Lower Minnesota River Watershed District
USGS/USACE Sediment Monitoring
2014 Preliminary Report Presentation

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Provisional Data Statement

- Data are provisional and subject to revision until they have been thoroughly reviewed and received final approval.

- Provisional data may be inaccurate due to instrument malfunctions or physical changes at the measurement site. Subsequent review based on field inspections and measurements may result in significant revisions to the data.

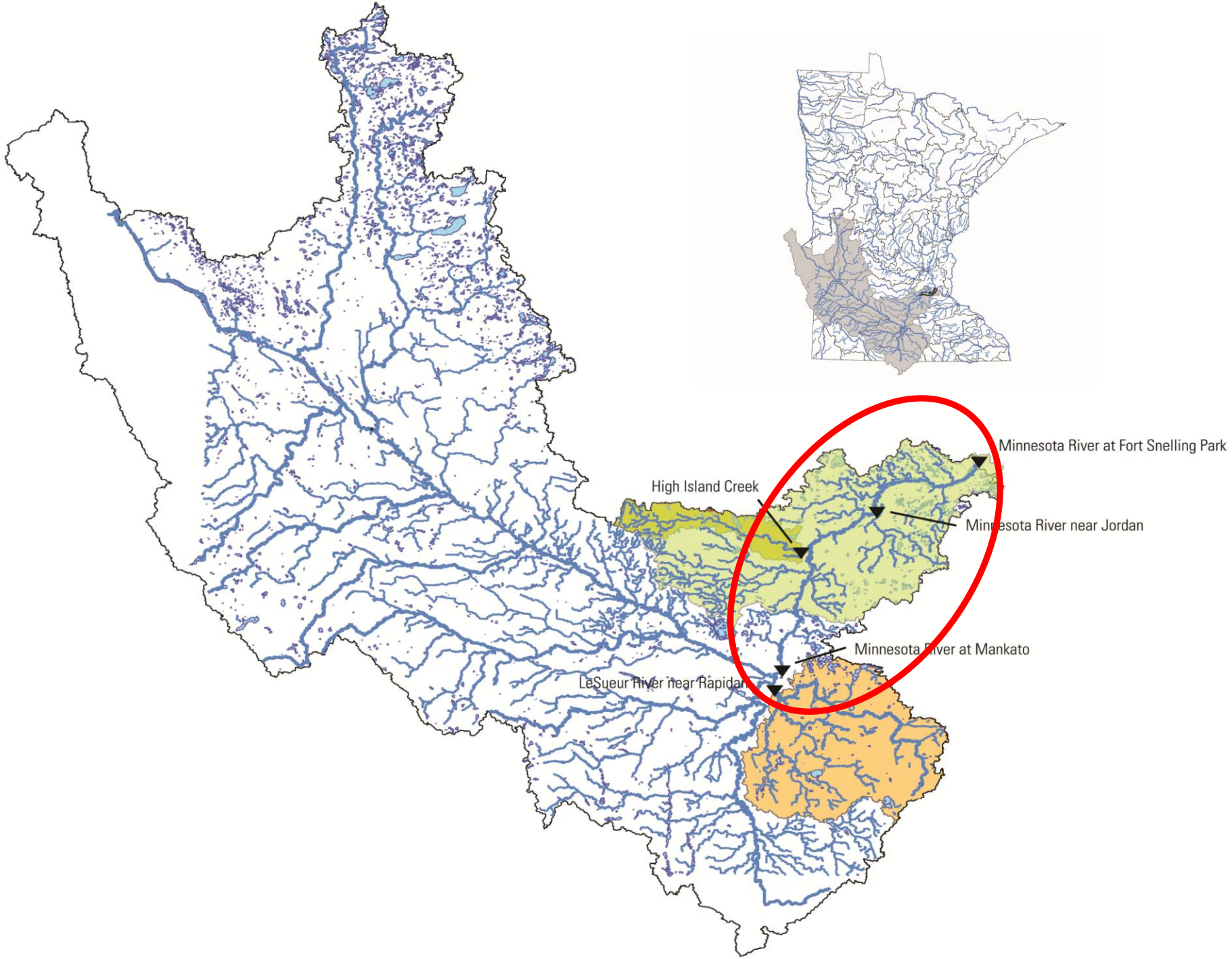
- Data users are cautioned to consider carefully the provisional nature of the information before using it for decisions that concern personal or public safety or the conduct of business that involves substantial monetary or operational consequences.

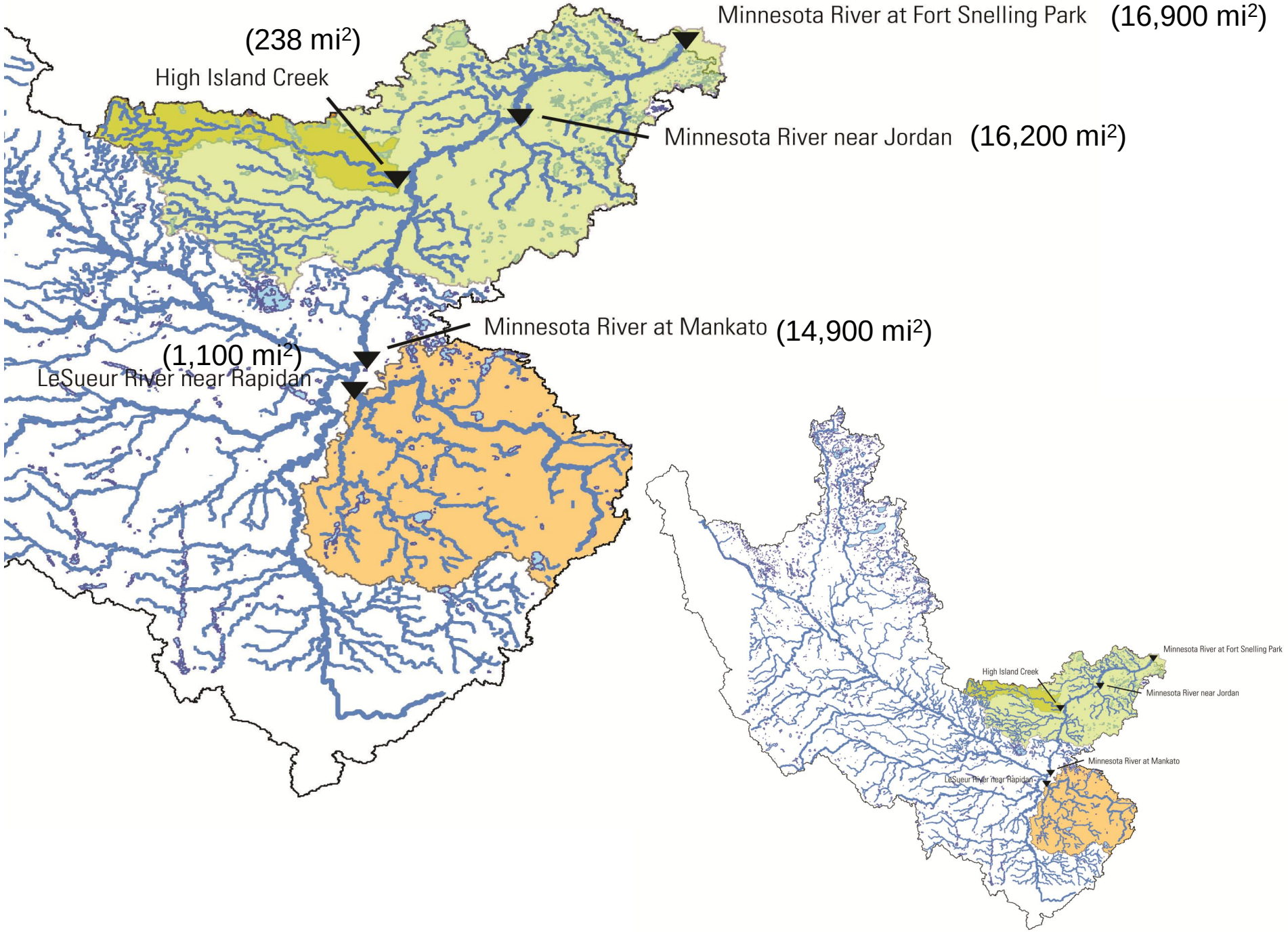
- Information concerning the accuracy and appropriate uses of these data or concerning other hydrologic data may be obtained from the USGS.

Problem and Background

- Current data are needed to quantify the sediment loads from the Minnesota and Mississippi Rivers at their confluence
- USACE required to maintain 9-foot navigation channel through dredging
- MPCA Lake Pepin TMDL and Lake Pepin Legacy Alliance; 80 – 90% of sediment entering Lake Pepin attributed to Minnesota River
- LMRWD is charged with identifying disposal sites for dredged materials

USGS


Minnesota River at Fort Snelling Park
High Island Creek
Minnesota River near Jordan
Minnesota River at Mankato
LeSueur River near Rapidan


Minnesota River at Fort Snelling Park (16,900 mi²)
(238 mi²)
High Island Creek
Minnesota River near Jordan (16,200 mi²)
Minnesota River at Mankato (14,900 mi²)
(1,100 mi²)
LeSueur River near Rapidan
Minnesota River at Fort Snelling Park
High Island Creek
Minnesota River near Jordan
Minnesota River at Mankato
LeSueur River near Rapidan

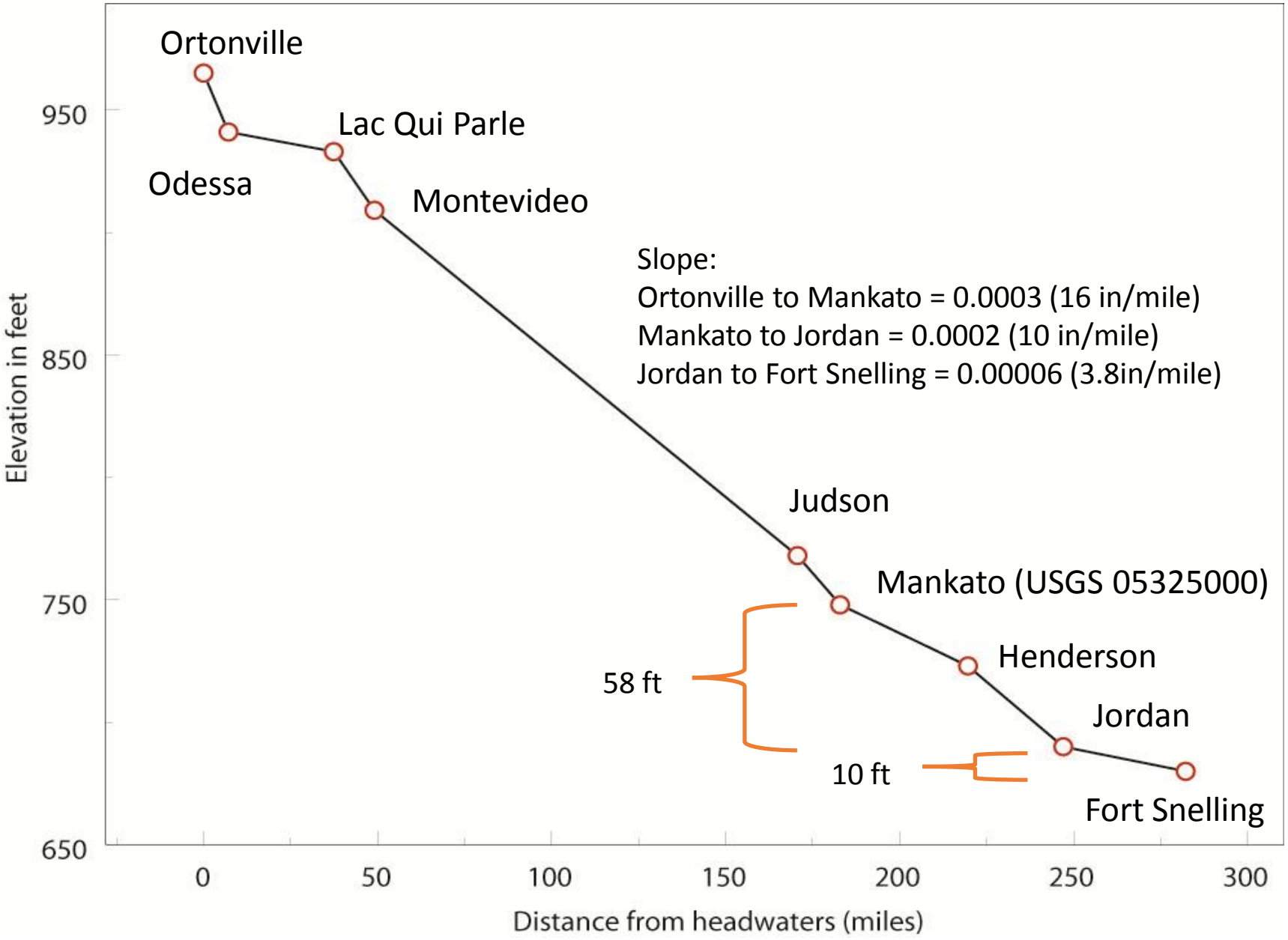
LeSueur River

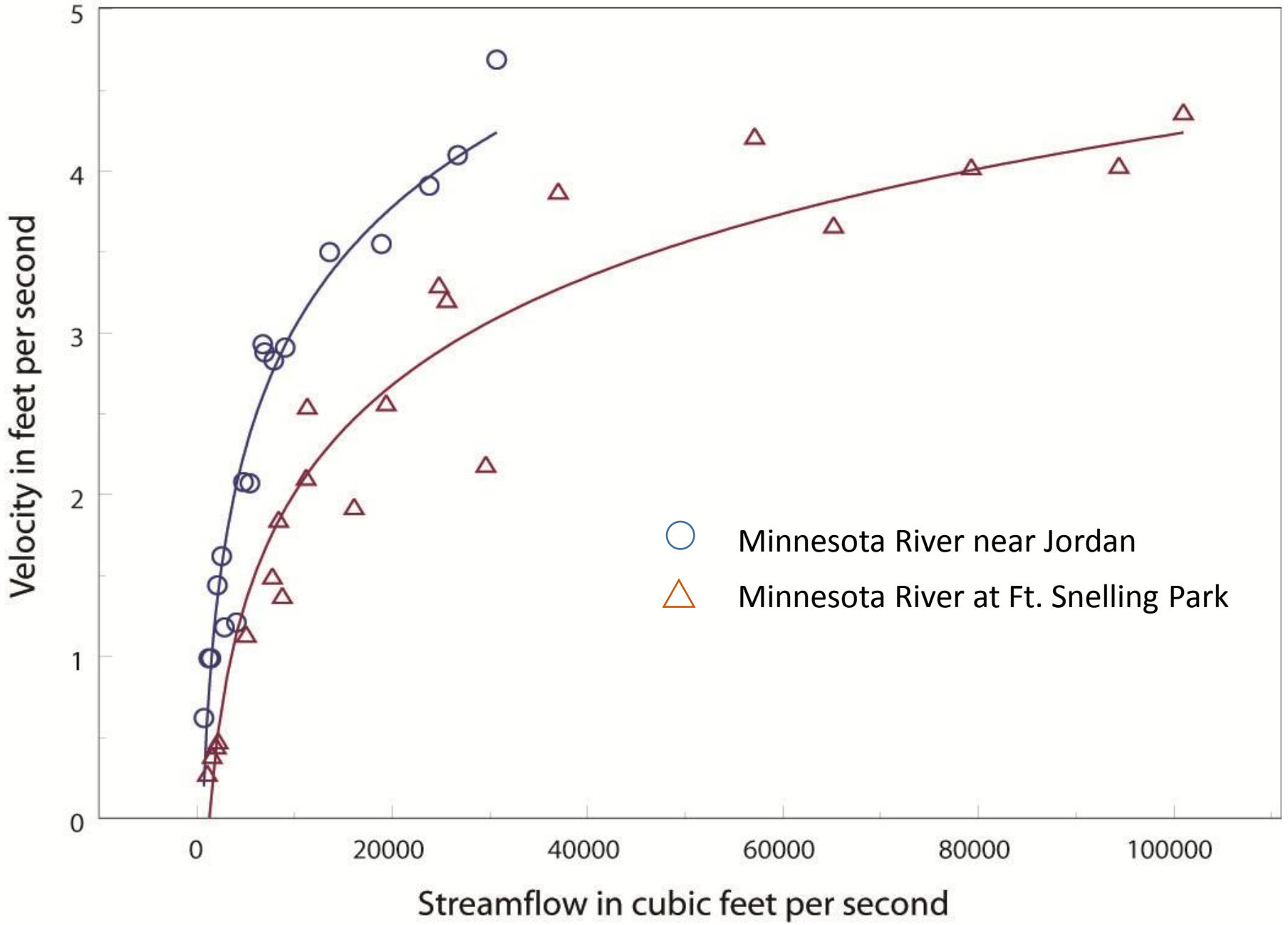
Minnesota River at Mankato

High Island Creek

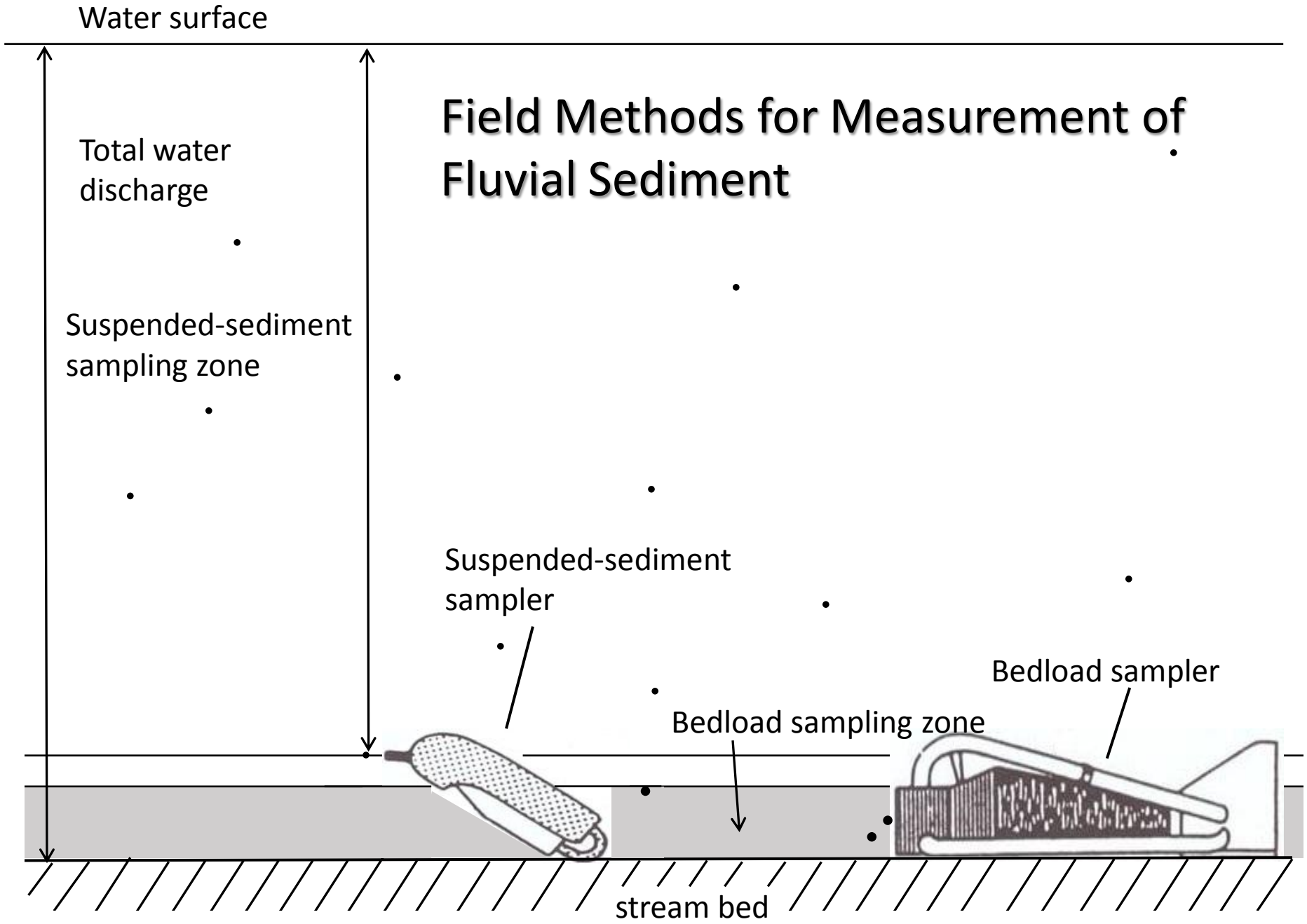

Minnesota River at Jordan (5/10/2012)
Streamflow = 18,100 cfs
Streamflow = 861 cfs

Minnesota River at Fort Snelling

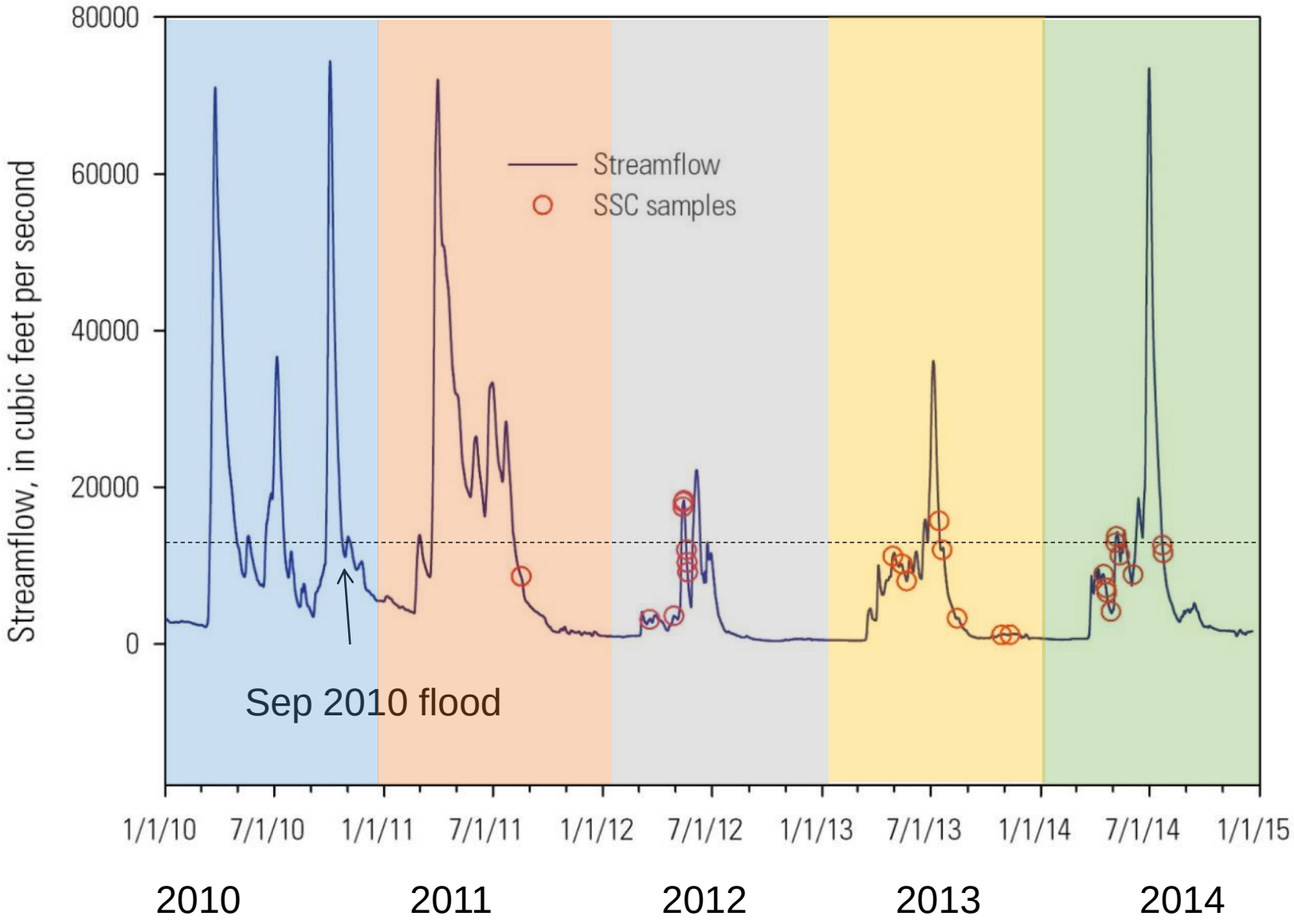

Ortonville
Lac Qui Parle
Odessa
Montevideo
Slope:
Ortonville to Mankato = 0.0003 (16 in/mile)
Mankato to Jordan = 0.0002 (10 in/mile)
Jordan to Fort Snelling = 0.00006 (3.8in/mile)
Judson
Mankato (USGS 05325000)
Henderson
58 ft
Jordan
10 ft
Fort Snelling
Elevation in feet
950
850
750
650
0
50
100
150
200
250
300
Distance from headwaters (miles)


Velocity in feet per second
5
4
3
2
1
0
0
20000
40000
60000
80000
100000
Streamflow in cubic feet per second
Minnesota River near Jordan
Minnesota River at Ft. Snelling Park

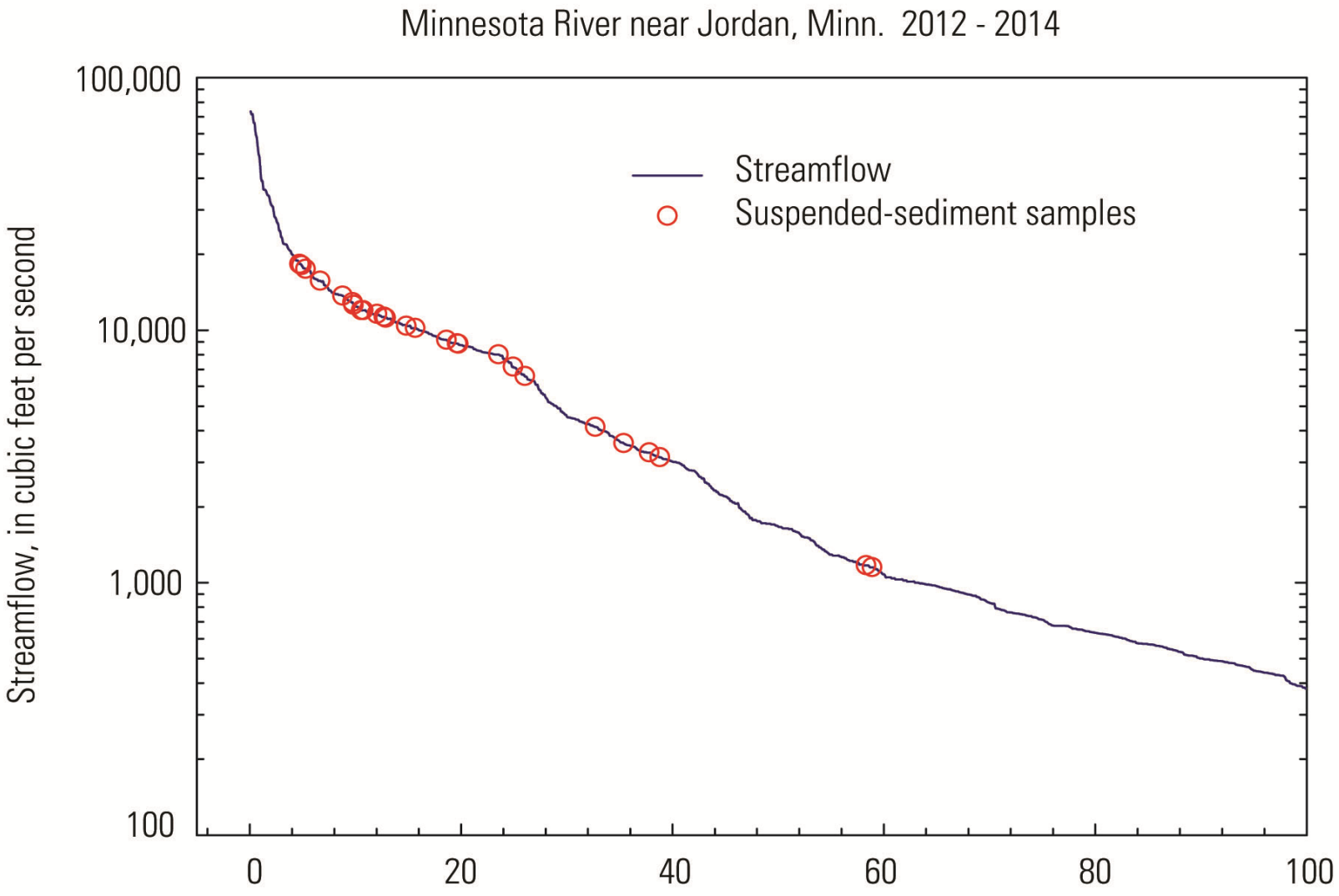
Field Methods for Measurement of Fluvial Sediment



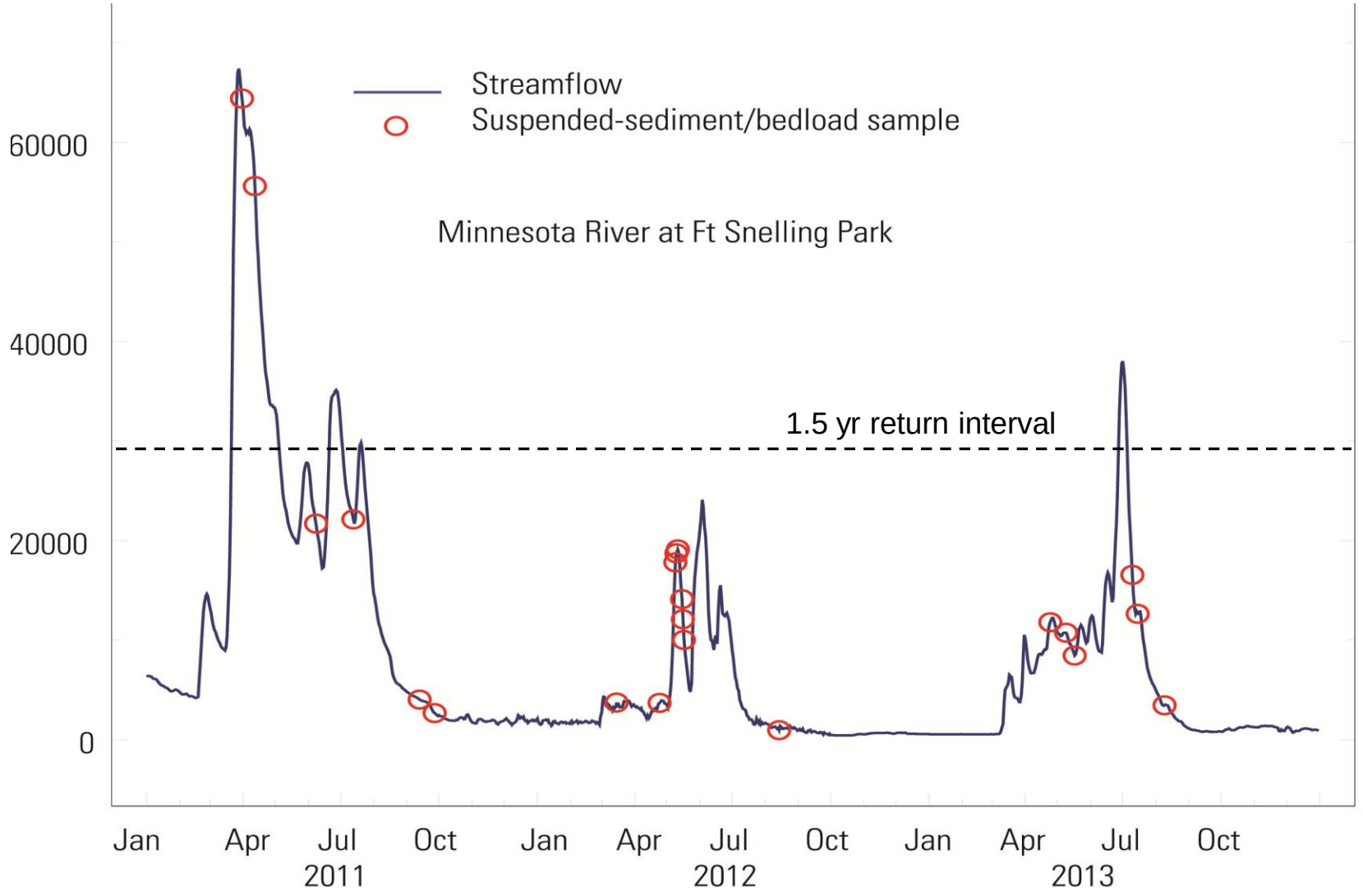
Minnesota River near Jordan



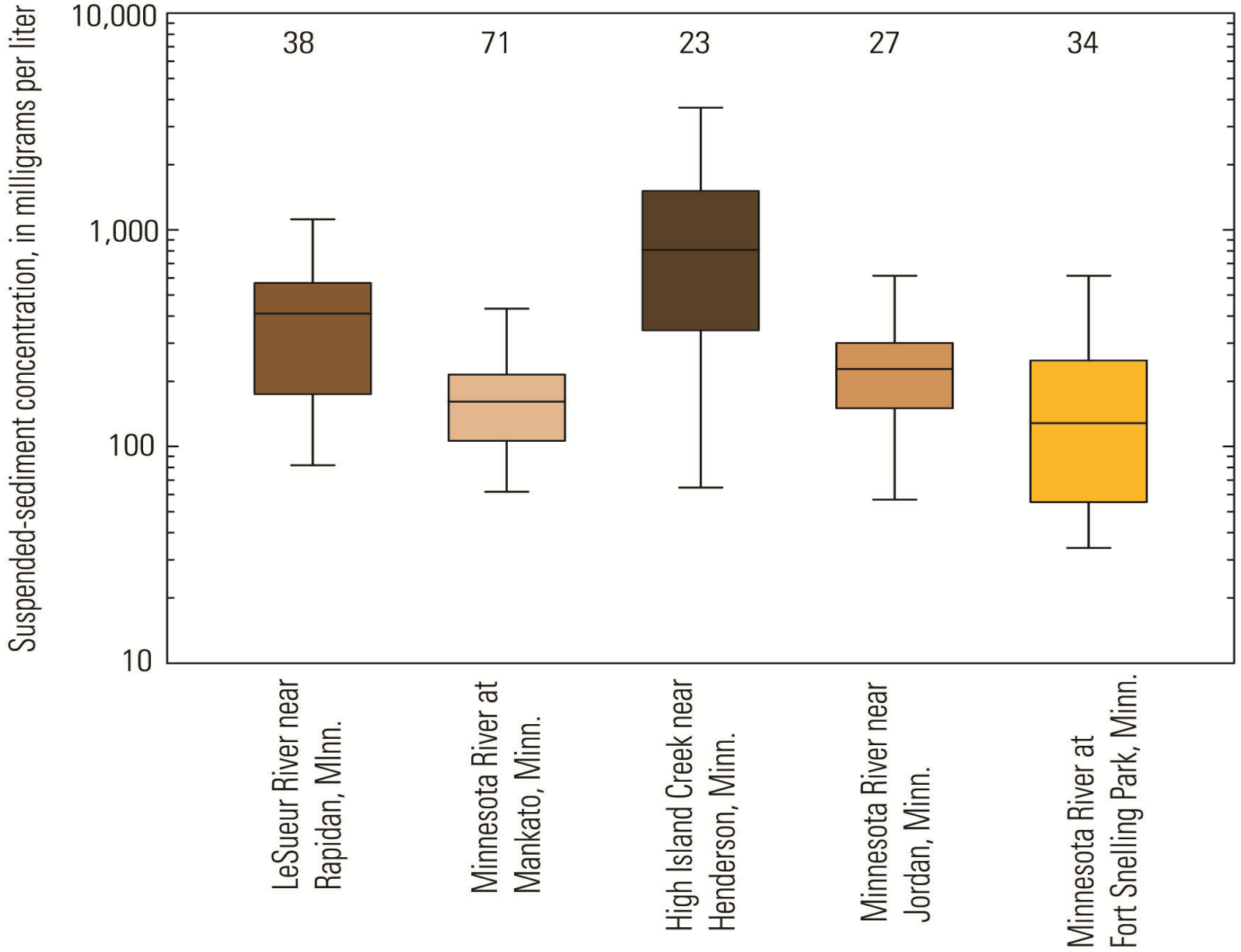
Flow Duration Curve



Sampling points on the hydrograph

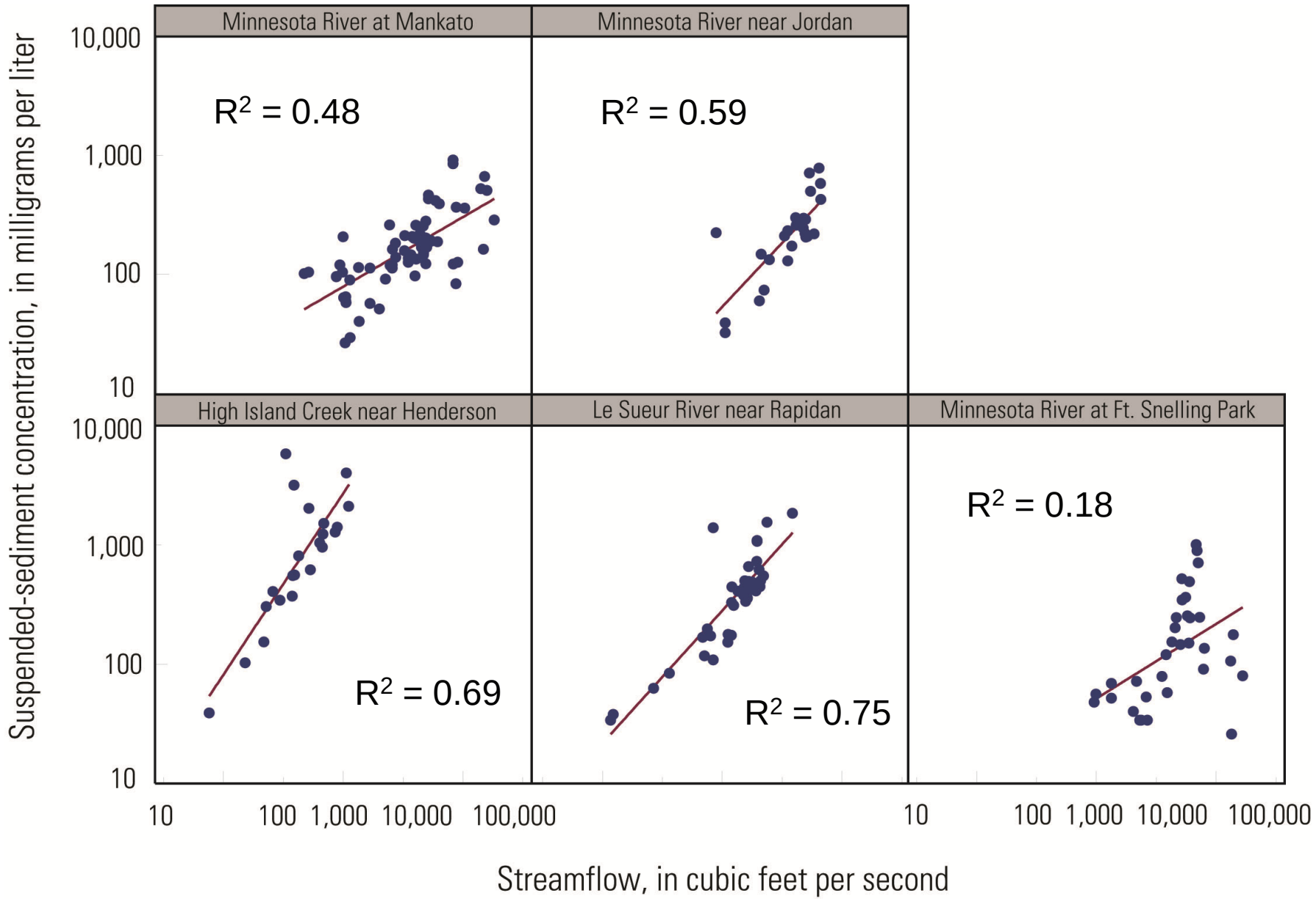


Suspended-sediment concentrations, 2011 - 2014

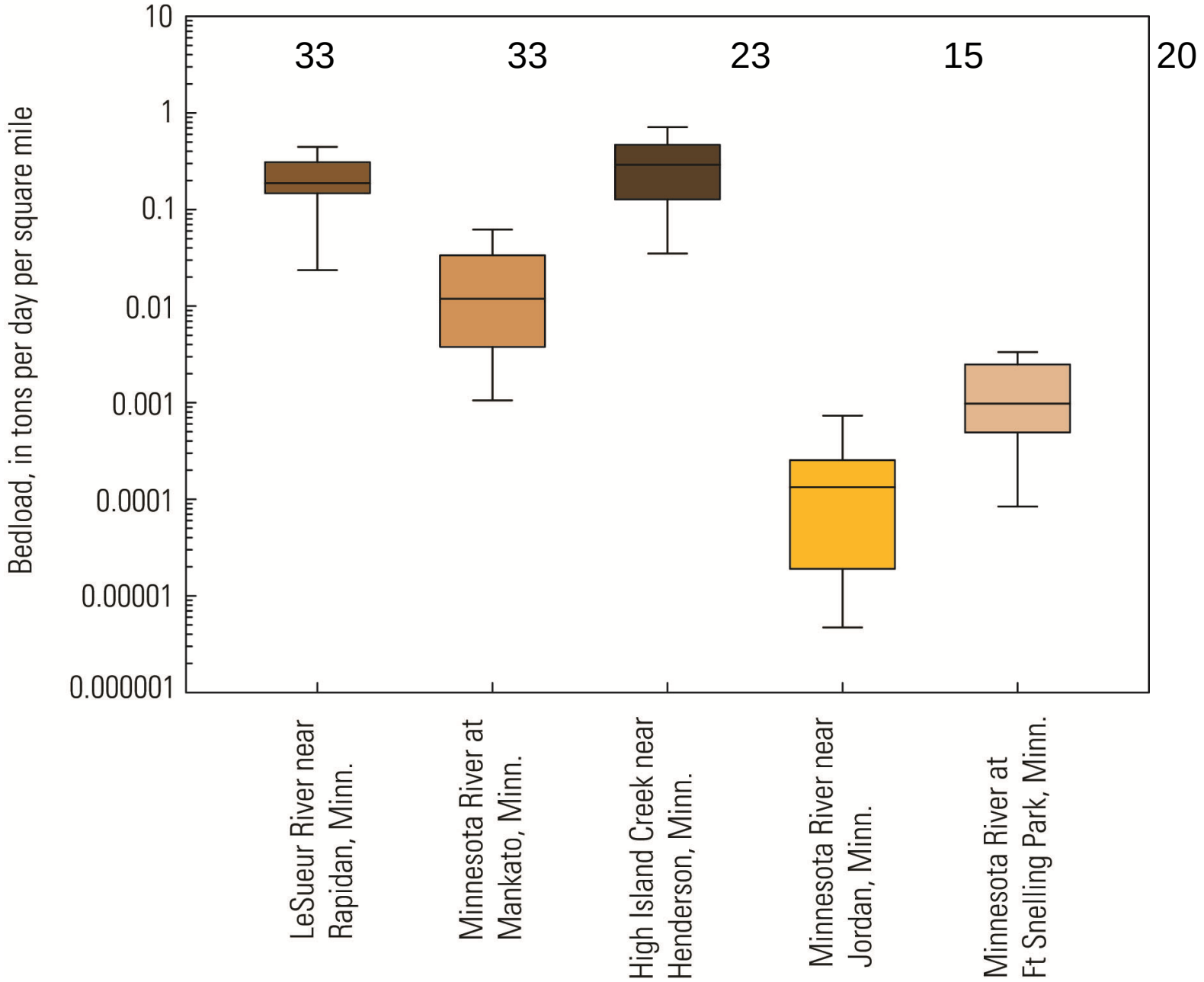


Station Name	Range of Streamflow sampled (ft^3/s)	Mean SSC (mg/L)	Median SSC (mg/L)	Range of SSC (mg/L)
LeSueur River near Rapidan, MN	47 – 7,320	**493**	**411**	34 – 1,843
Minnesota River at Mankato, MN	314 – 78,100	**208**	**161**	27 - 927
High Island Creek near Henderson, MN	57 - 969	**1,254**	**809**	39 – 5,830
Minnesota River near Jordan, MN	900 – 18,300	**272**	**228**	33 - 794
Minnesota River at Ft. Snelling, MN	948 – 67,600	**216**	**128**	26 – 1,010

Total suspended-sediment concentration relation to streamflow

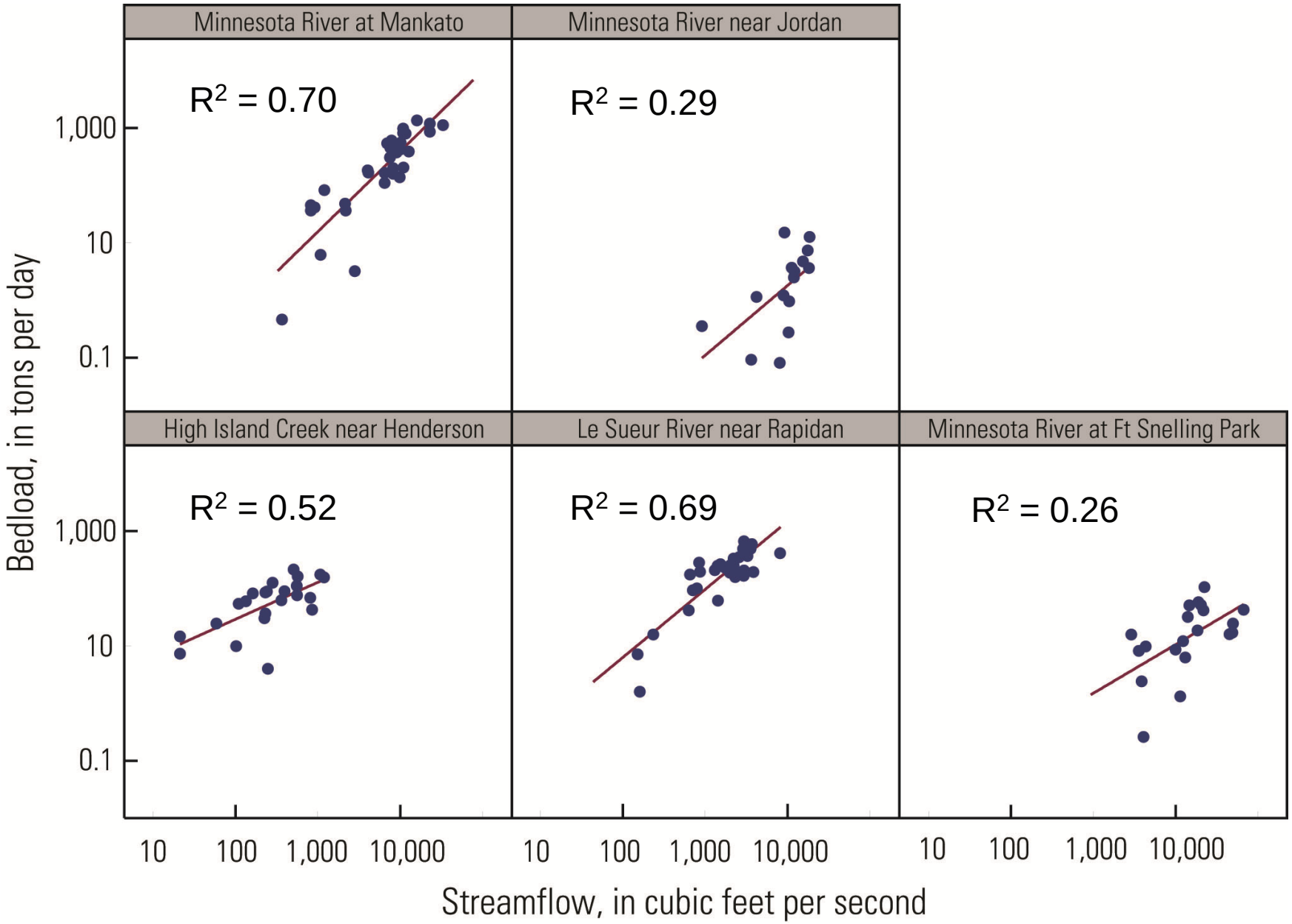


Bedload transport, 2012 - 2014

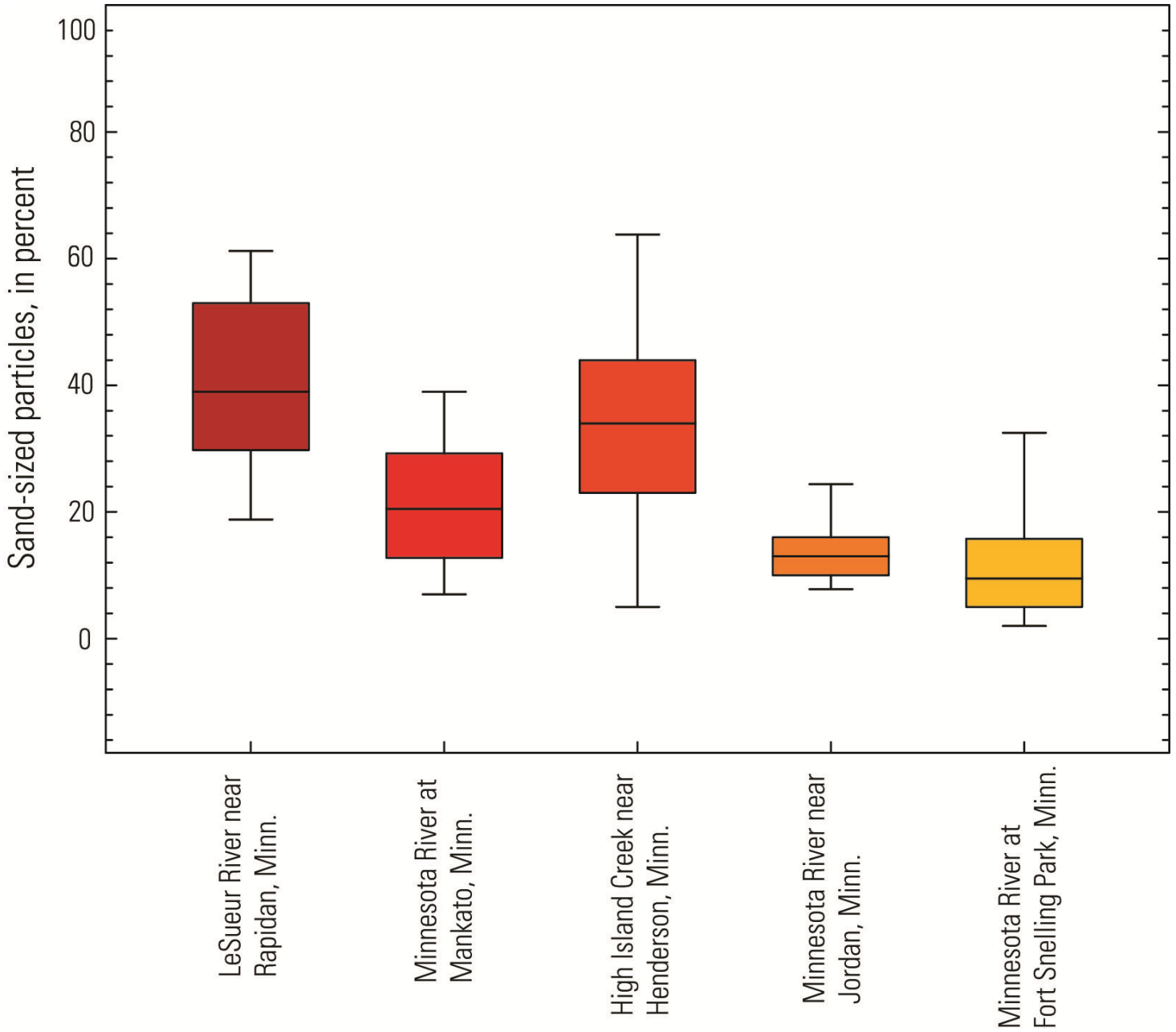


Station Name	Mean bedload (tons/day)	Median bedload (tons/day)	Range of bedload (tons/day)
LeSueur River near Rapidan, MN	**246**	**207**	2 – 661
Minnesota River at Mankato, MN	**340**	**178**	0.4- 1,170
High Island Creek near Henderson, MN	**77**	**69**	4 – 214
Minnesota River near Jordan, MN	**3.3**	**2.2**	0.1 - 13
Minnesota River at Ft. Snelling, MN	**26**	**16**	0.3– 105

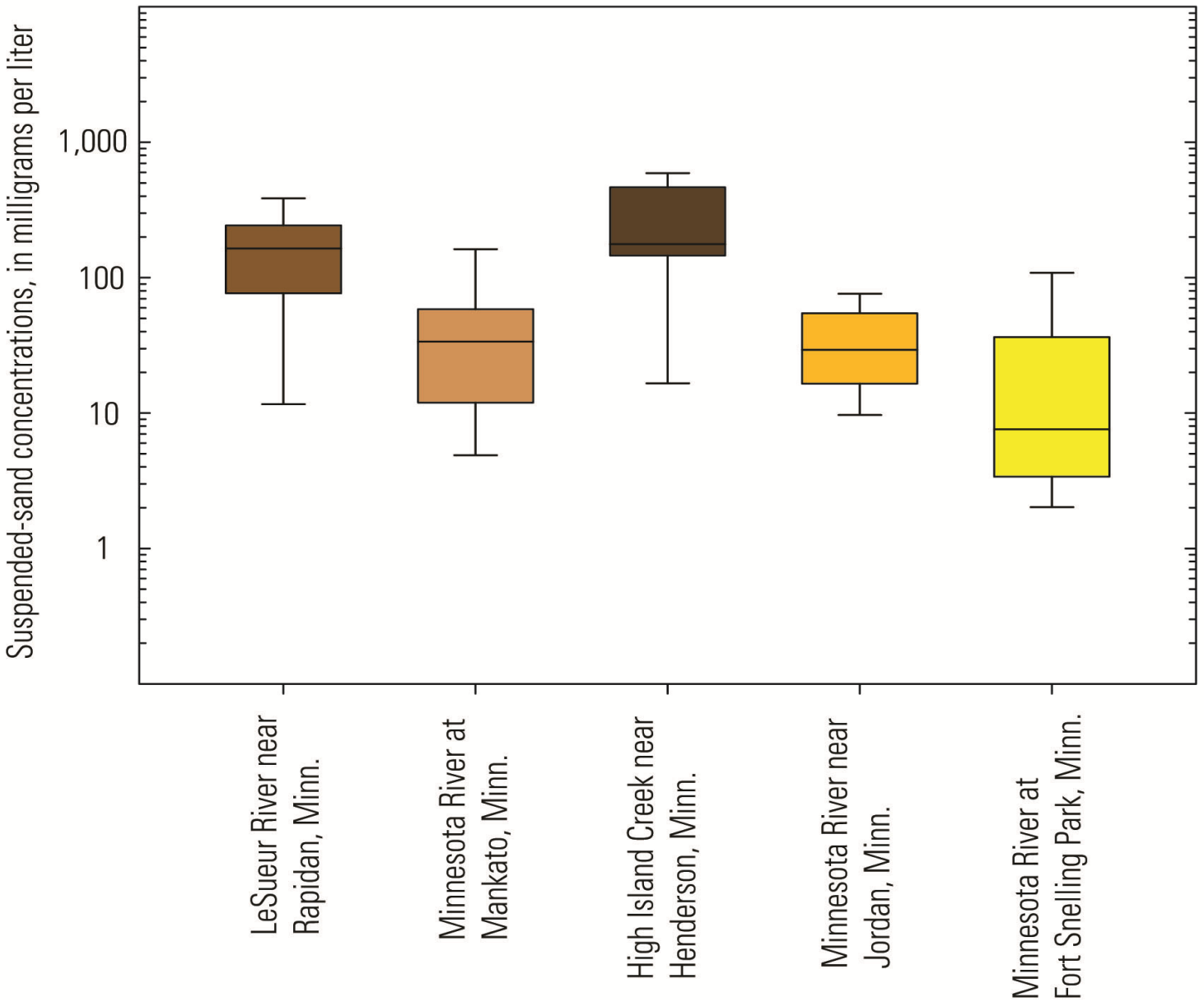
Bedload relation to streamflow, 2012 - 2014



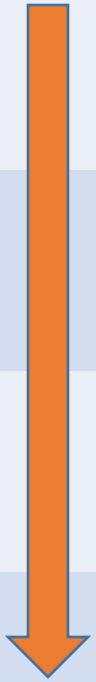
Sand-sized particles in suspension, in percent



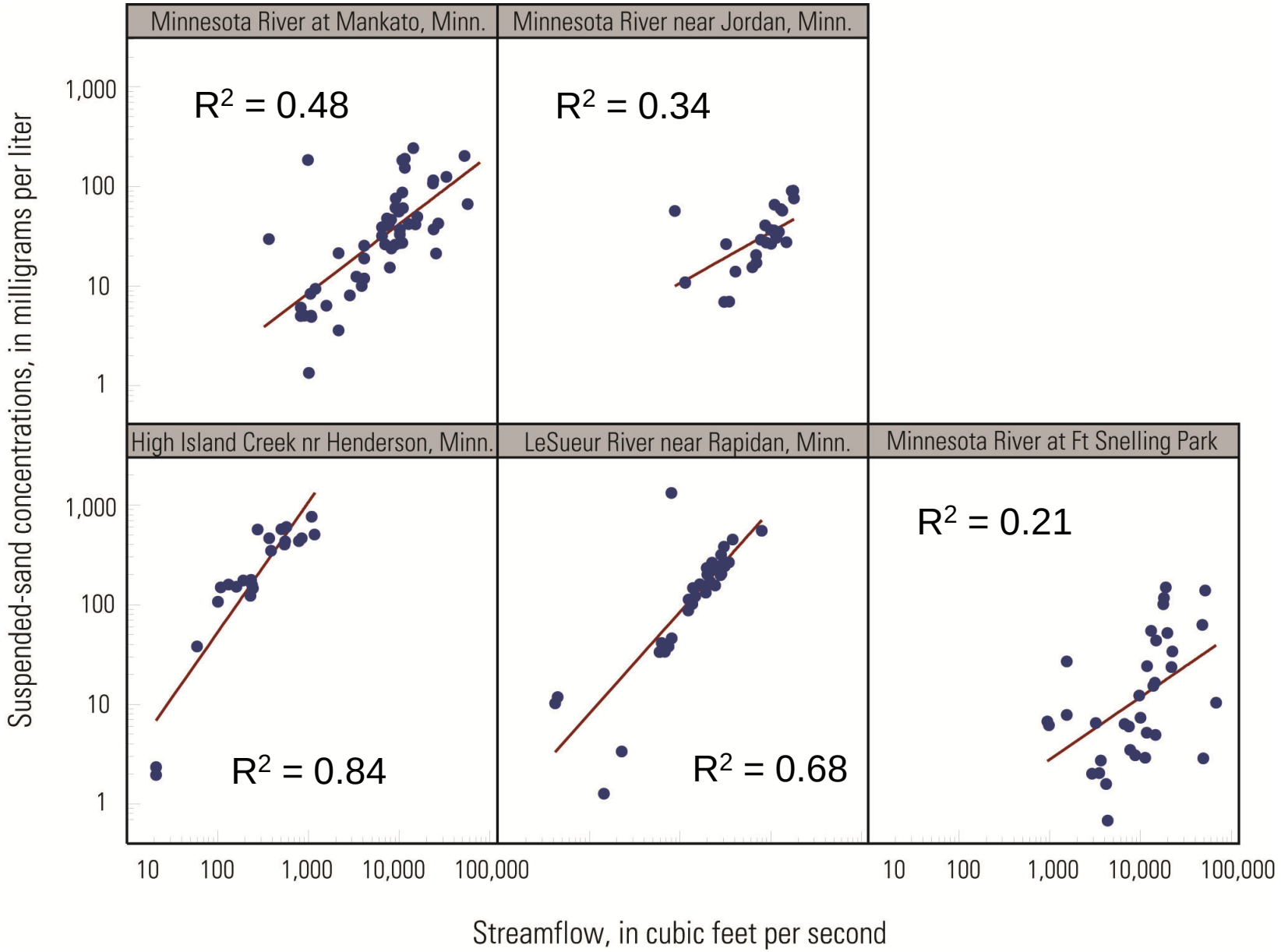
Sand-sized concentrations in suspension



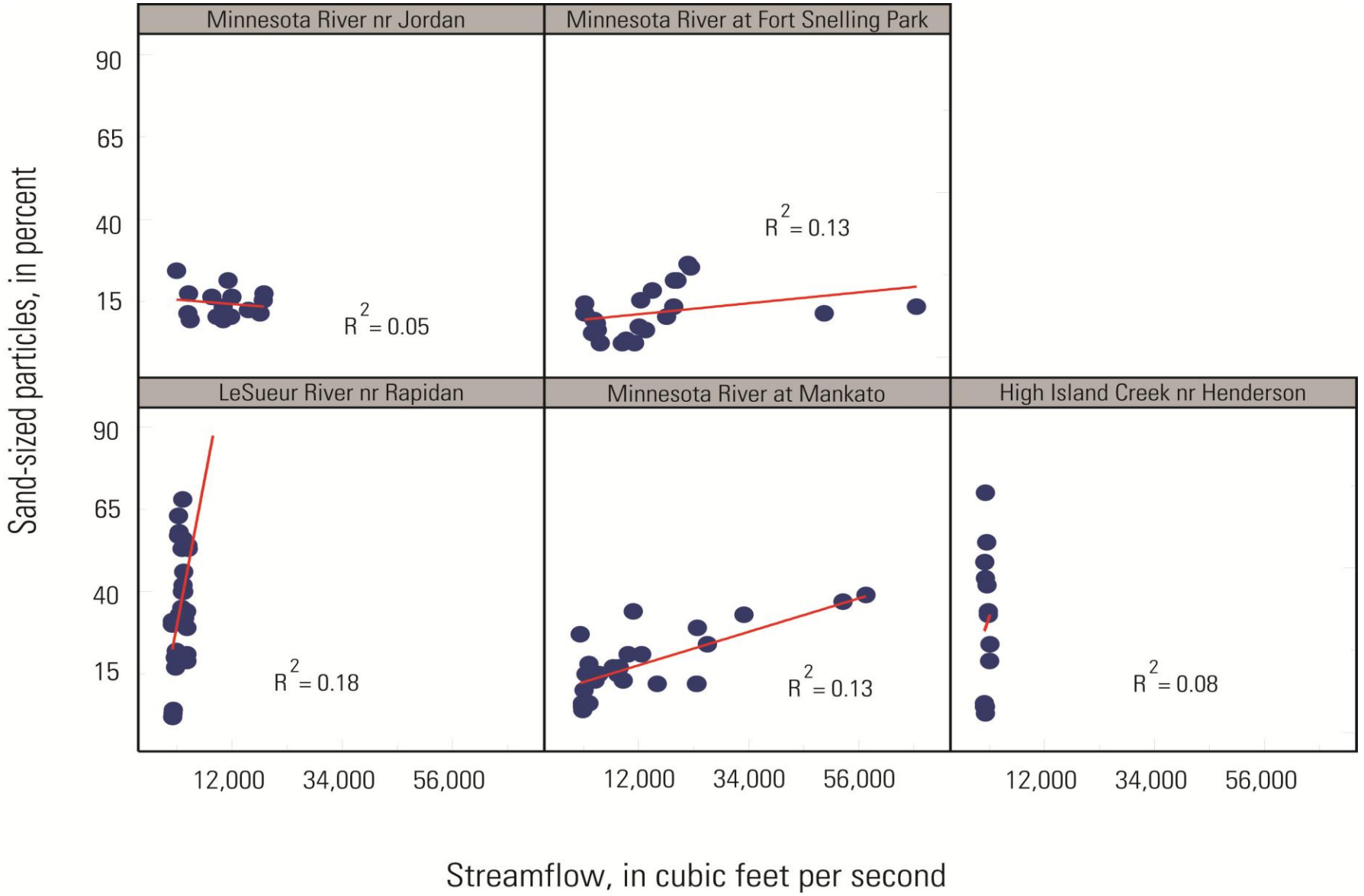
Station Name	Mean sand-sized particles (mg/L)	Median sand-sized particles (mg/L)	Range of sand-sized particles (mg/L)
LeSueur River near Rapidan, MN	**204**	**164**	1 – 1,320
Minnesota River at Mankato, MN	**51**	**34**	1 - 236
High Island Creek near Henderson, MN	**302**	**177**	2 - 760
Minnesota River near Jordan, MN	**35**	**29**	7 - 88
Minnesota River at Ft. Snelling, MN	**28**	**8**	1 - 149



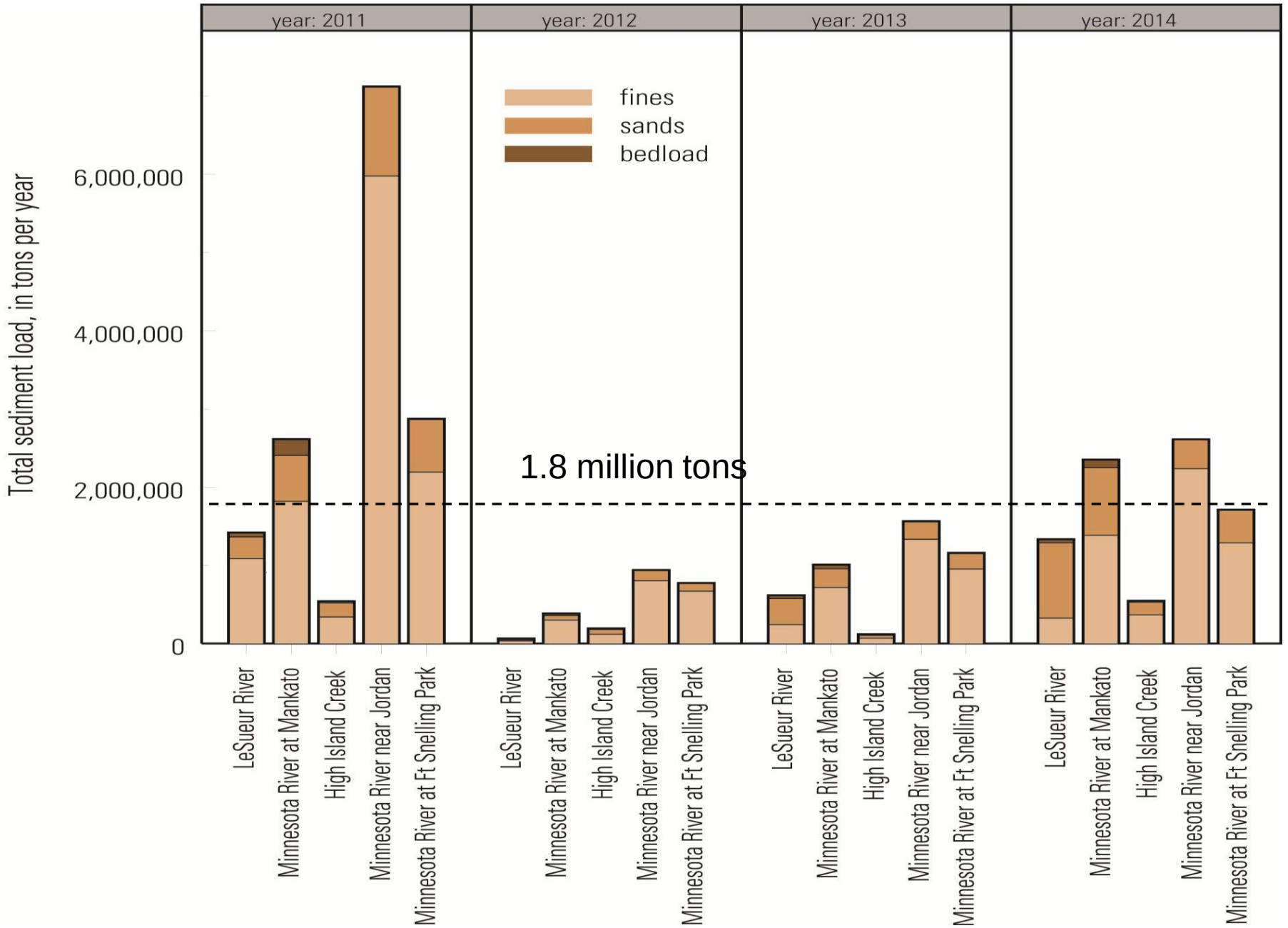
Suspended-sand concentrations relation to streamflow



Sand-sized particles (percent) relation to streamflow



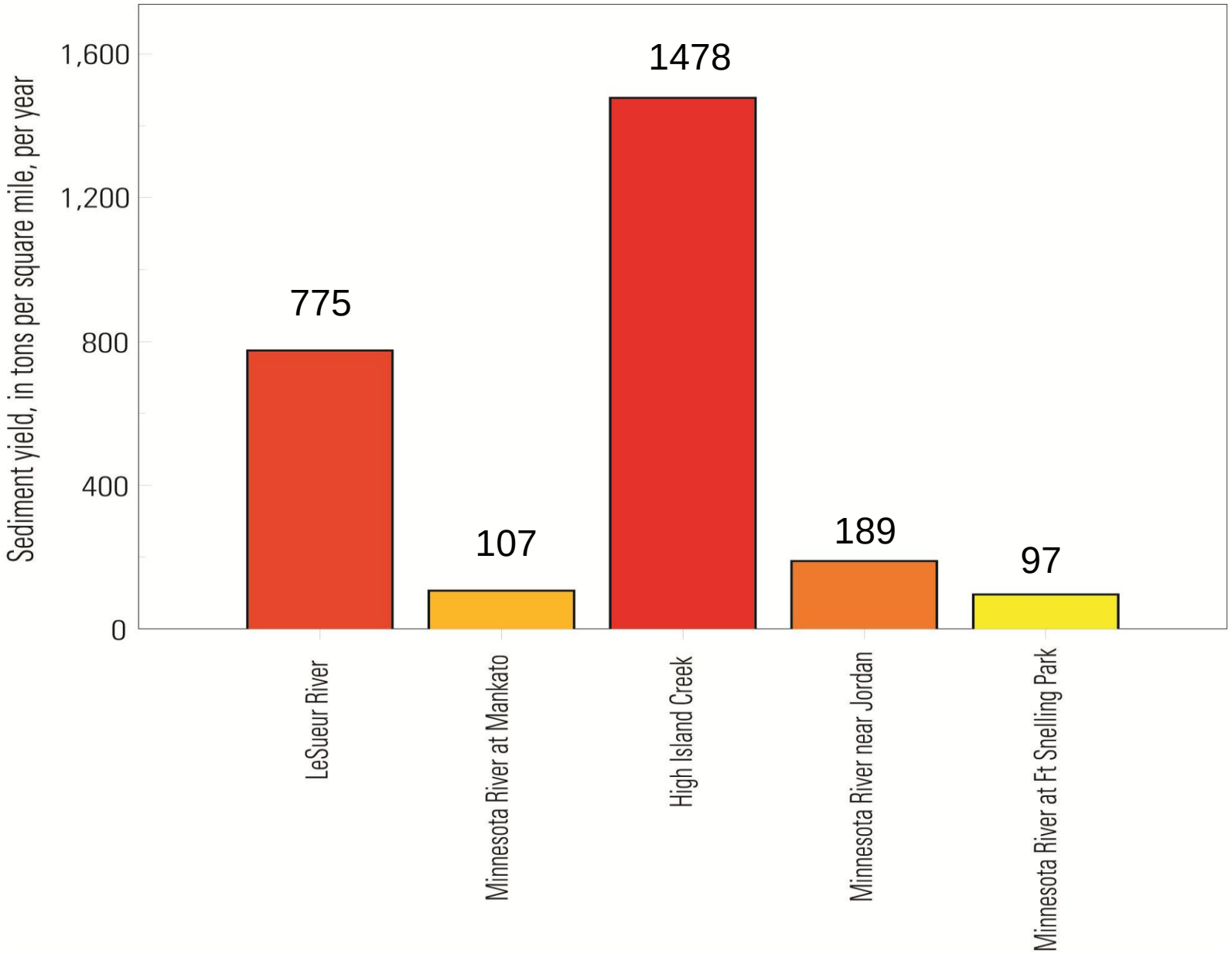
Total Sediment Loads, 2011 through 2014



Total Sediment Loads 2011 - 2014

Station Name	Fines (tons)	Sands (tons)	Bedload (tons)	Total Load (tons)	Average Annual Load
LeSueur River near Rapidan, MN	1,717,995	1,589,383	134,572	3,441,950	860,488
Minnesota River at Mankato, MN	4,250,478	1,750,972	360,425	6,361,875	1,590,469
High Island Creek near Henderson, MN	921,728	442,200	43,396	1,407,324	351,831
Minnesota River near Jordan, MN	10,379,019	1,860,649	1,745	12,241,413	3,060,353
Minnesota River at Ft. Snelling, MN	5,130,626	1,381,756	11,300	6,523,682	1,630,921

Sediment Yield by Basin 2011 - 2014



Bedload Particle Sizes

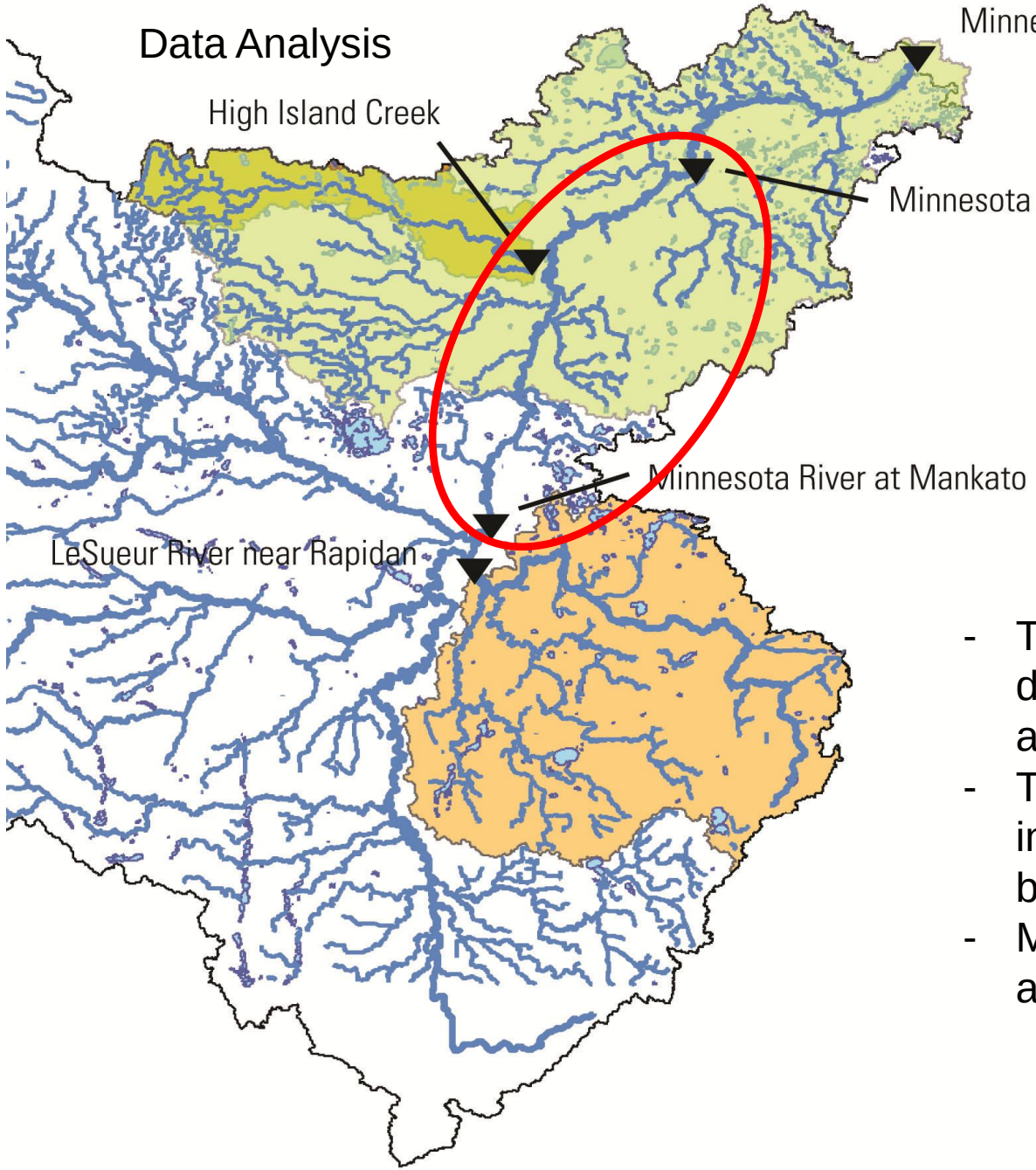
table values are in percent (sand sizes 0.062 – 2 mm)

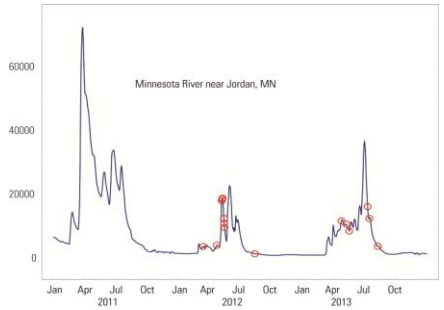
Site	< .062mm	<.125mm	<.25mm	<.5mm	<1mm	<2mm	<4mm	<8mm	<16mm
LeSueur River	0.0	0.0	0.6	15.2	42.8	63.9	78.7	88.6	95.4
Minnesota River at Mankato	0.1	6.1	7.7	32.4	66.6	83.4	92.8	97.5	99.7
High Island Creek	0.1	0.7	6.5	38.7	65.6	79.3	87.8	94.1	98.1
Minnesota River near Jordan	0.5	1.5	6.5	57.9	85.0	93.1	97.8	99.9	100.0
Minnesota River at Ft Snelling Park	4.3	7.8	28.3	69.6	88.3	94.6	97.2	98.5	98.8

Sand sized

Pebbles

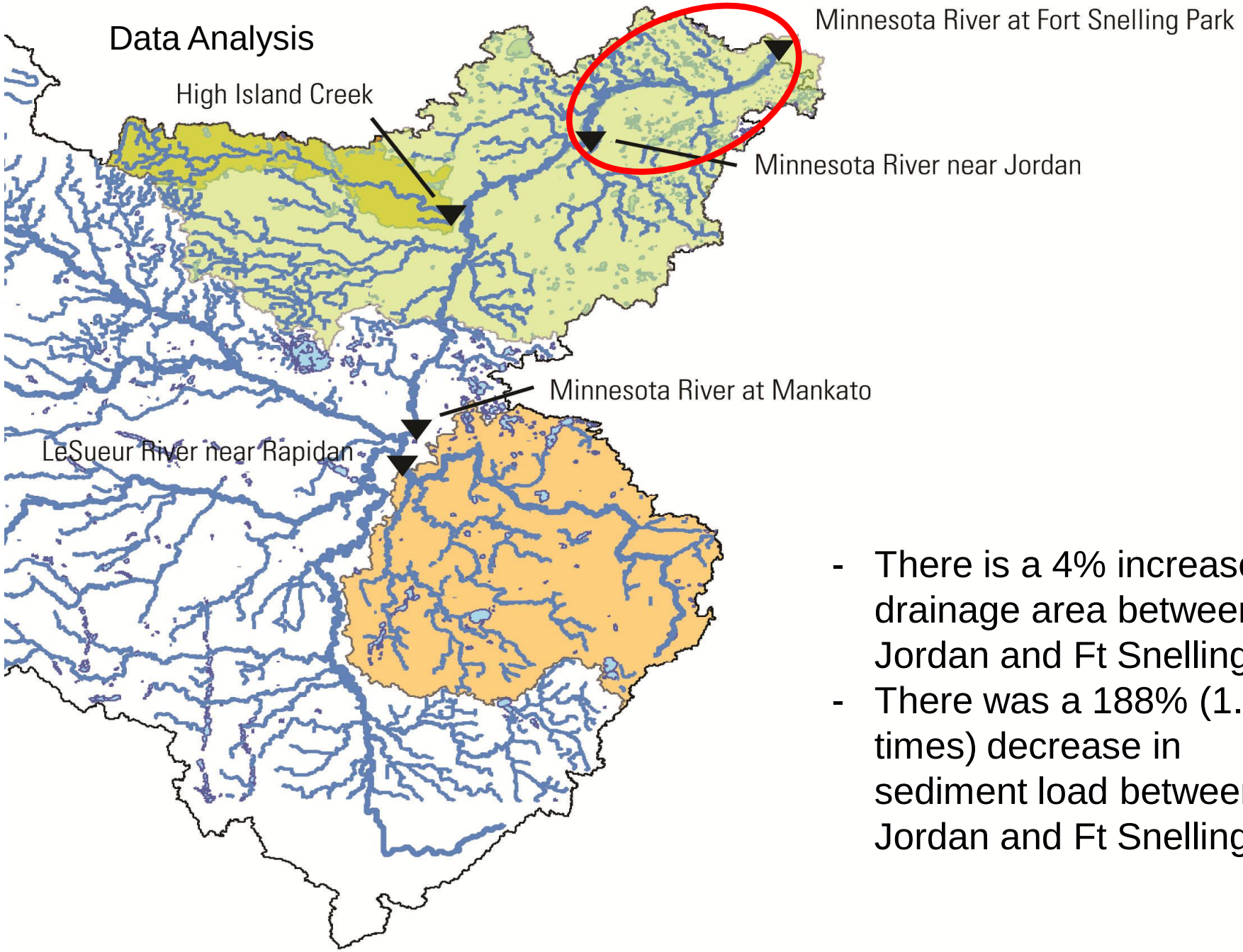
Data Analysis





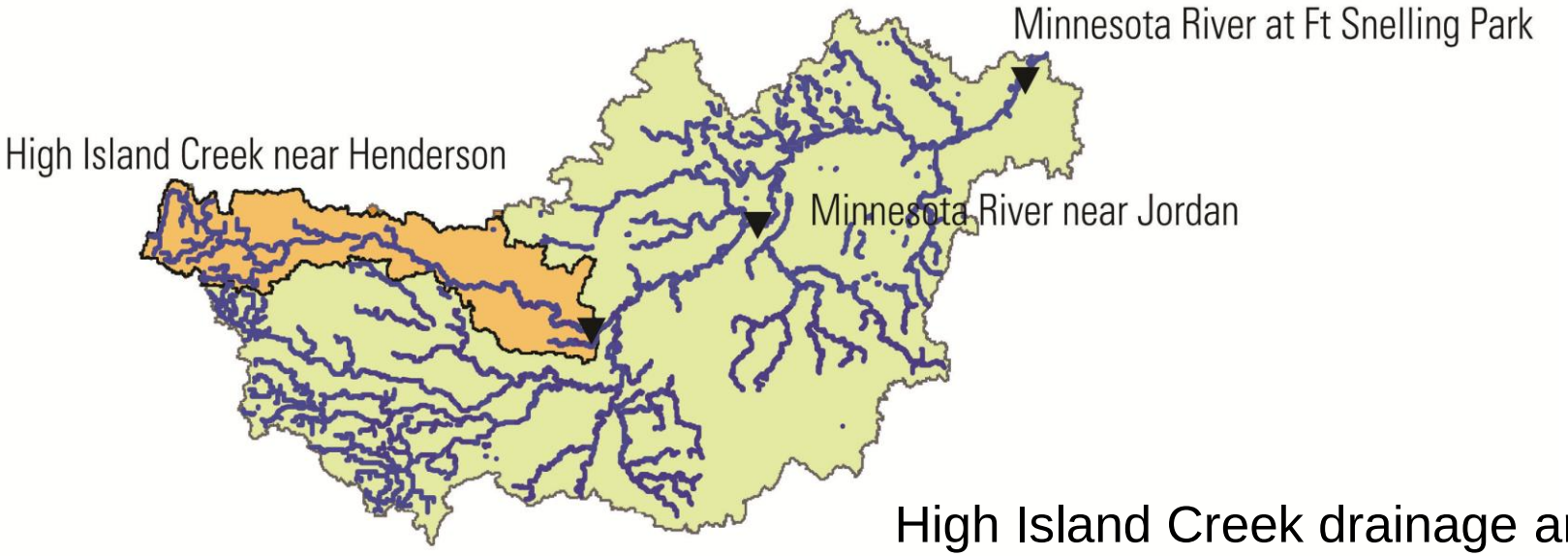
- There is an 8% increase in drainage area between Mankato and Jordan
- There was a 192% (1.92 times) increase in sediment load between Mankato and Jordan
- Most of this increase is associated with 2011 loads

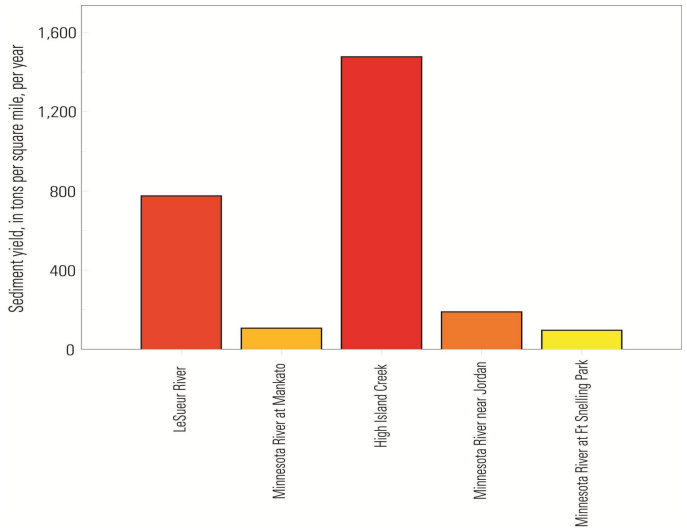
Data Analysis



- There is a 4% increase in drainage area between Jordan and Ft Snelling
- There was a 188% (1.88 times) decrease in sediment load between Jordan and Ft Snelling

Data Analysis



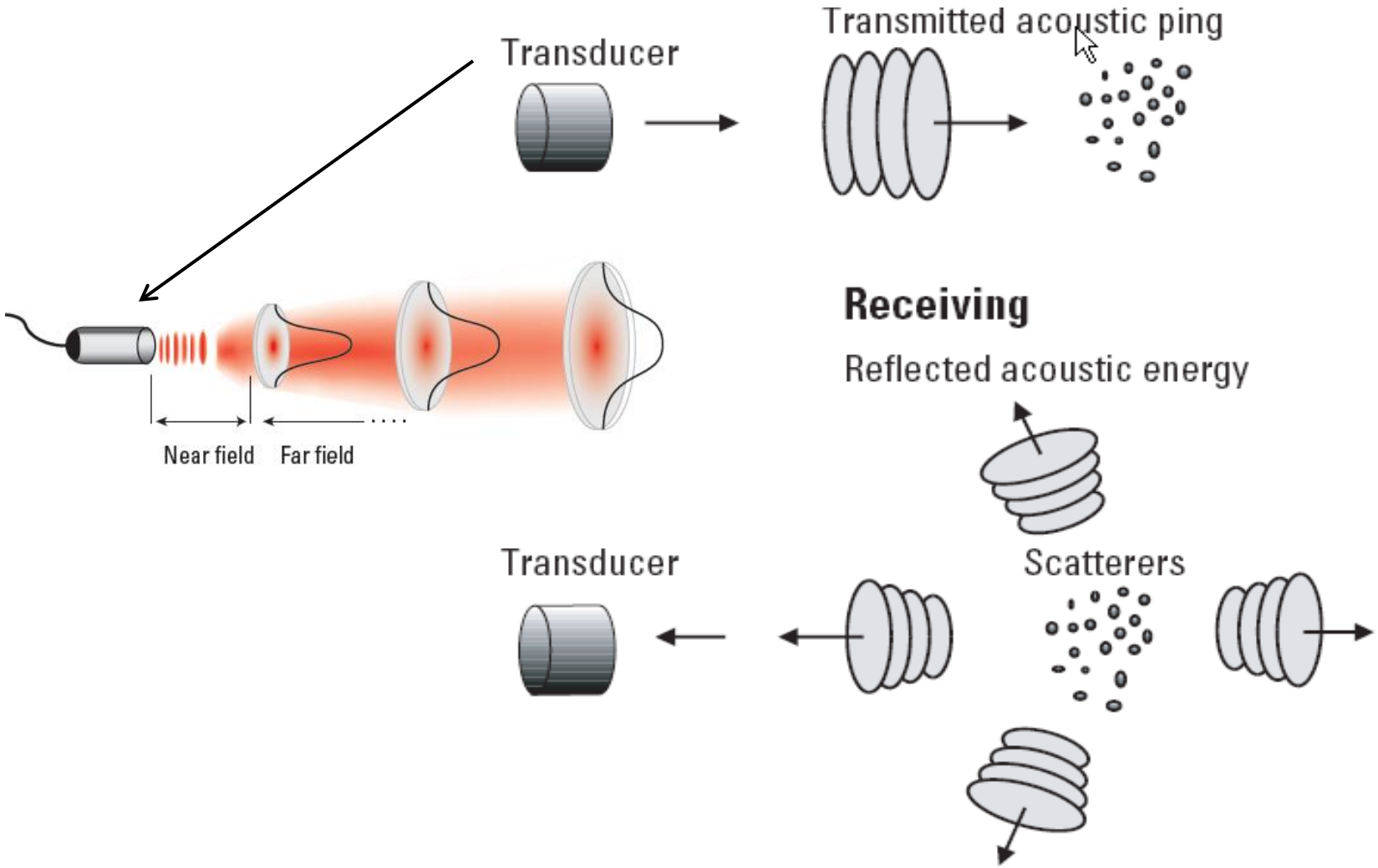


High Island Creek drainage area is equal to 21% of LeSueur River area and produced 41% of the loads of the LeSueur River

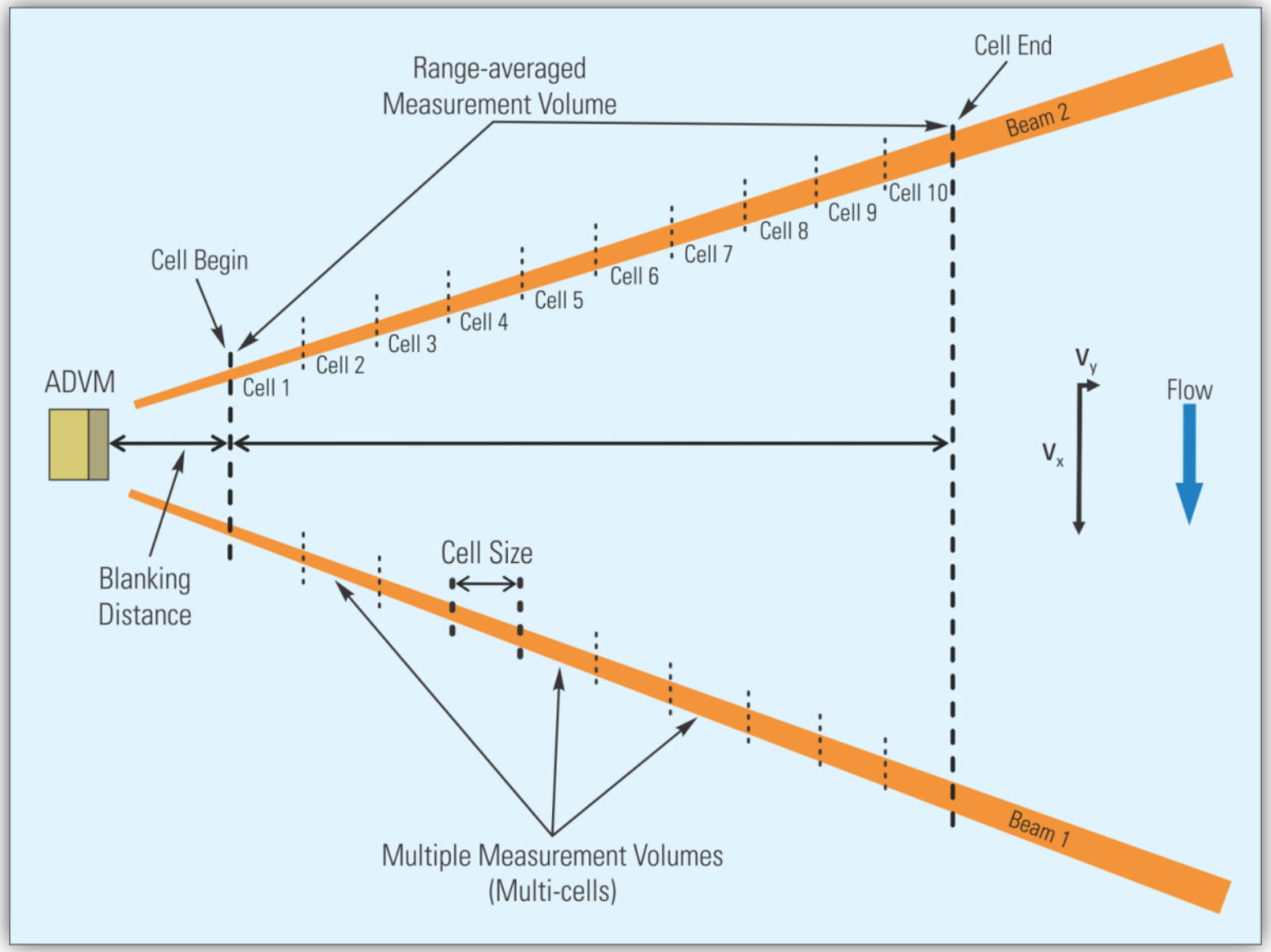
High Island Creek had largest sediment yield

- 1.9 times larger than LeSueur
- 13.8 times larger than Mankato
- 7.8 times larger than Jordan
- 15.2 times larger than Ft Snelling

The strength of the return echo, in certain environments is proportional to SSC



Measurement Volume and Multi-Cell

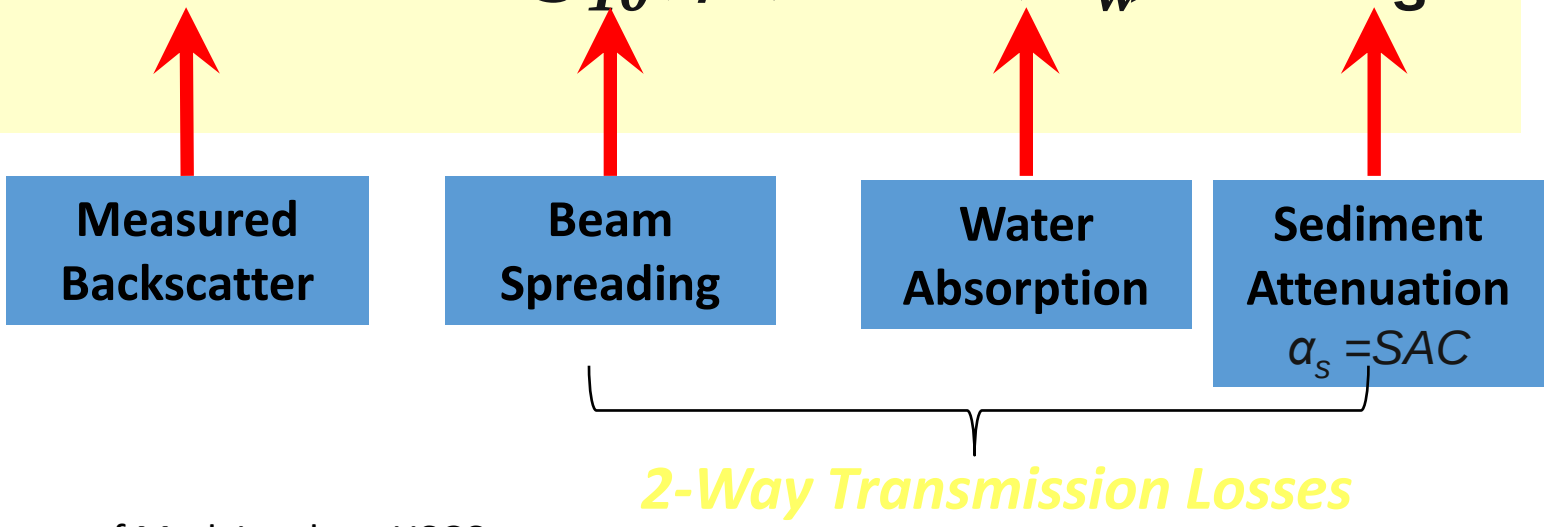


Processing ADVM data is labor intensive

$$WCB = MB + 20\log_{10}(\psi r) + 2r(\alpha_w)$$

$$SCB = WCB + 2r\alpha_s$$

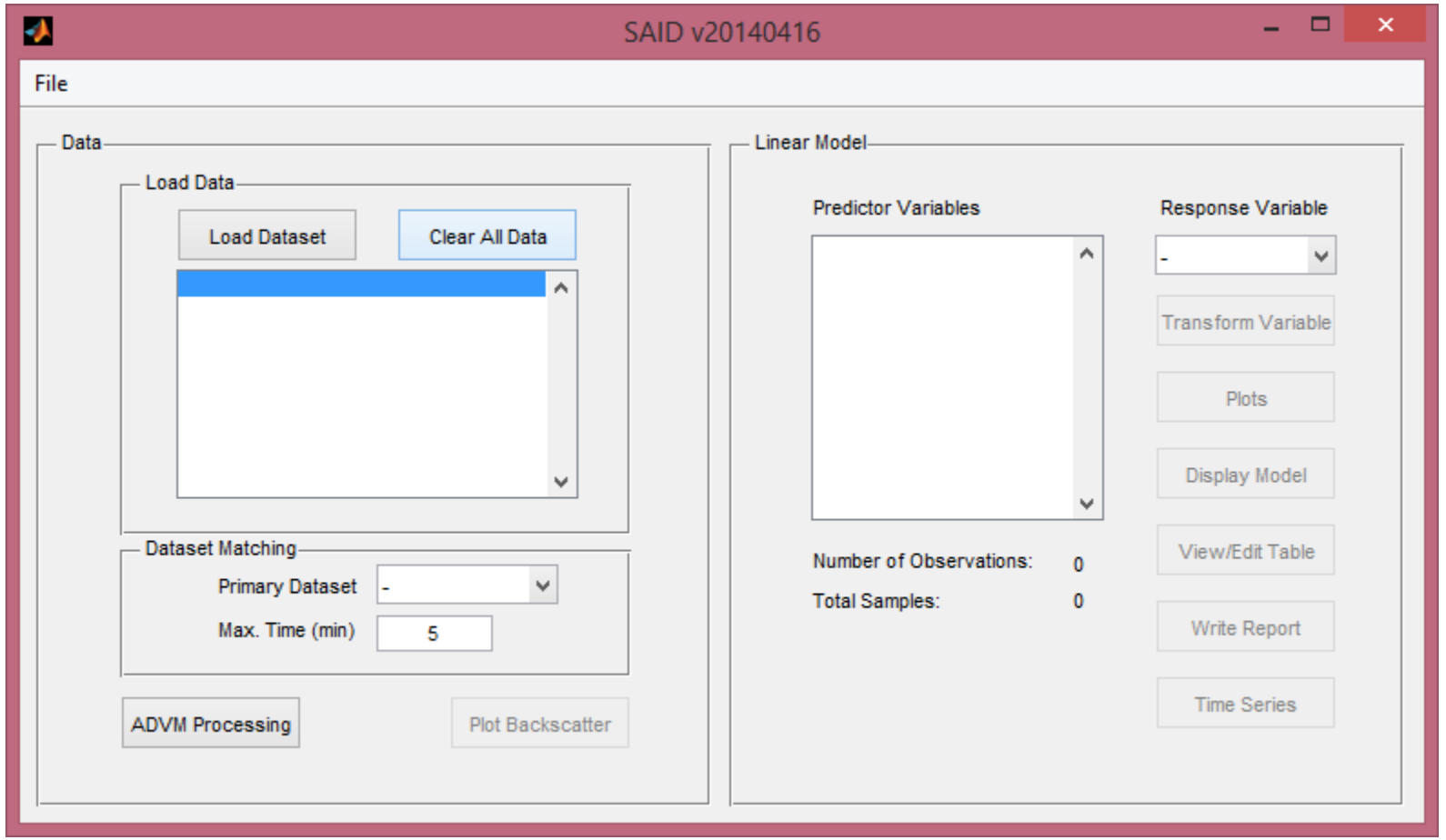
$$SCB = MB + 20\log_{10}(\psi r) + 2r(\alpha_w) + 2r\alpha_s$$



Slide courtesy of Mark Landers, USGS

Data processing automated

Sediment Acoustics Index Development Tool



ADVM model using mean sediment corrected backscatter to calculate SSC

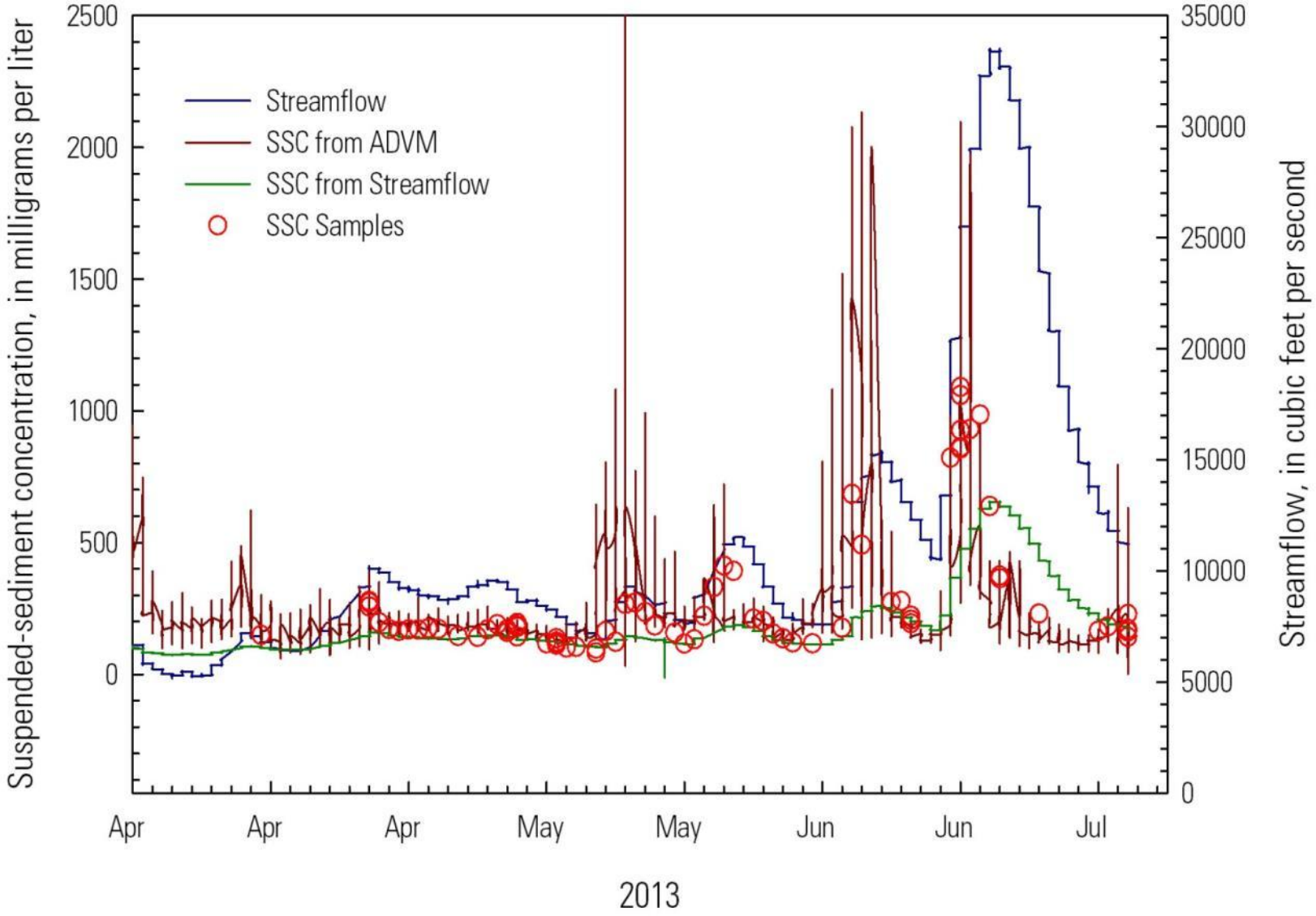
Minnesota River at Mankato

$R^2 = 0.90$

Minnesota River at Ft Snelling Park

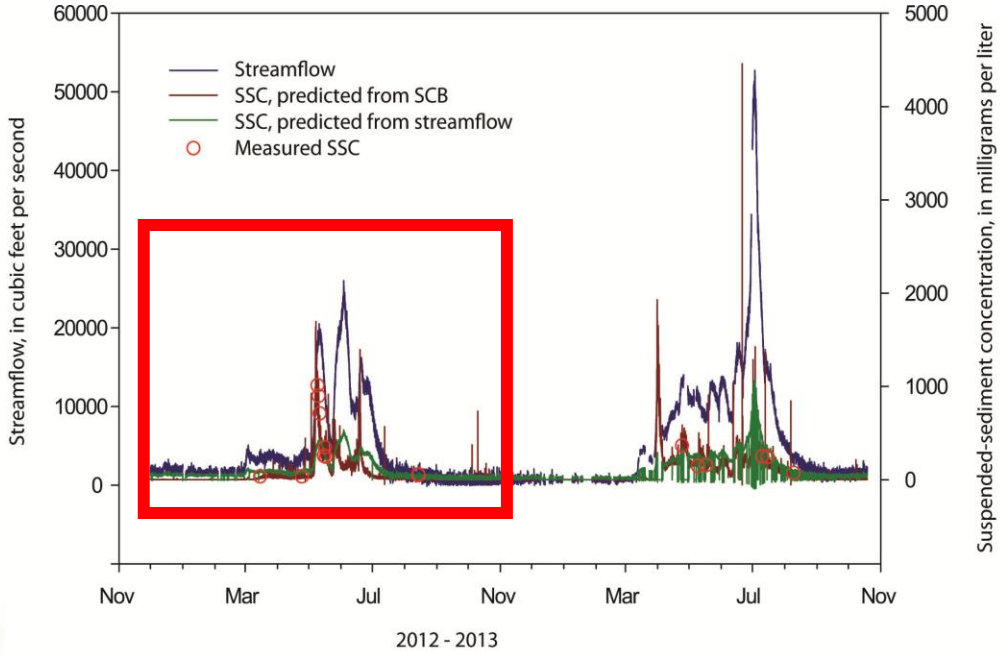
$R^2 = 0.92$

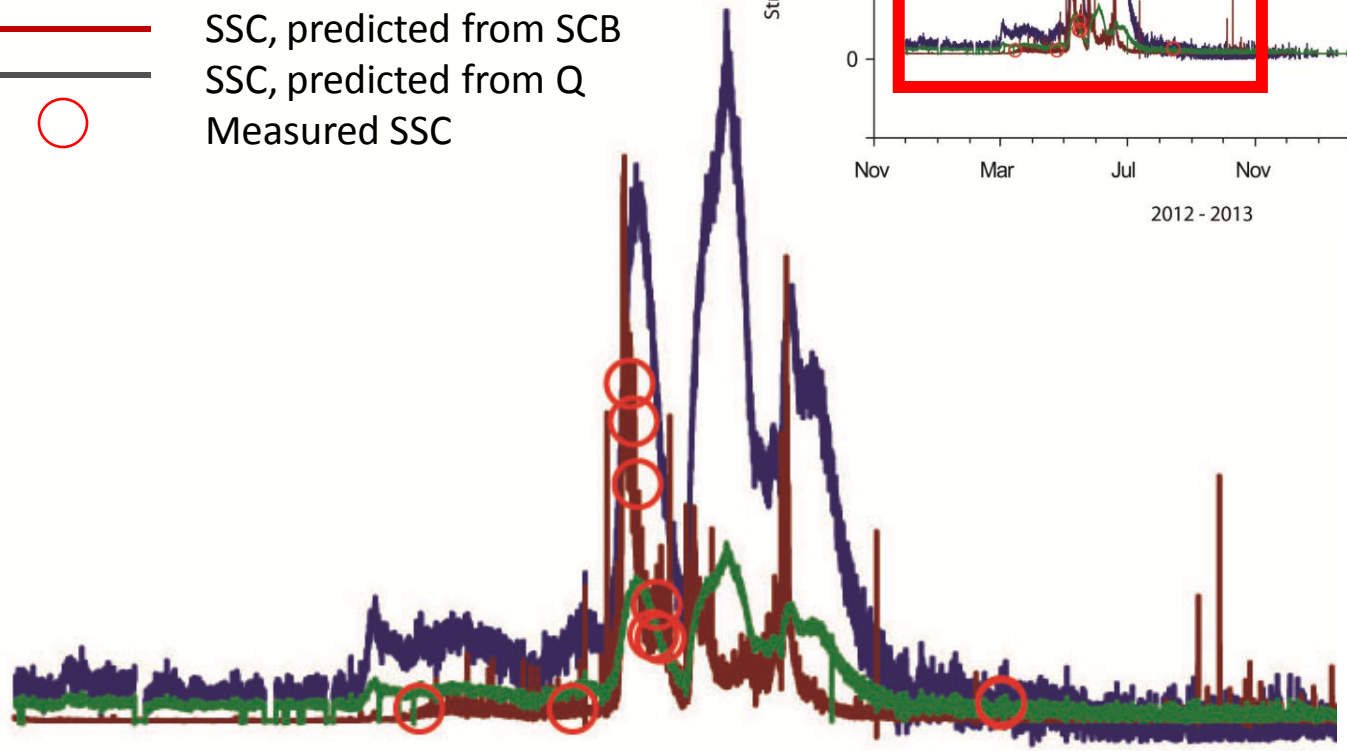
Minnesota River at Mankato
Acoustic backscatter to estimate sediment concentrations

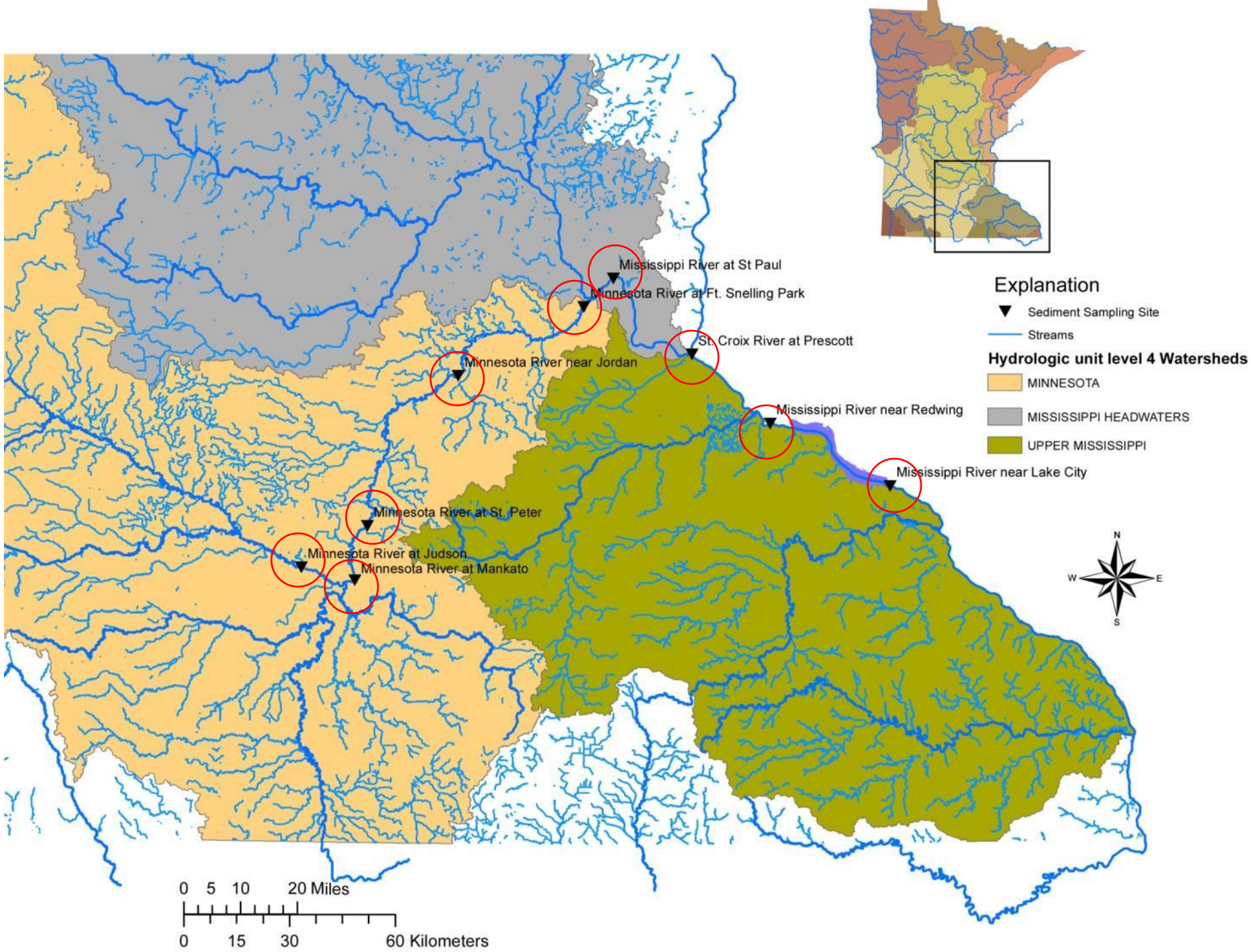


Minnesota River at Ft Snelling Park
Acoustic backscatter to estimate SSC

Streamflow
SSC, predicted from SCB
SSC, predicted from Q
Measured SSC






Mississippi River at St Paul
Minnesota River at Ft. Snelling Park
St. Croix River at Prescott
Minnesota River near Jordan
Mississippi River near Redwing
Mississippi River near Lake City
Minnesota River at St. Peter
Minnesota River at Judson
Minnesota River at Mankato
Explanation
Sediment Sampling Site
Streams
Hydrologic unit level 4 Watersheds
MINNESOTA
MISSISSIPPI HEADWATERS
UPPER MISSISSIPPI
N
W
E
S
0 5 10 20 Miles
0 15 30 60 Kilometers

Questions

Minnesota River near Jordan (09/29/201