How does sediment affect fish and macroinvertebrates?

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- Suspended sediment (TSS):
  breathing, vision
- Sediment on streambed:
  egg development
  living space

Suspended sediment (TSS)

Setting an effective TMDL for suspended sediment:

easy to say, but fish provide a moving target

What is a TMDL?

Total Maximum DAILY Load

1) Problem identification
2) Target values
   MPCA standard 25 NTU or ~ 46 mg/l
3) Source assessment
4) Link targets and sources
5) Allocate among inputs
6) Develop monitoring and evaluation plans

Excess suspended sediment often results in:

1) Reduced diversity/altered species composition

2) Altered size and age structure

3) Temporal variability in abundance

What causes these changes ?

Suspended sediment directly affects fish through:

1) Behavioral changes

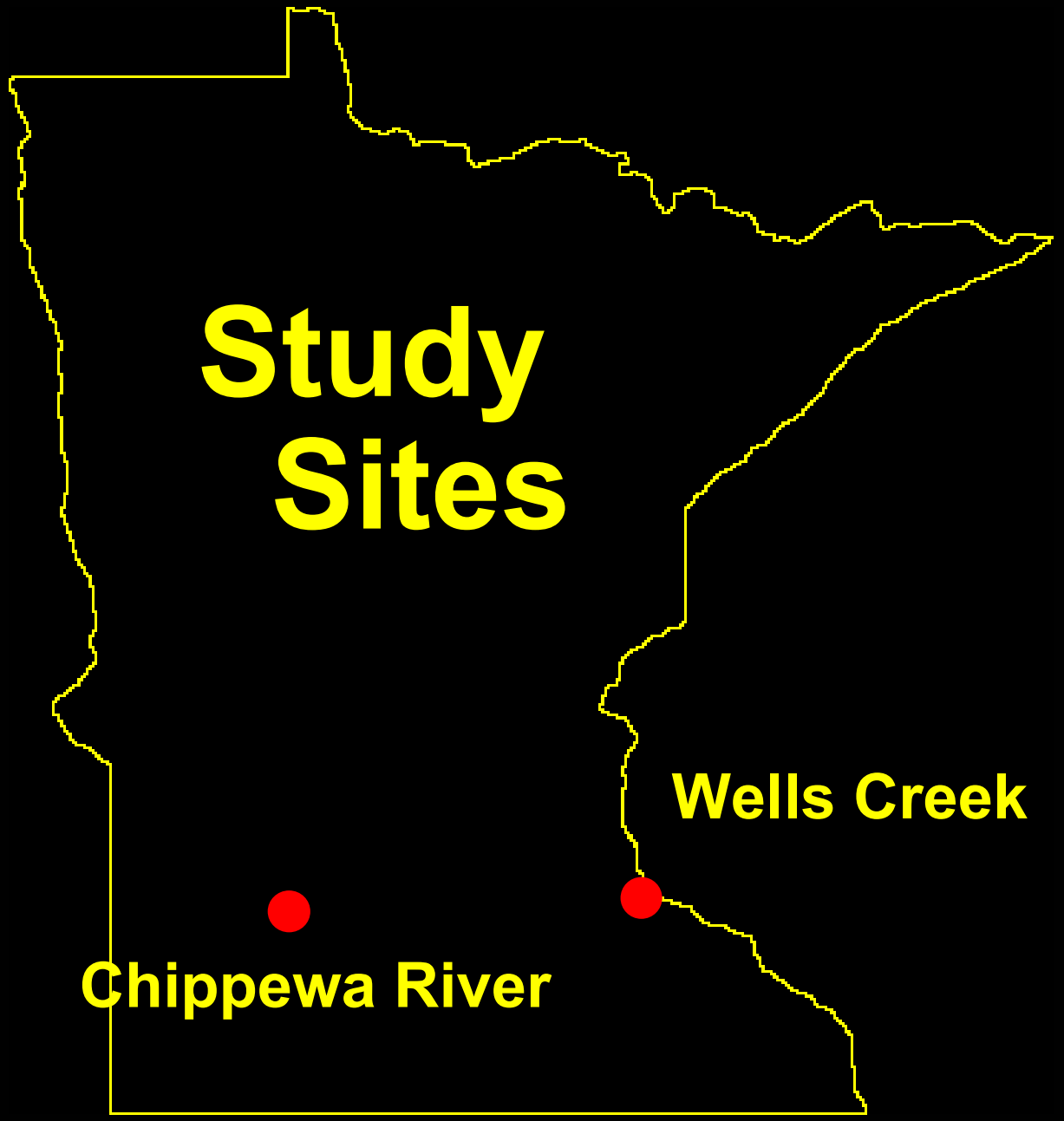
2) Sublethal and lethal effects

Past research:

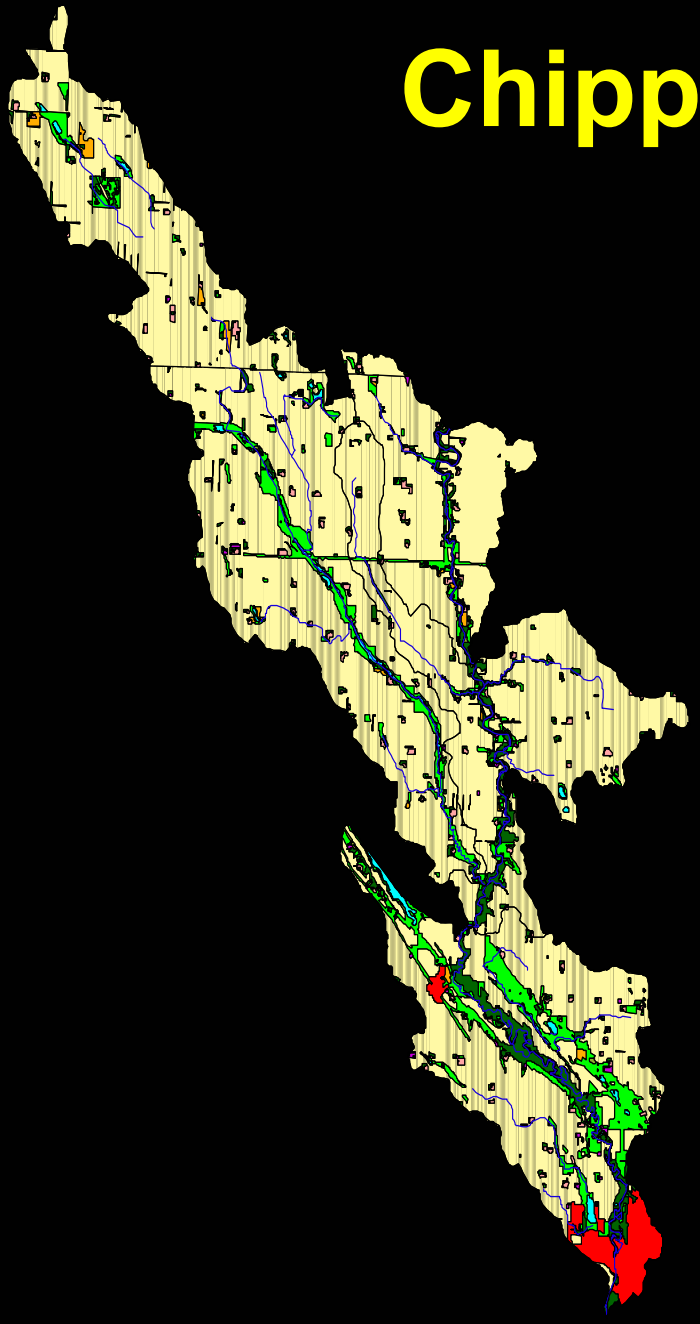
1) Model suspended sediment loads in two basins

2) Quantify sediment load:
   -concentration
   -duration

3) Estimate effects on fish


Study Sites
Wells Creek
Chippewa River

Chippewa River Land Use



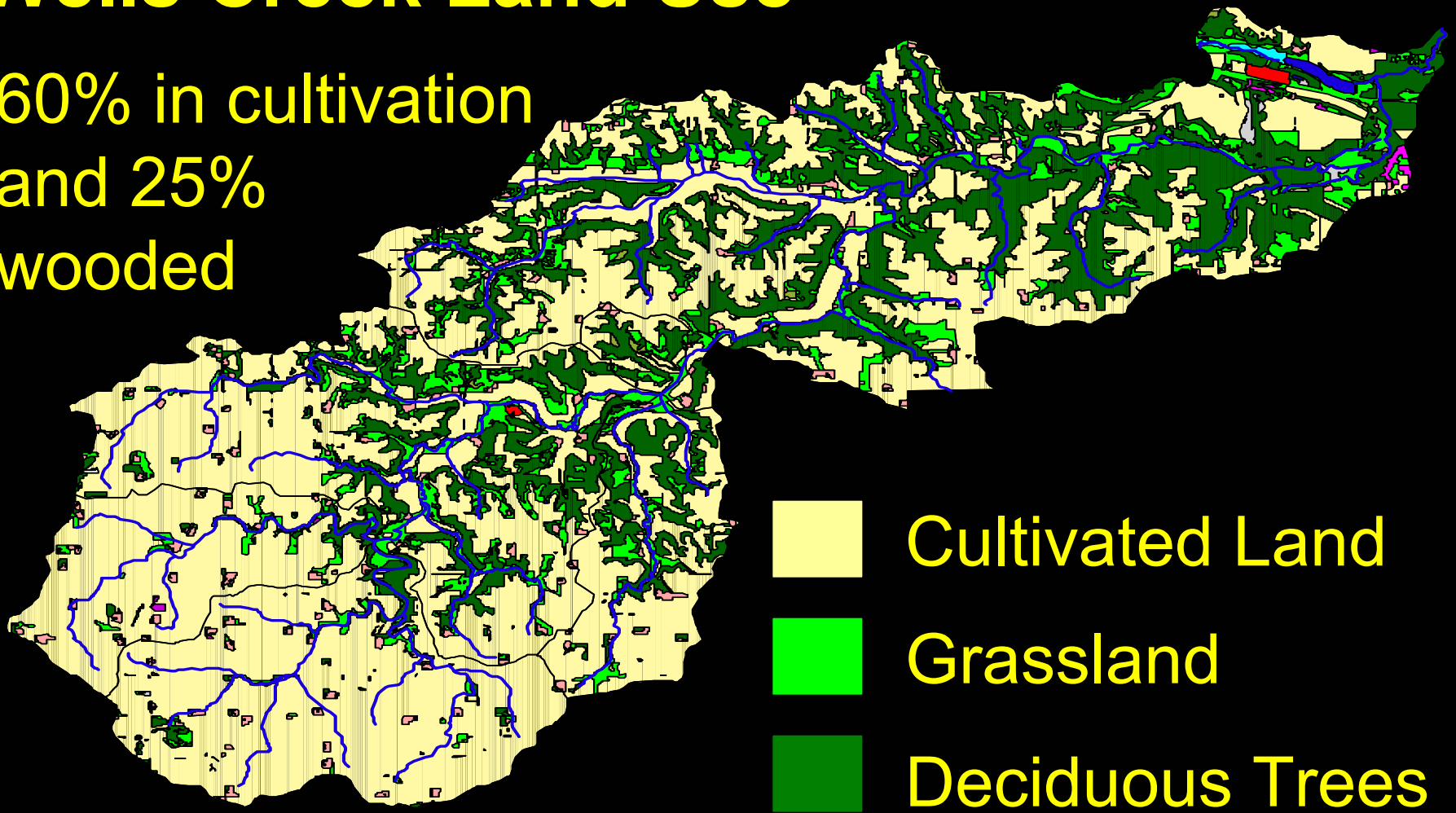
80% in cultivation and includes a portion of Montevideo

- Cultivated Land
- Grassland
- Deciduous Forest
- Urban

Study area: 17,994 ha

Wells Creek Land Use

60% in cultivation and 25% wooded



Study Area:
16, 264 ha

Methods

1) ADAPT model

Agricultural Drainage and Pesticide Transport

50-year simulation

2) Survey farmers in each study area

3) Streambank erosion

20% in Wells Creek

40% in the Chippewa River

Effects of sediment on fish

Newcombe and Jensen (1996)

Sublethal - Reduction in feeding rate or success, coughing and increased respiration, moderate habitat degradation, and impaired homing

Lethal - Reduced growth, reduced density, increased predation, and mortality

Sublethal Thresholds (mg/L SS)

Newcombe and Jensen (1996)

	Salmonids	Non-salmonids
1 day	3	1
2 day	3	1
6 day	1	1
14 day	1	1

Lethal Thresholds (mg/L SS)

Newcombe and Jensen (1996)

	Salmonids	Non-salmonids
1 day	2981	8103
2 day	1097	403
6 day	403	55
14 day	403	3

Sediment Delivery

Mean event duration

Chippewa River = 2.9 ± 3.8 days
Wells Creek = 1.5 ± 1.1 days

Maximum event duration

Chippewa River = 35 days
Wells Creek = 14 days

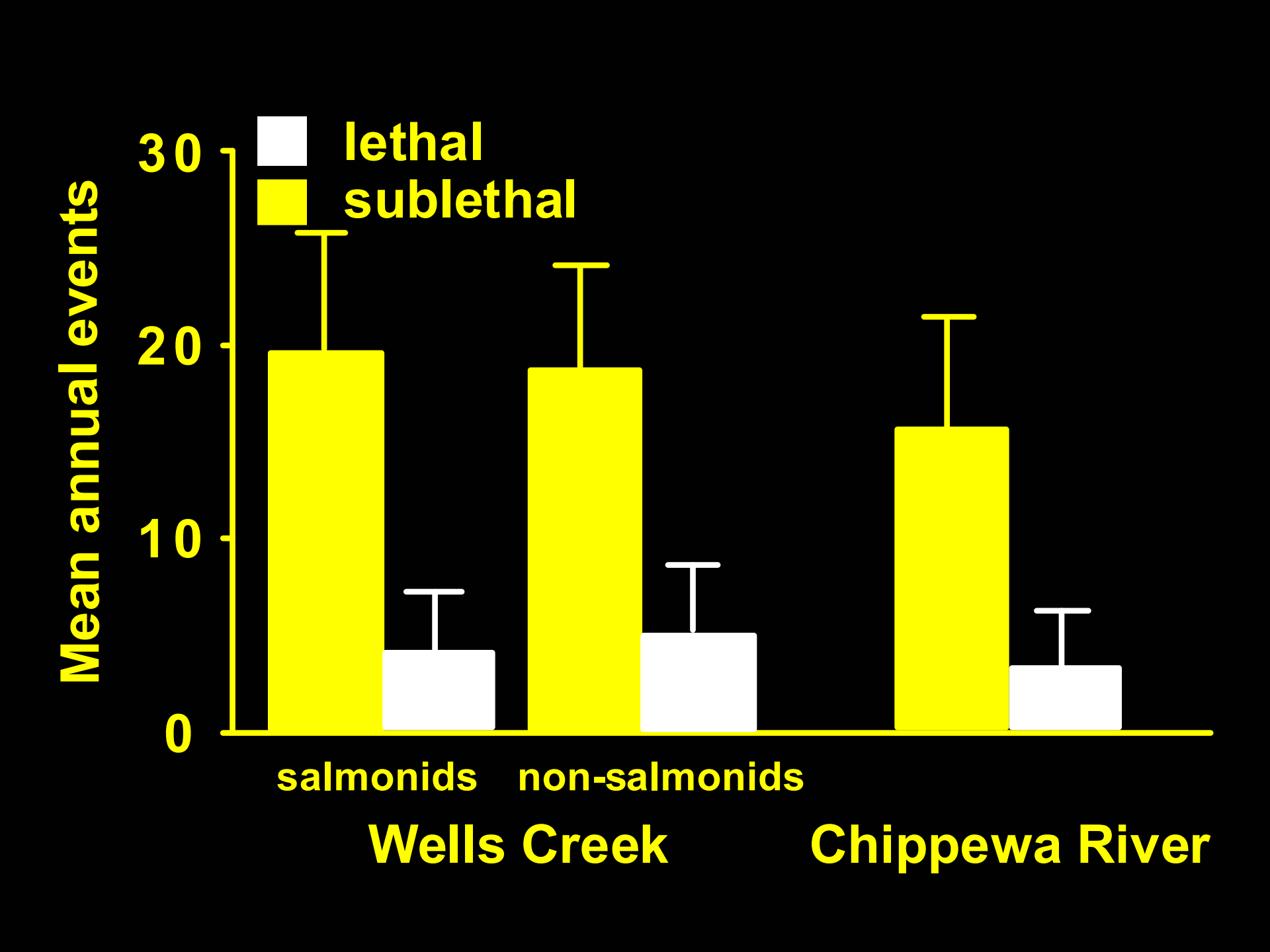
Duration of sediment delivery

Days	Wells Creek	Chippewa River
≥ 1	827	489
≥ 2	337	417
≥ 6	15	111
≥ 14	1	26

Mean days exceeding 46 mg/L TSS

Chippewa River = 31.9 ± 22.4

Wells Creek = 29.5 ± 13.5


lethal
sublethal
Mean annual events
30
20
10
0
salmonids
non-salmonids
Wells Creek
Chippewa River

Conclusions

1) ~ 25 events/year with physiological stress to fish (lethal or sublethal)

2) Sediment often delivered over a period of several days

3) Duration of event as critical as concentration and complicates setting TMDL

Particle size of streambed

Fine particles (clay) to boulders or bedrock

- Fish and aquatic macroinvertebrates use a range of particles sizes
  - Trout generally prefer large particle sizes to maintain position and feed
- Fine sediment deposited on the streambed is a major cause of changes in species structure and abundance and may lead to local extinction

Particle size of streambed

Causes of changes in species structure and abundance

- Microhabitat scale: fine sediment fills interstitial spaces
  - reduces habitat for invertebrates
  - covers eggs
- Macrohabitat scale: fine sediment reduces habitat diversity
  - streambed uniform
  - shift to few, abundant organisms

Grazing in riparian areas

Examine relationships between channel morphology and grazing as related to streambank erosion,
in-channel habitat,
and benthic macroinvertebrates

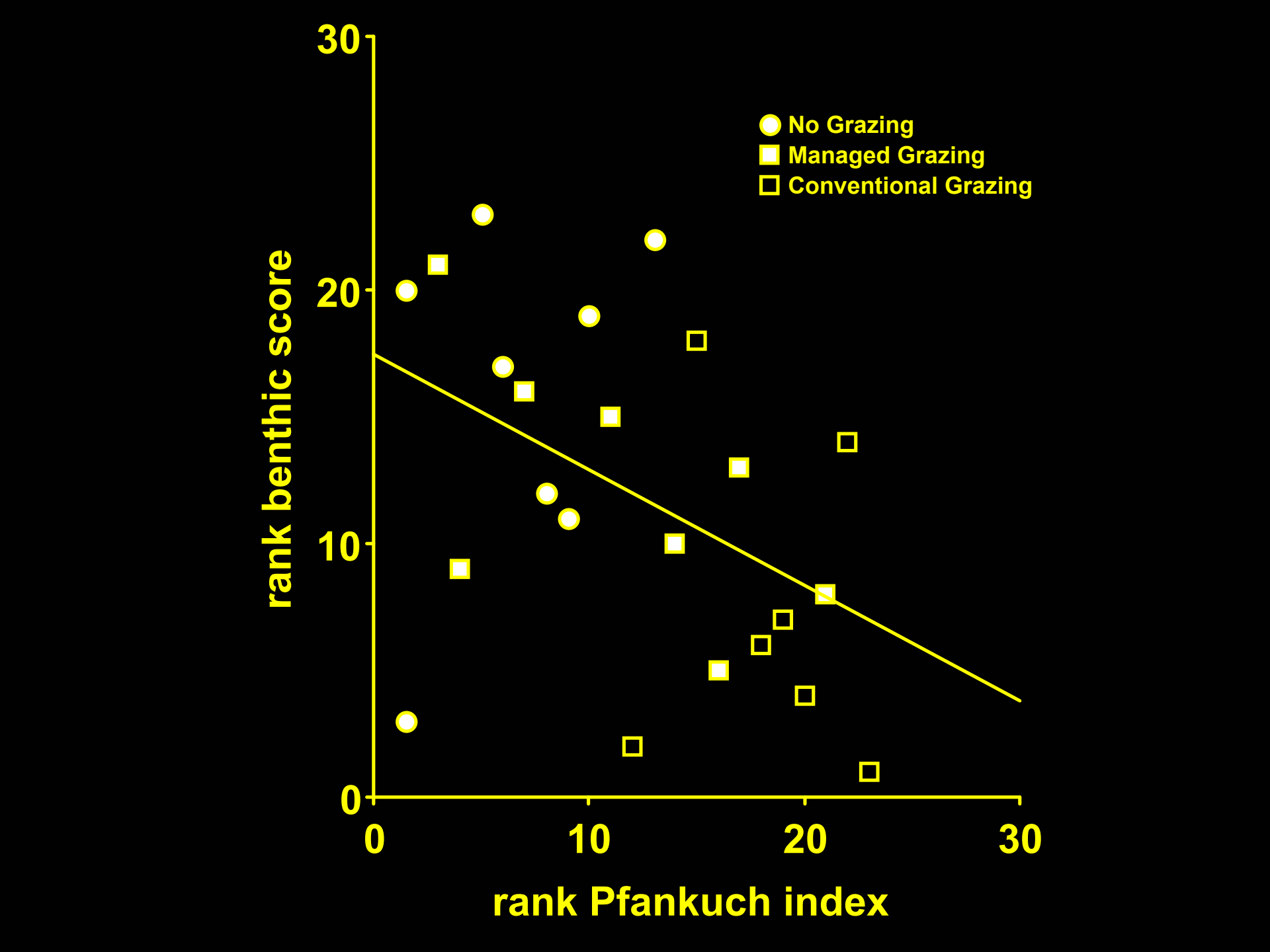
Grazing in riparian areas

- Three treatments:
  non-grazed (NG),
  conventionally grazed (CG), and
  managed grazed (MG)

- Drainage area range from < 1 km^2 to > 120 km^2
- 4 watershed metrics,
- 5 riparian management metrics,
- 21 channel response metrics
  (including channel stability index), and
- a benthic macroinvertebrate index of biotic integrity

Grazing in riparian areas

- Important variables from analysis
  - soil compaction
  - vegetation (trees and grass)
  - vegetation height
  - channel stability index
  - size of streambed substrate (D_{84})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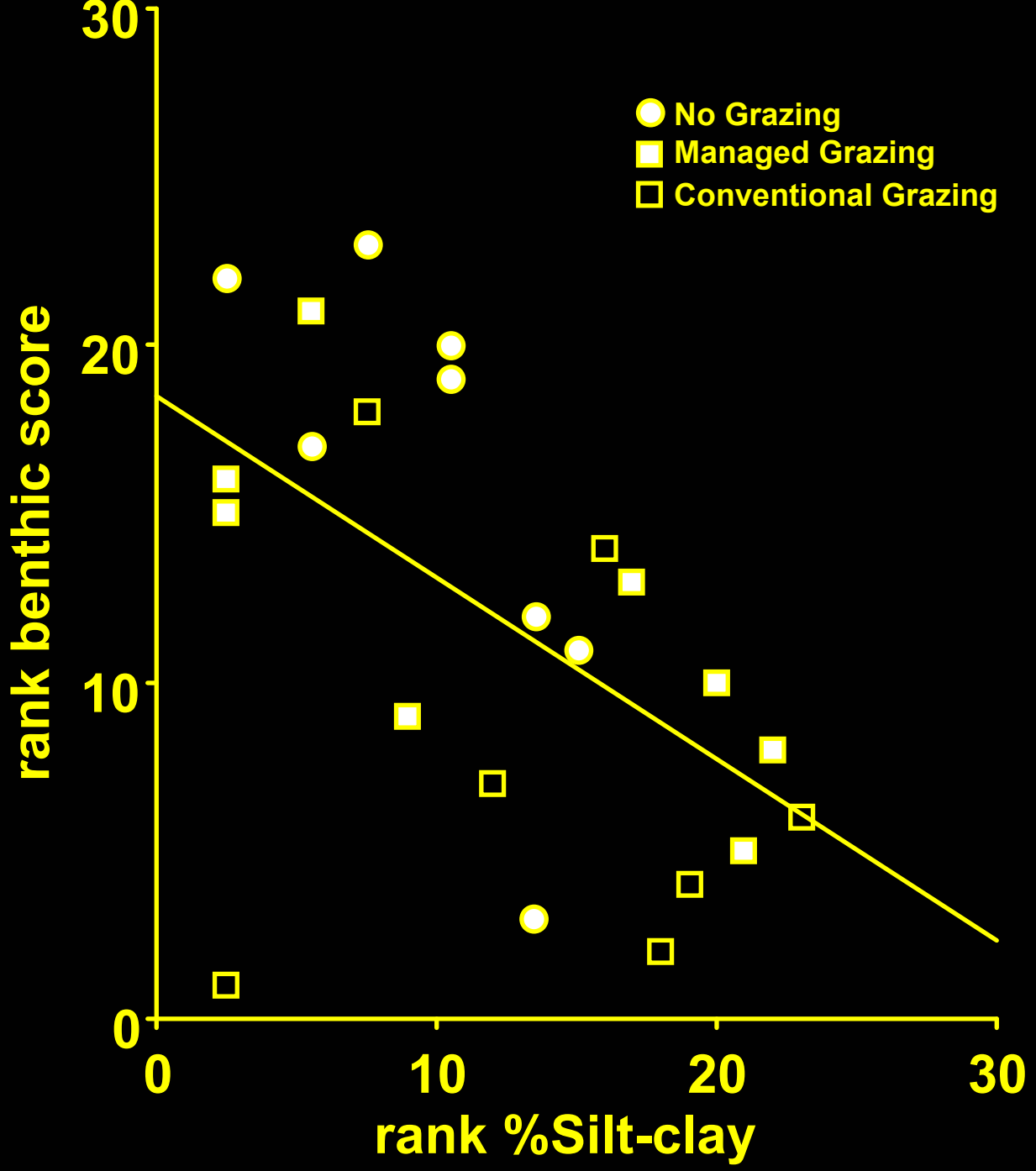
No Grazing
Managed Grazing
Conventional Grazing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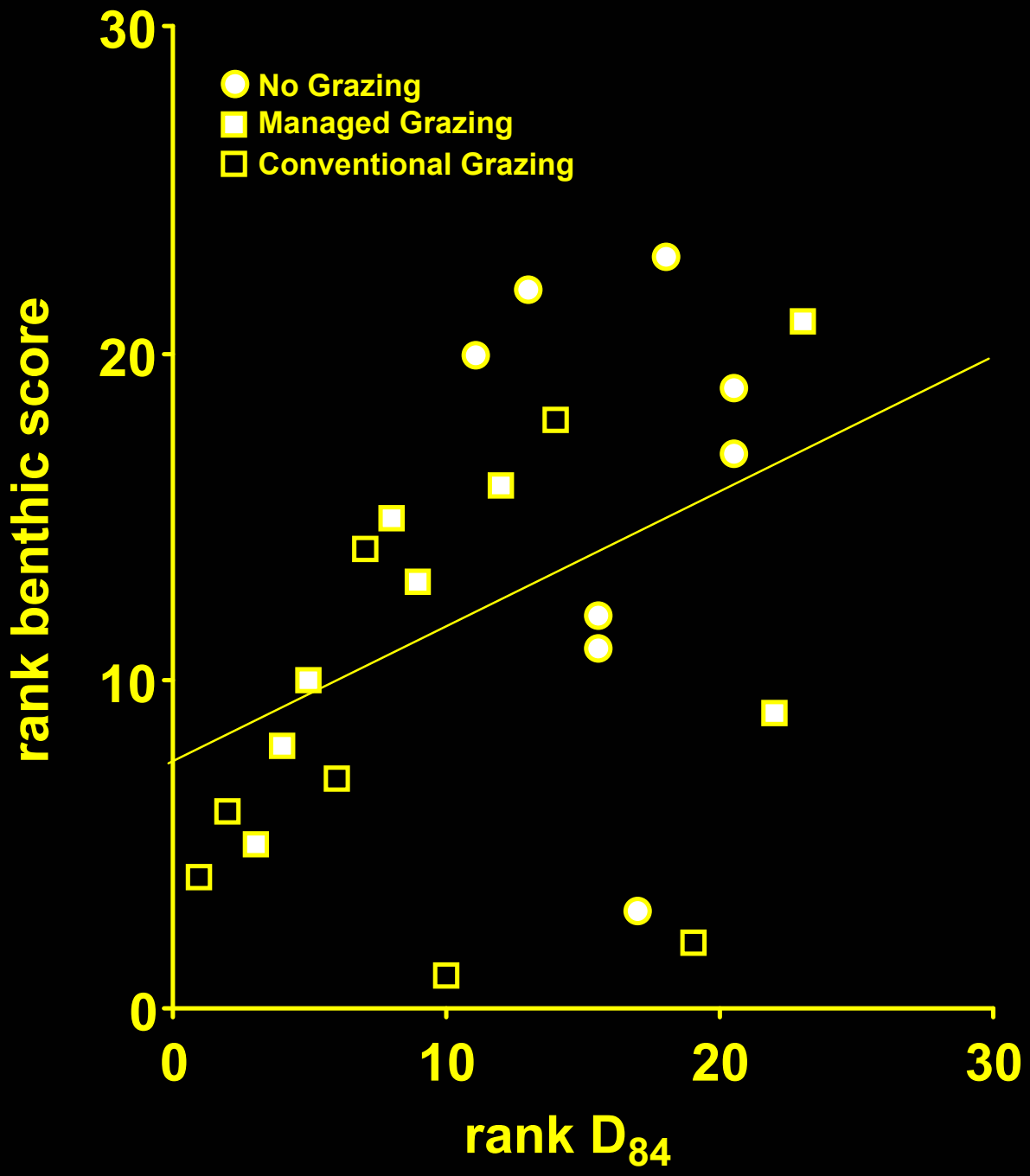
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