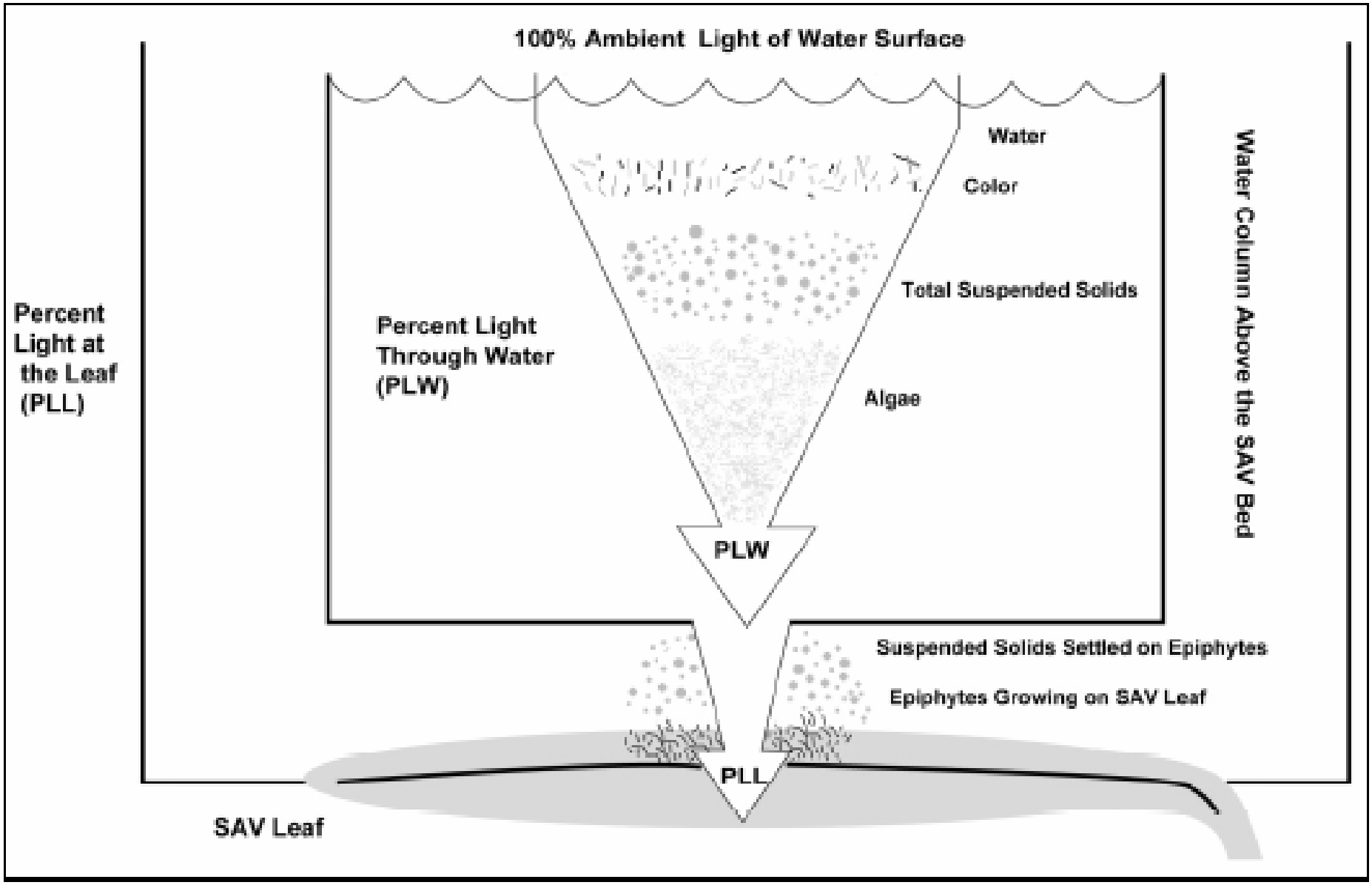
- statistical procedures
- modeling

Components in Sediment TMDL development



Sediment sources, storage, and transport in the Chesapeake Bay watershed

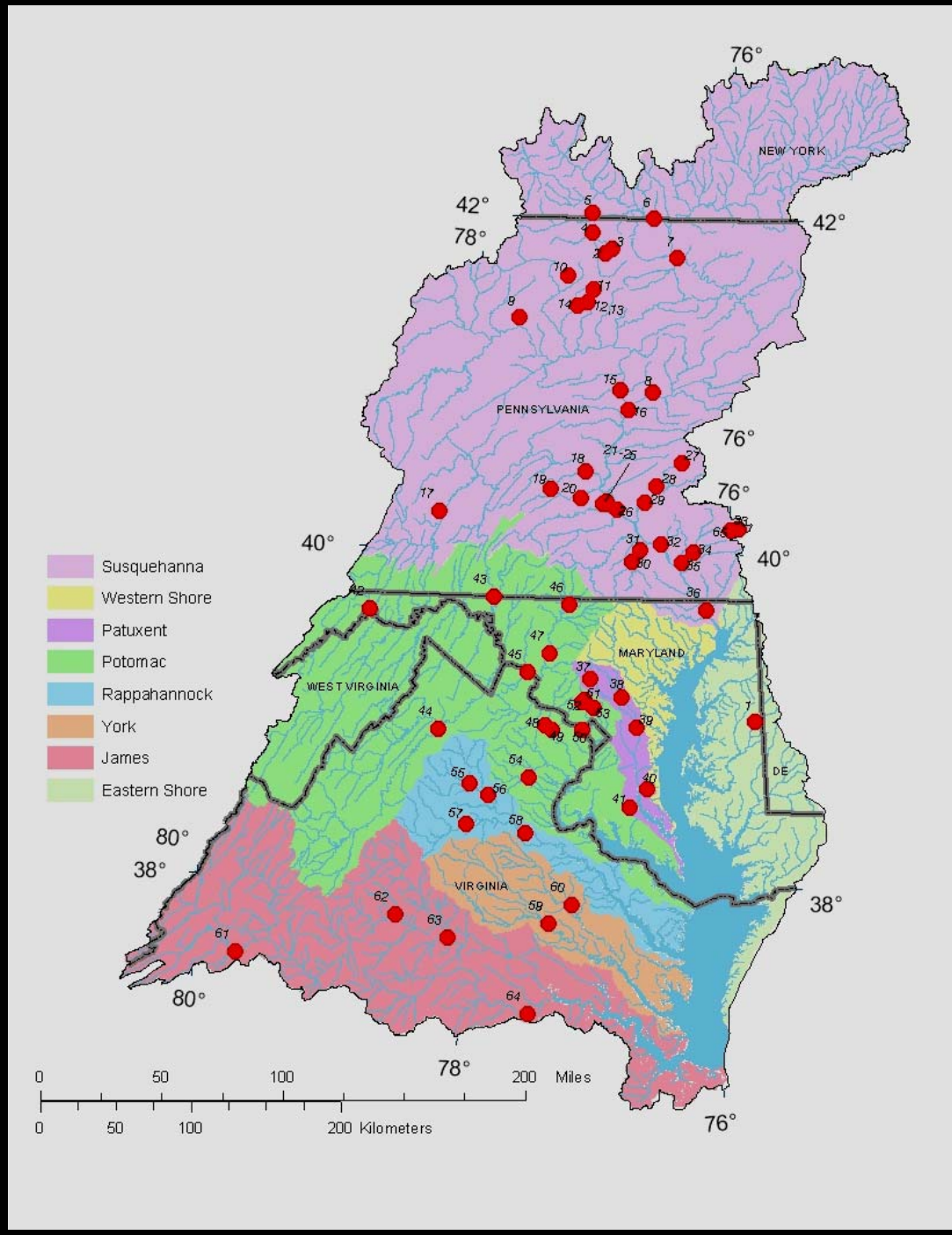
Multiple Factors Affecting Light



USGS Historic Suspended-Sediment Load Stations

Between 1952 and 2001, a total of 64 stations in the Chesapeake Bay Watershed recorded sediment at different years.

The most stations operating at one time was 29 in 1975.



43 USGS STATIONS

Sediment Yield,

1952-84

EXPLANATION

tons/mi^2

- **>10**
- **>50 - 100**
- **>100 - 200**
- **>200 - 500**
- **>500**

Highest 3 sediment yields are in the Washington D.C. area

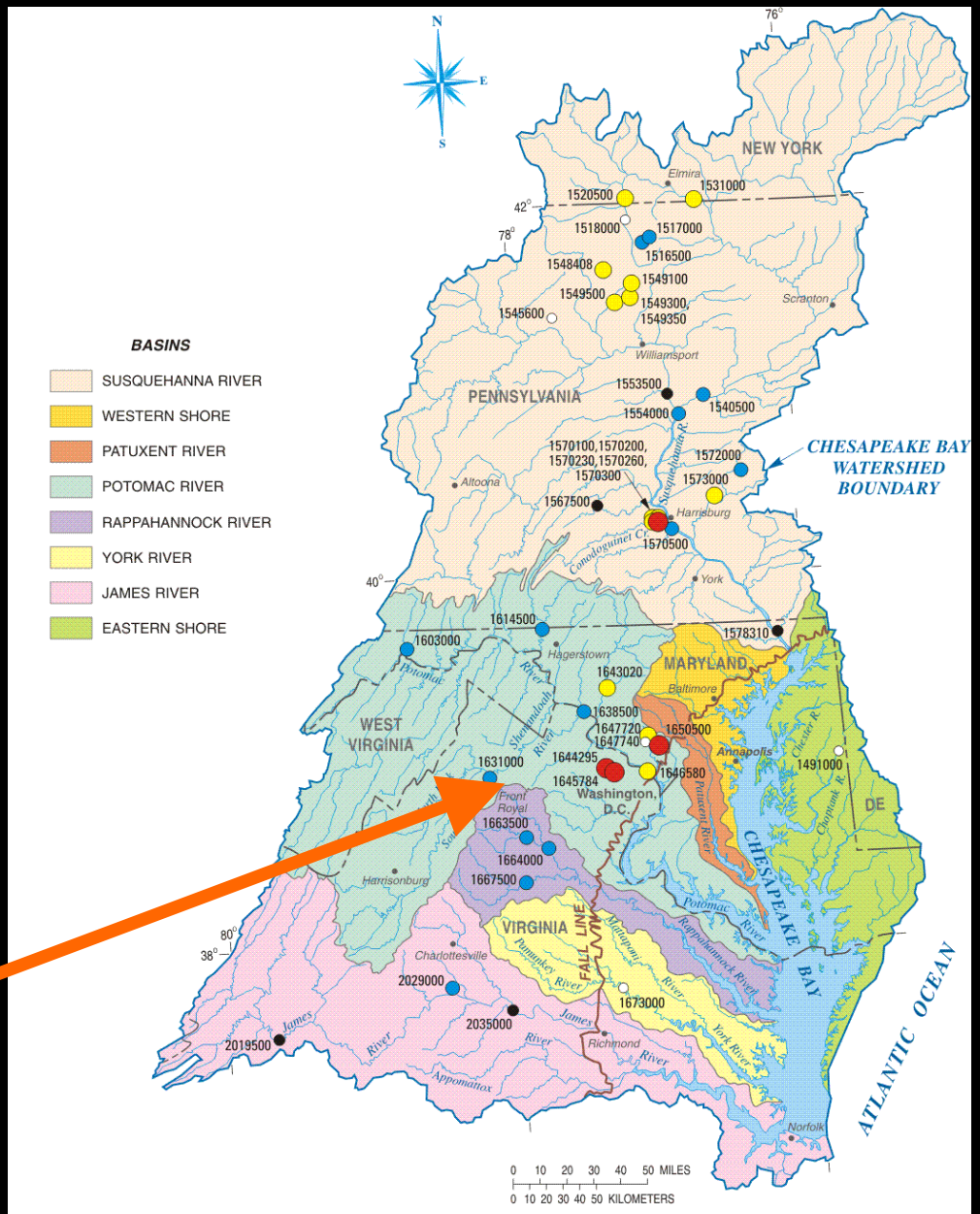


Figure 7b. Average annual sediment yield from 1952 through 1984 for 43 stations in the Chesapeake Bay Watershed with at least 3 years of record. *(Refer to table 3 for listing of stations.)*

25 USGS STATIONS

Sediment Yield,

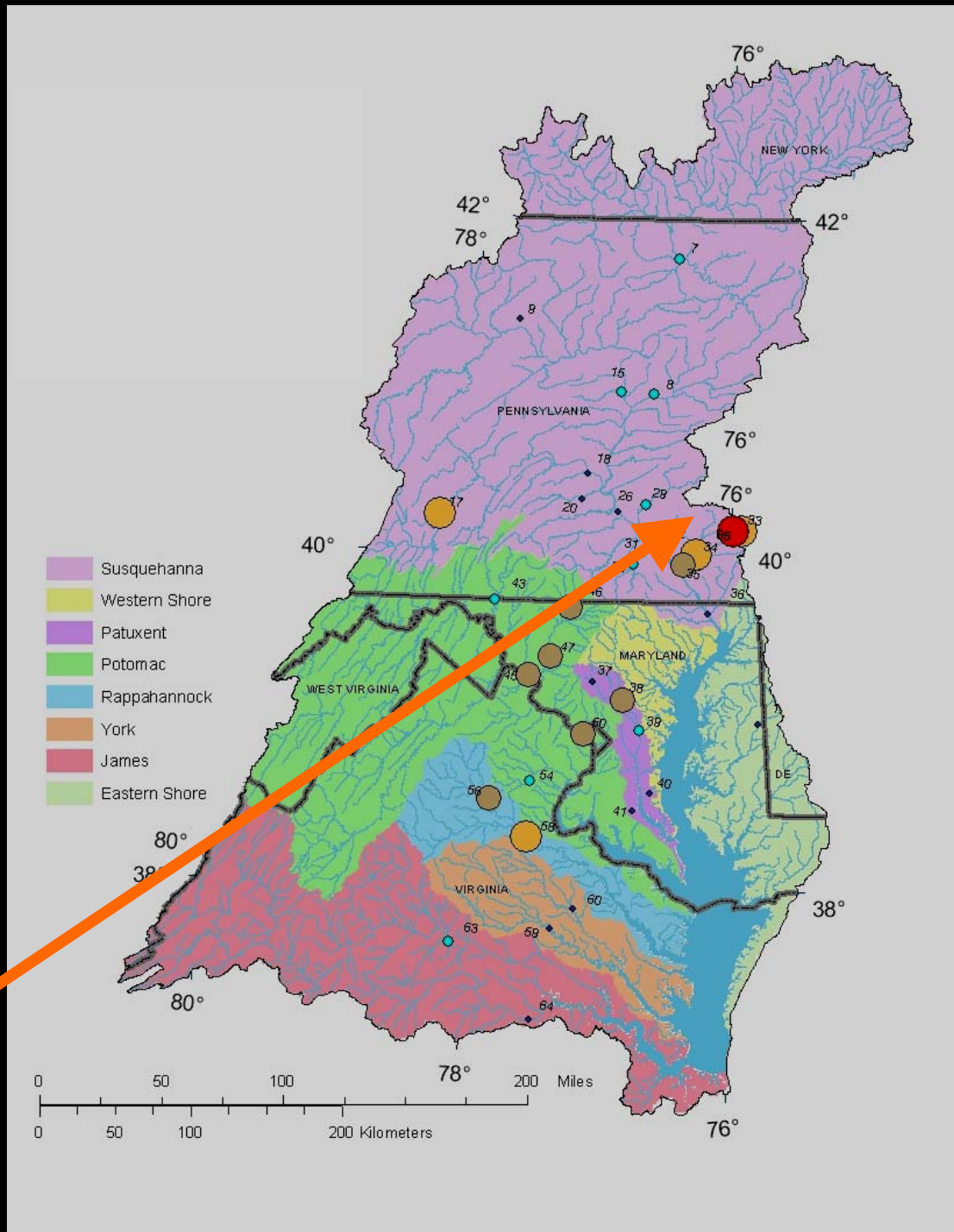
1985-2000

EXPLANATION

tons/mi^2

- **>10**
- **>50 - 100**
- **>100 - 200**
- **>200 - 500**
- **>500**

4 of 6 highest sediment yields are in the Conestoga River Basin, Lancaster, County



51 USGS STATIONS

1985-2001

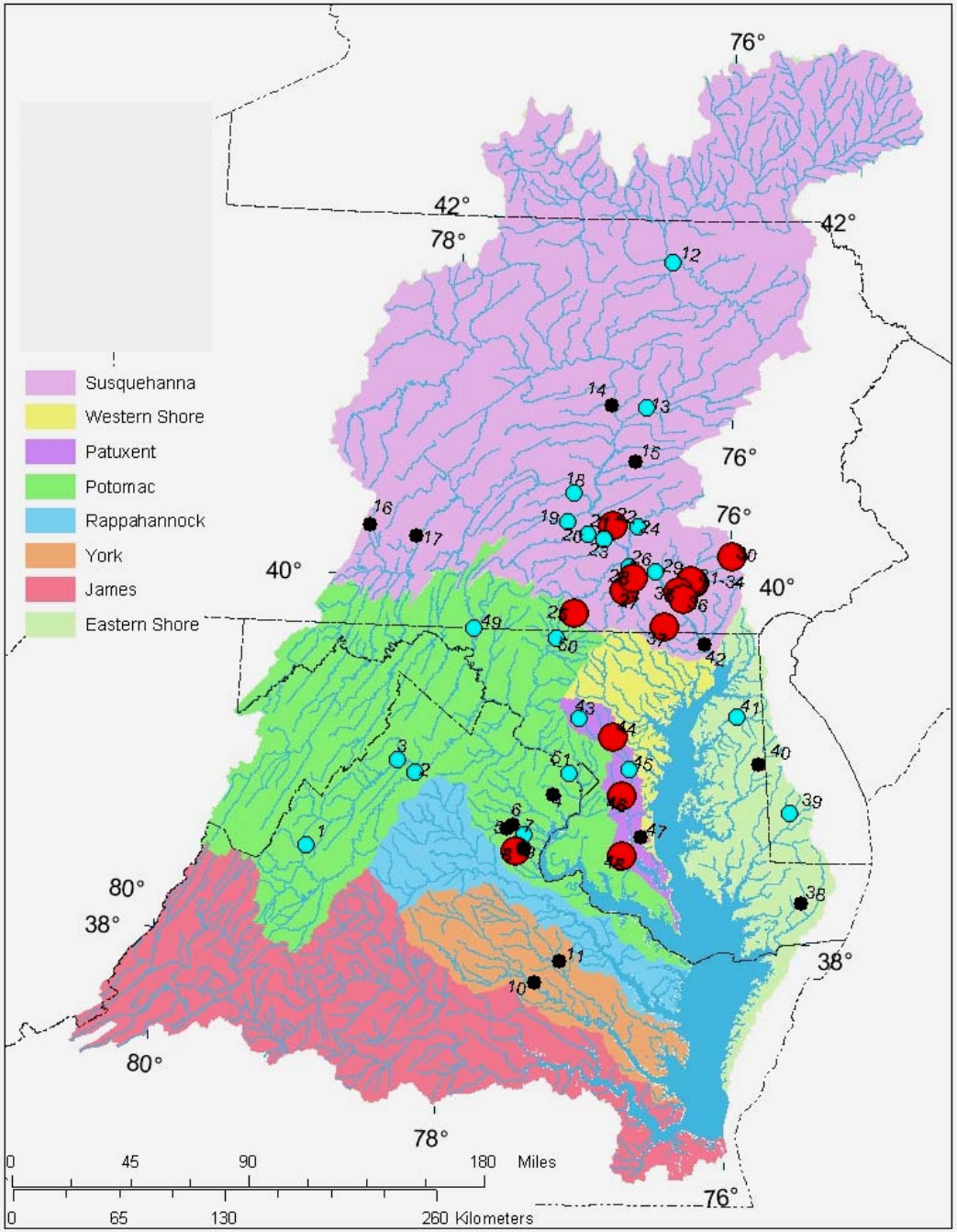
Suspended sediment

90th Percentile

EXPLANATION

Sediment Concentration, mg/L

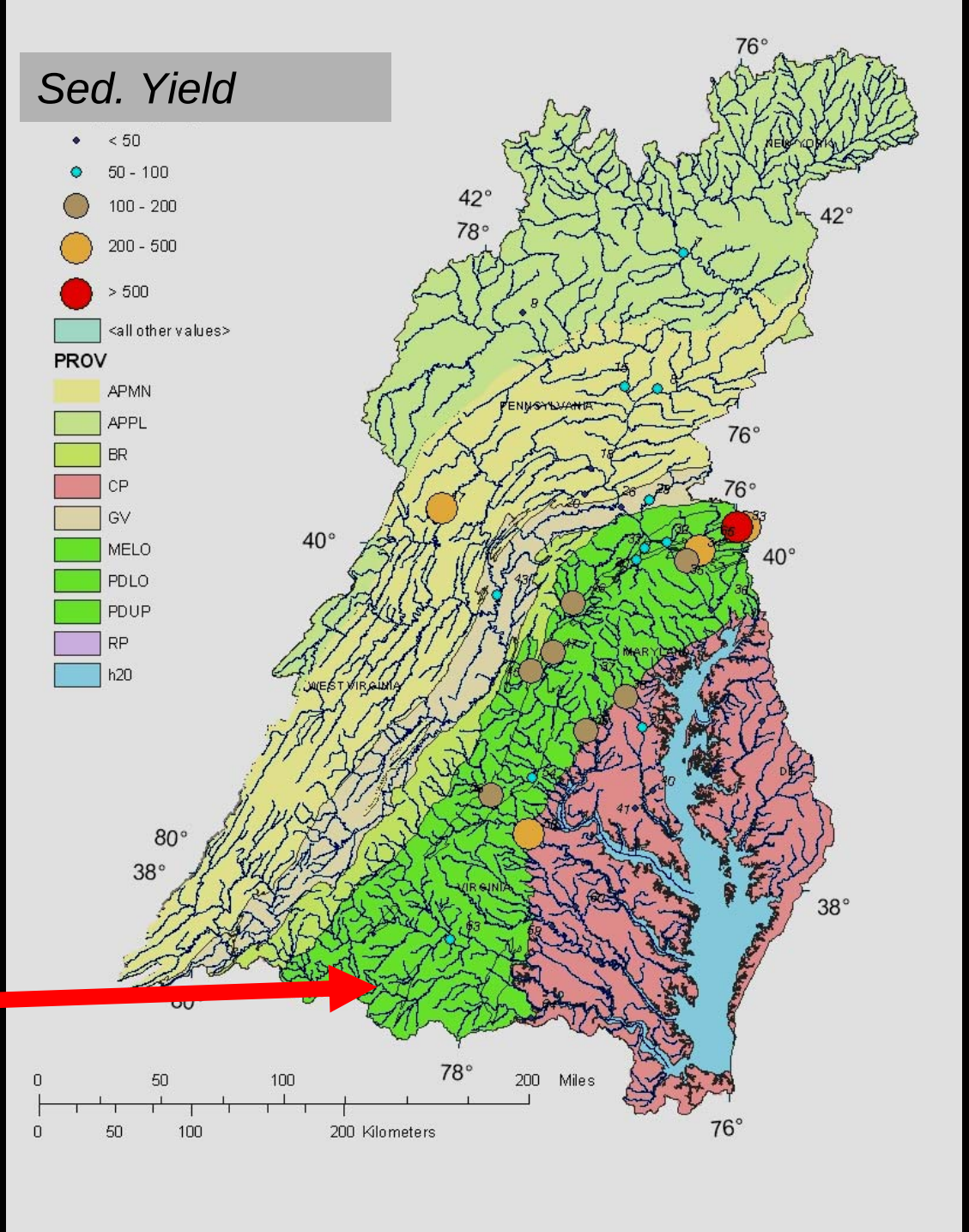
- 14 - 100
- >100 - 500
- >500 - 1000
- >1000 - 5000
- >5000 – 28,500



1	L. Conestoga Ck nr Churchtown, PA
2	Pequa Ck nr Martic Forge, PA
3	Bald Eagle Ck nr Fawn Grove, PA
4	Mill Ck nr Eshelman, PA
5	Killpeck Ck at Huntersville, MD

Mouth of Susquehanna

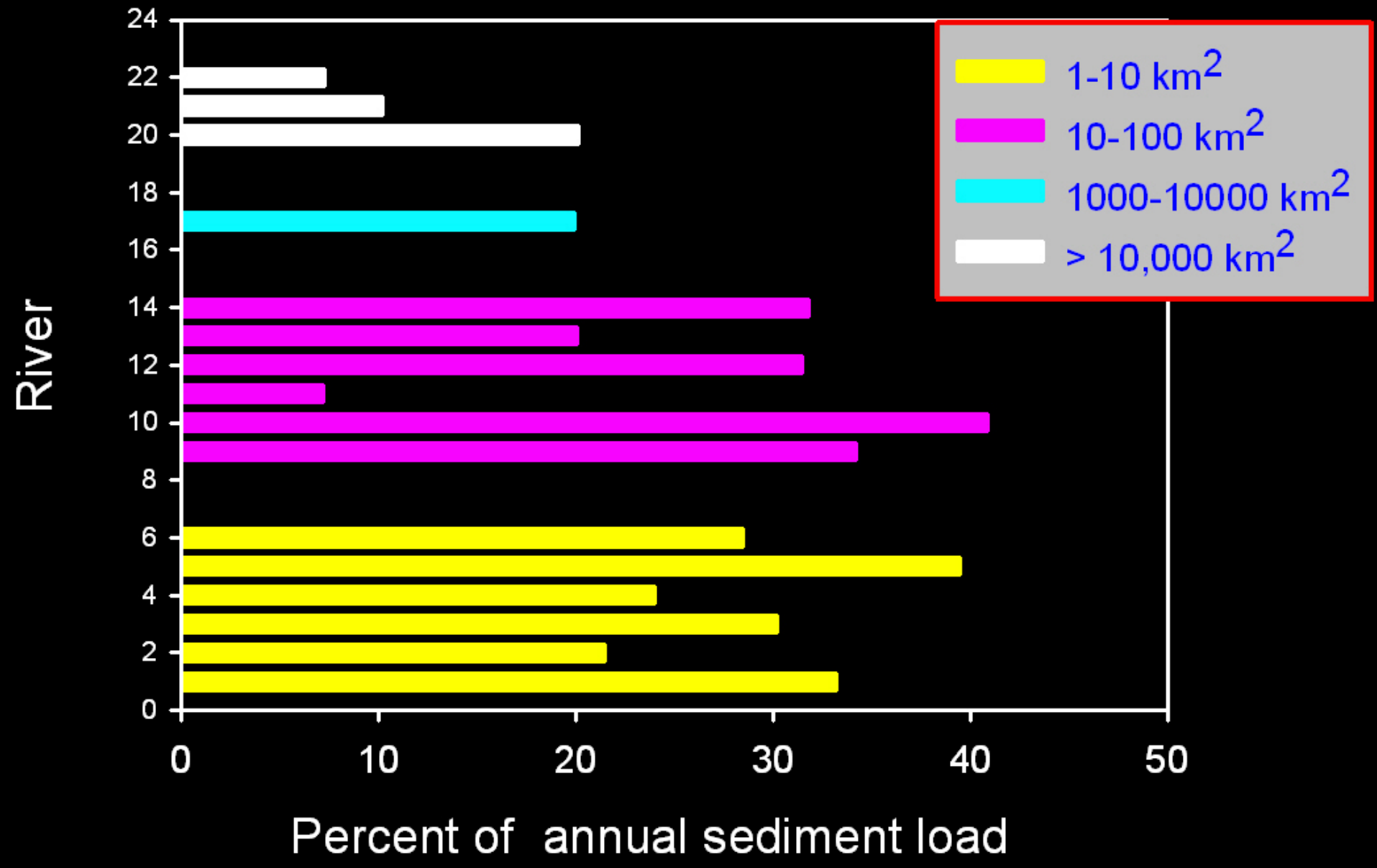
PHYSIOGRAPHIC REGION



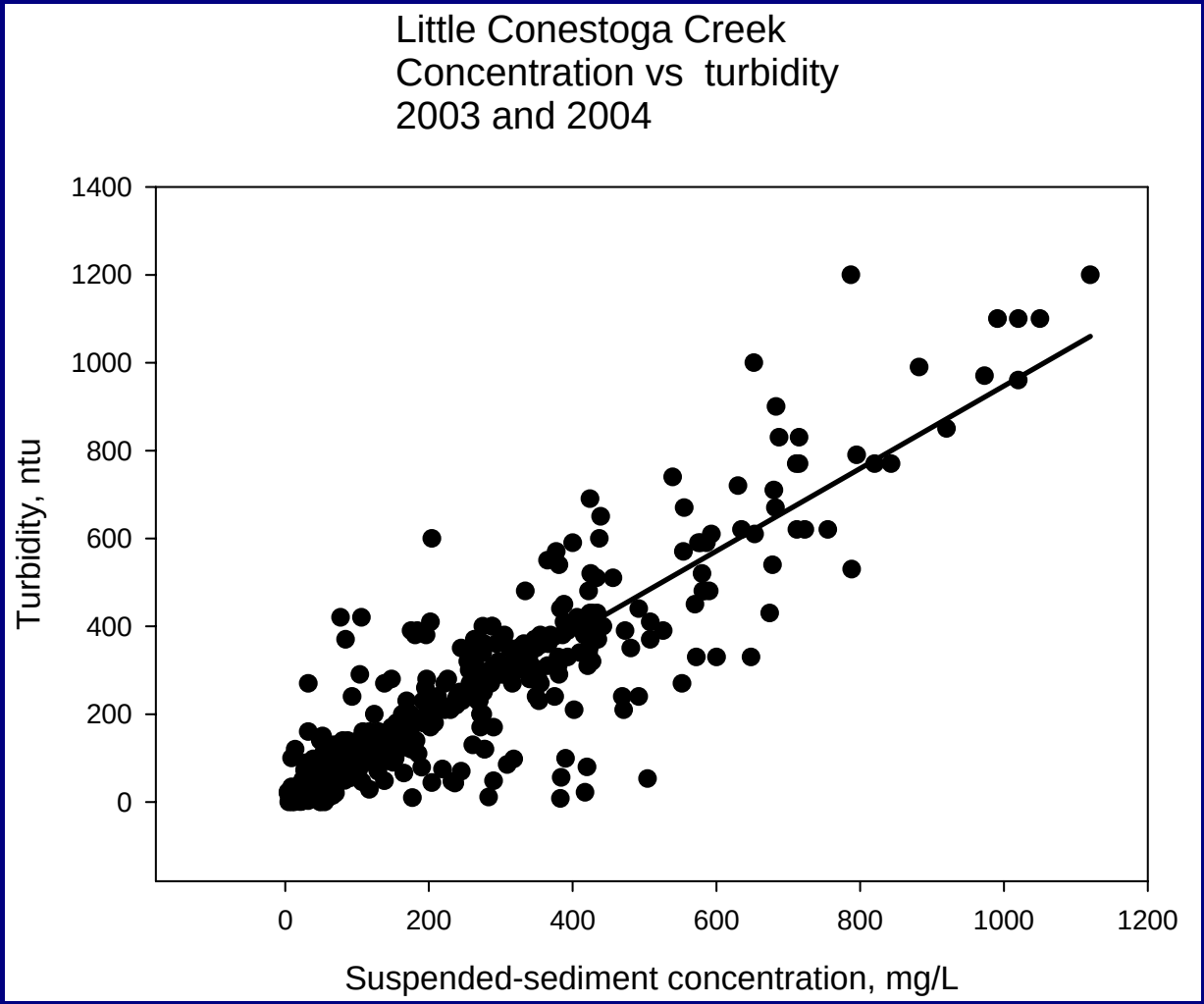
Piedmont

Physiographic Region	Average annual sediment yield (tons/mi2/yr)
Piedmont >49%	296.0
Valley/ridge >46%	189.2
APPALACHIAN >50%	167.8
BLUE RIDGE >50%	162.2
Coastal Plain >50%	34.0

On average:
Percent of annual sediment transported in one day



Suspended-sediment collection



SEDIMENT FINGERPRINTING

Underlying principle – potential sediment sources can be characterized using a number of diagnostic physical and chemical properties

Comparison of these fingerprints with equivalent information for suspended sediment samples permits the relative importance of the potential sources

Walling et al., 1999

Sediment fingerprinting uses various physical and chemical properties

- Radionuclides (^{137}Cs, ^{210}Pb)
- Cosmogenic Isotopes (^{10}Be, ^{7}Be)
- Stable Isotopes (C-13,N-15)
- Total Carbon,Nitrogen, Phosphorous
- Clay Mineralogy
- Magnetic Susceptibility

Statistical methods to determine appropriate fingerprints (Landwehr, USGS)

Determine that fluvial samples are bracketed by sources

↓

Kruskal-Wallis H-Test

↓

Student T-Test

↓

Mann-Whitney

↓

Multivariate *unmixing* model

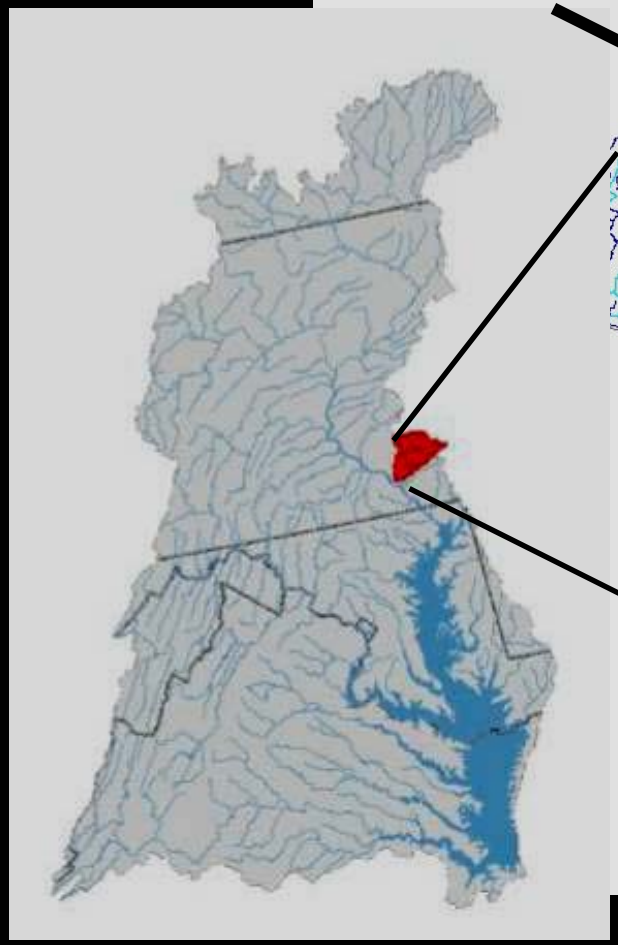
Upland collection of fingerprints

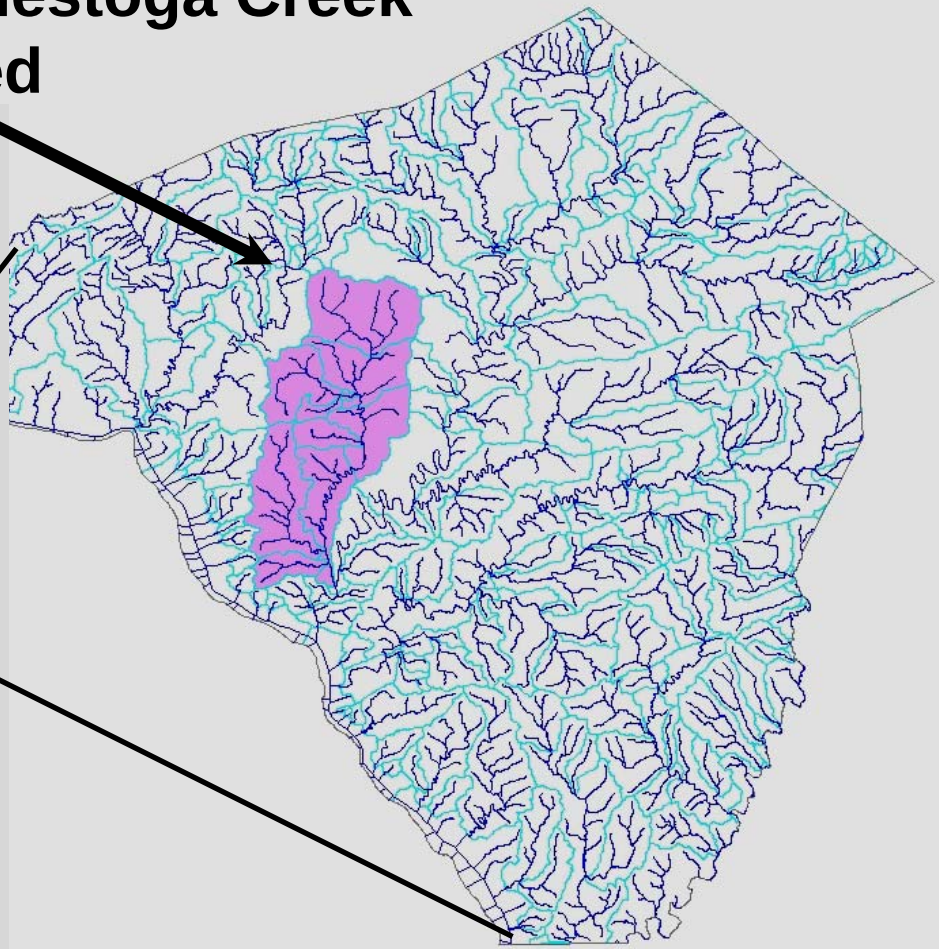
- top 1-3 cm
- grid sampling or random walk
- sieve to get less than 63 λm

Stream Corridor

- bank face
- channel bed, bars
- floodplain

Little Conestoga Creek Watershed





Little Conestoga Creek

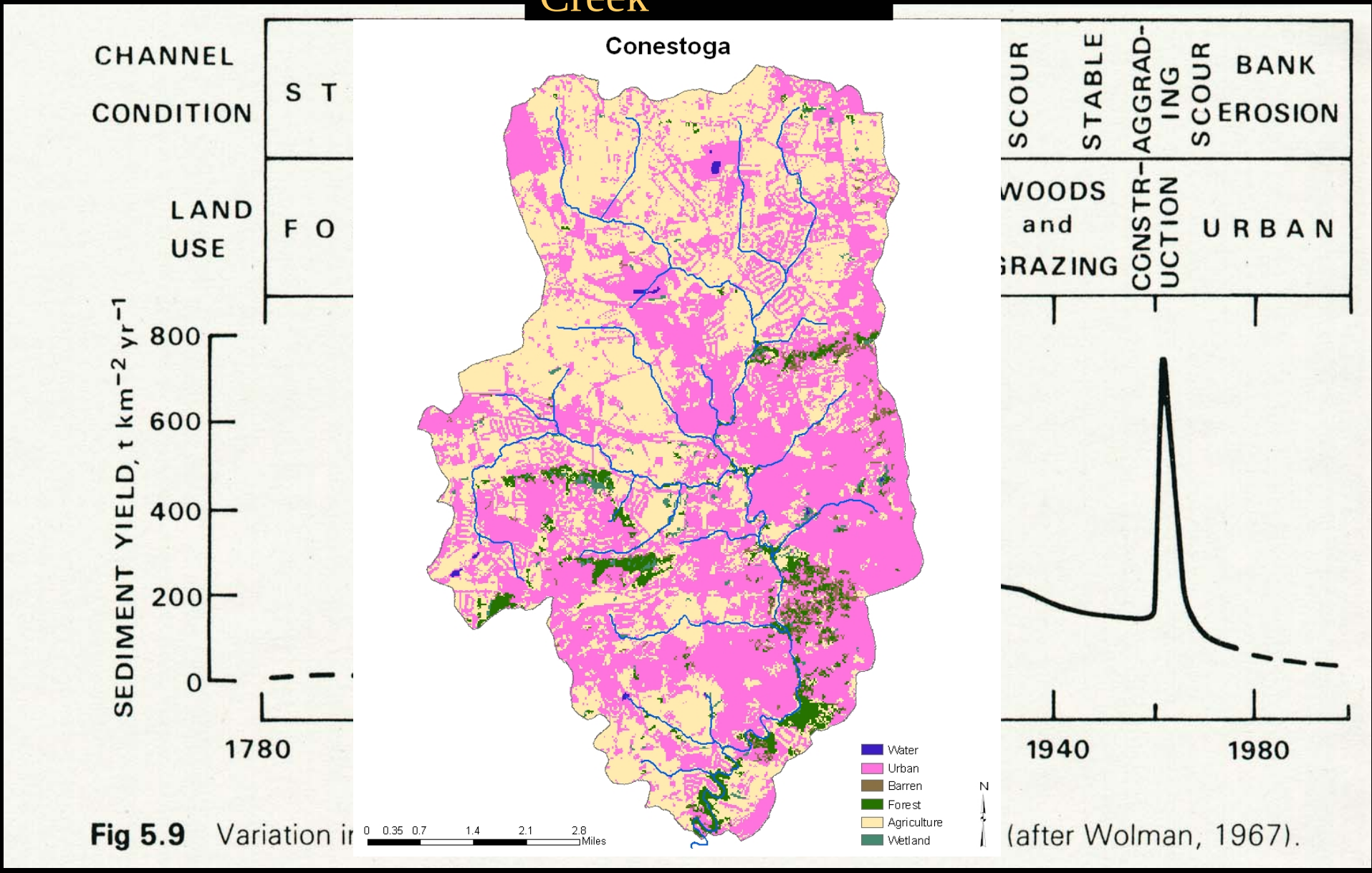
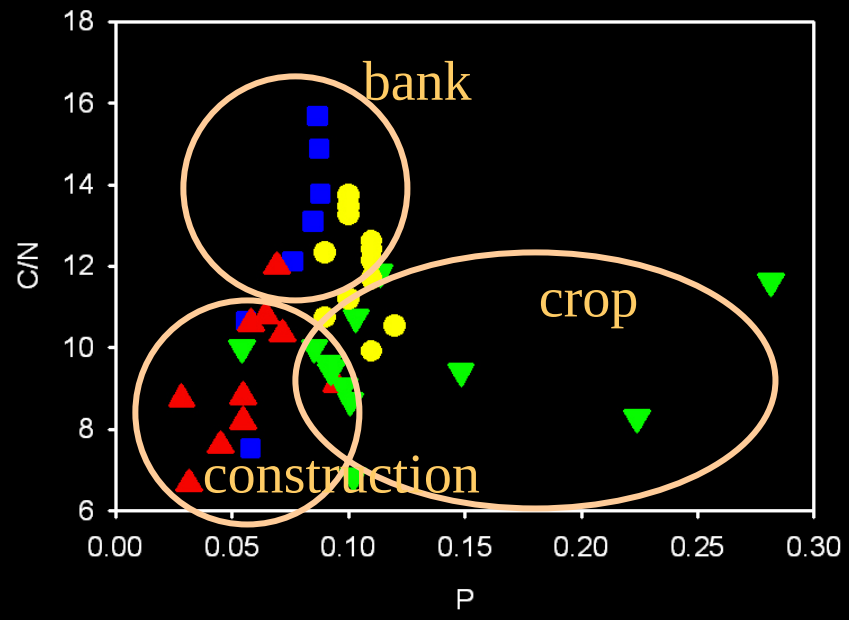


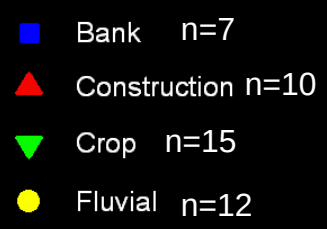
Fig 5.9 Variation in (after Wolman, 1967).

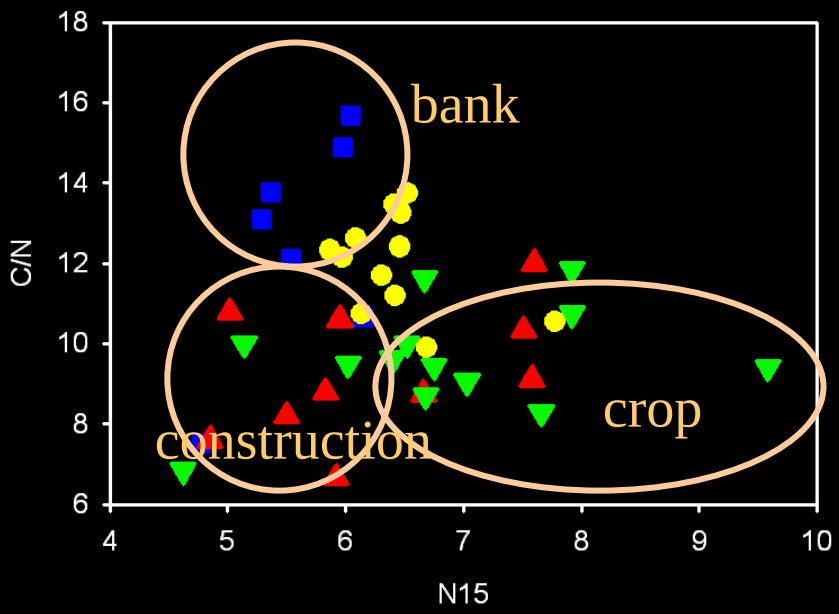
2004/01/01

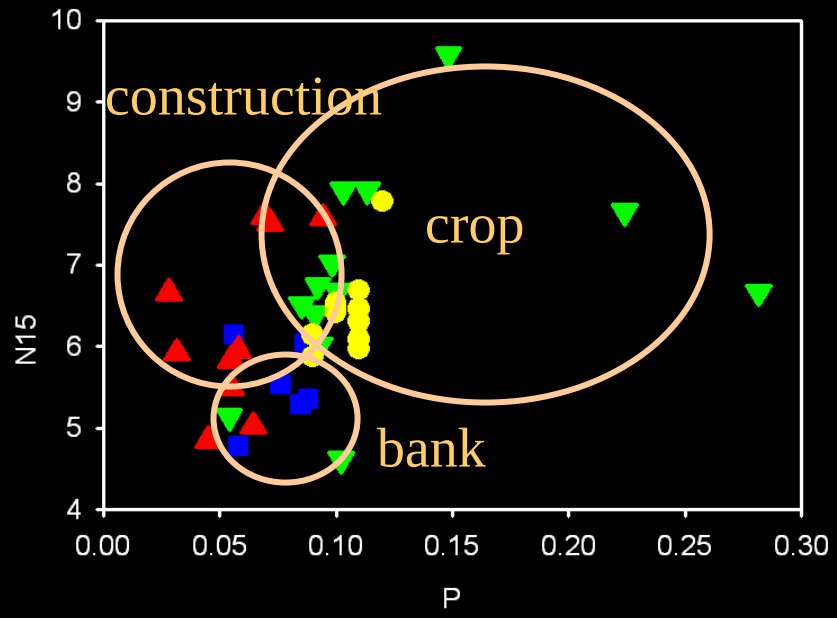
Little Conestoga Creek

Fingerprinting results
n=12 events









	SOURCES				Peak Discharge
DATE	Banks	Construction	Crop	ERROR	m^3/s
2/6-7/2004	50	0	50	0.48	28.9
3/20-21/2003	50	0	50	0.13	17.4
10/14-16/2003	4	0	96	0.27	17.2
6/4-5/2003	44	0	56	0.50	16.3
6/7-7/2003	48	0	52	0.60	14.2
3/9/2003	50	0	50	0.02	10.5
4/11/2003	78	0	22	0.62	10.5
9/1-2/2003	42	0	58	0.39	9.3
5/26/2003	68	0	32	0.74	8.5
6/5/2004	60	0	40	0.13	6.3
3/2/2003	41	21	38	0.04	5.3
9/19-20/2003	11	11	78	0.43	5.0
AVERAGE %	**46**	**3**	**52**		

Common Sense Approach to sediment mitigation

- Identify Important Sediment Yielding Subbasins

  Target areas

- Identify Major Sources of Sediment in these Subbasins

  Upland versus channel corridor

- Mitigate the problem

  Channel versus soil conservation

- Monitor

  Suspended sediment, channel morphology

CONCLUSIONS

In the Chesapeake Bay watershed the Piedmont is the highest sediment yielding region

There are numerous methods to determine sediment sources

Sediment fingerprinting combined with a geomorphic reconnaissance provides a reliable methodology to quantify important sources

- identifies upland versus channel erosion