HYDRAULIC CONCERNS 2020 AND 2021

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US Army Corps of Engineers®

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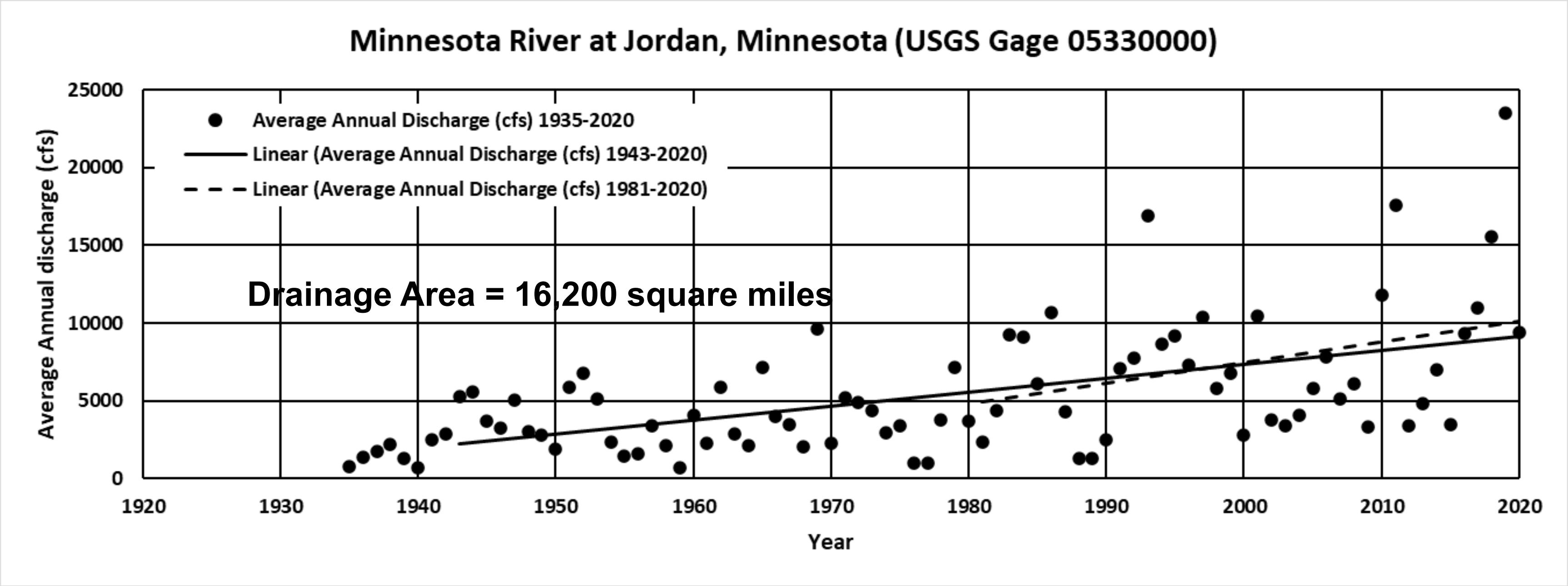
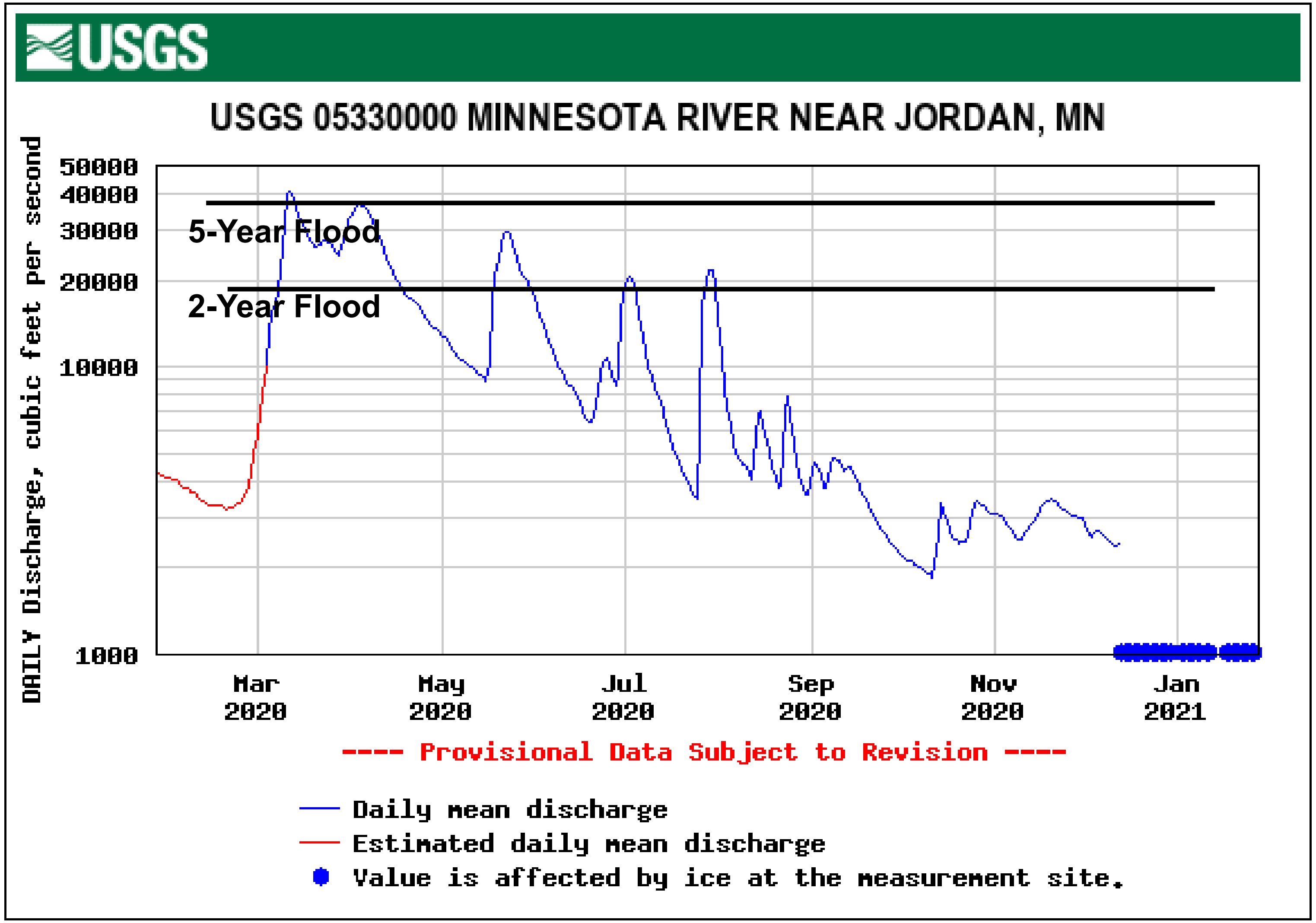
MINNESOTA RIVER



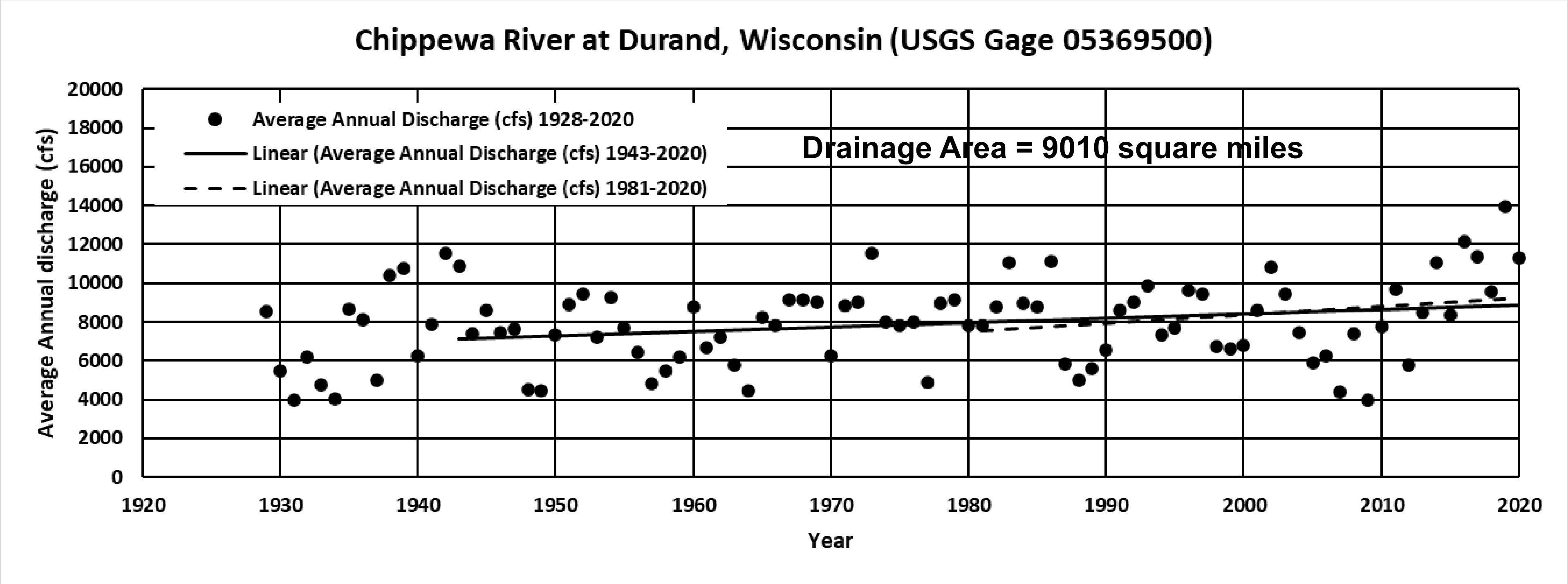
Decade	Bankful Flooding Events
1930-1939	0
1940-1949	1
1950-1959	3
1960-1969	5
1970-1979	2
1980-1989	5
1990-1999	9
2000-2009	6
2010-2019	18

- There is a statistically significant trend of increasing discharge from 1943 to 2020
- Average Discharge at Jordan
  - 1943 to 1980 = 3770 cfs
  - 1981 to 2020 = 7510 cfs (double the 1943 to 1980 ave.)
- Discharge in 2016, 2017, 2018, 2019, 2020 = 9360, 11,000,15520, 23550, 9370 cfs
- The number of bankfull flooding events (Q > 26,000 cfs) has increased in the 2010s (see table)
- 2011 to 2020 is wettest decade on record

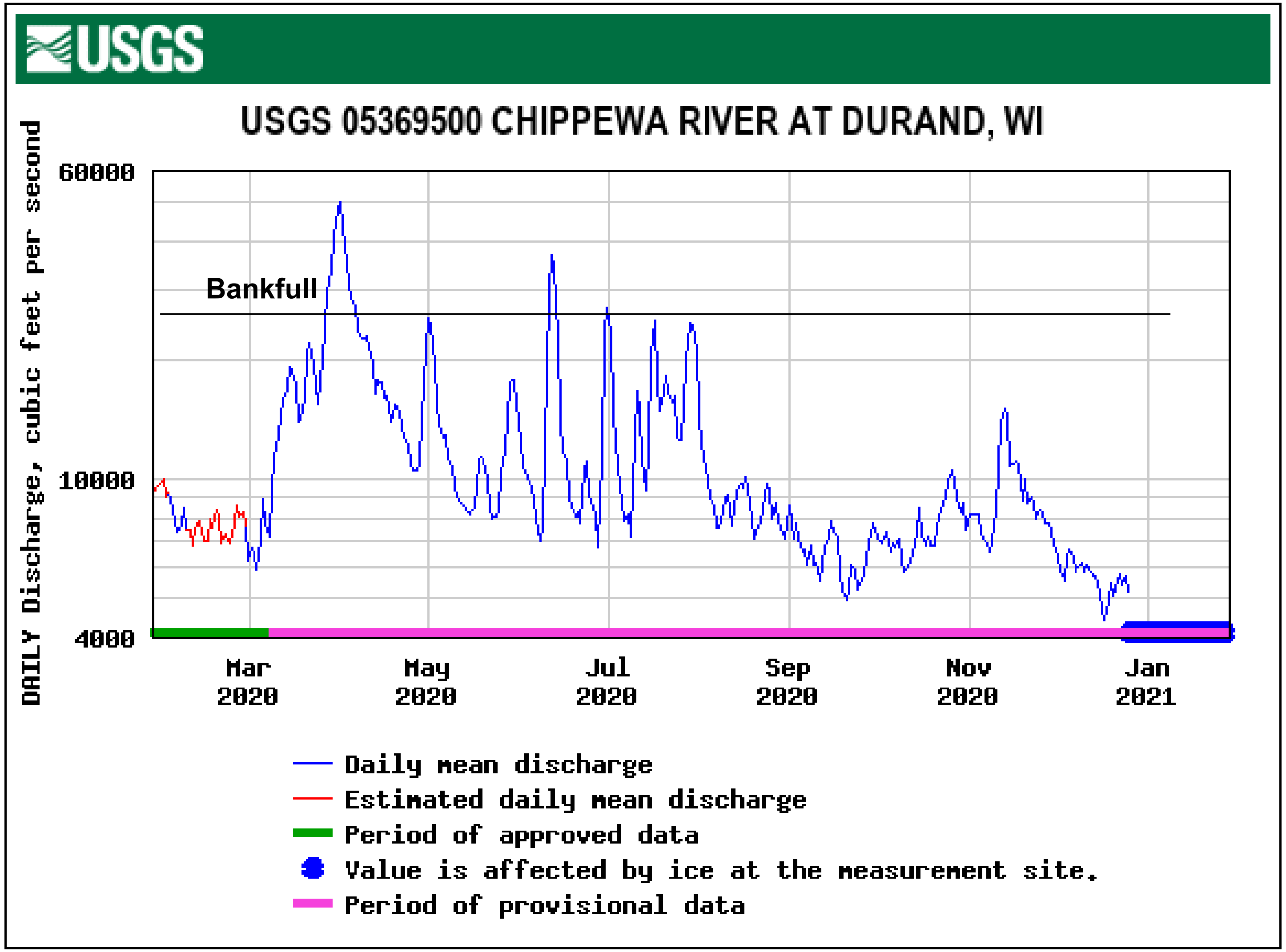
MINNESOTA RIVER, 2020



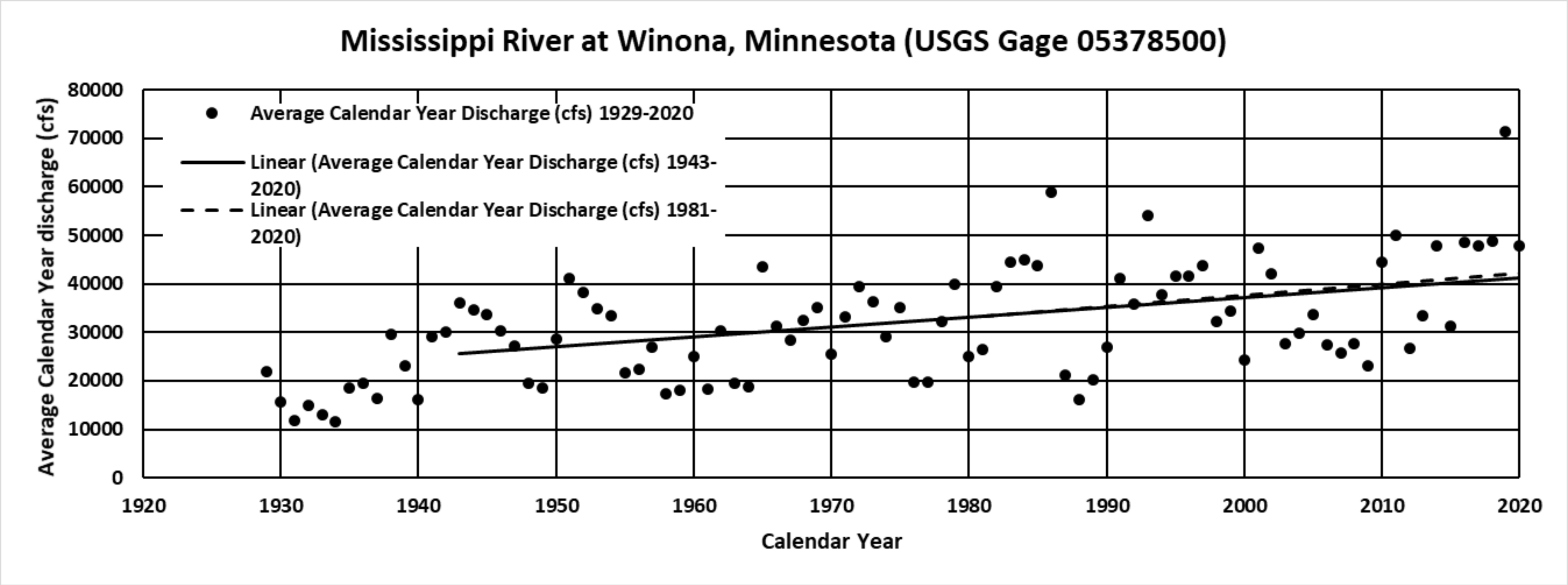
CHIPPEWA RIVER



CHIPPEWA RIVER, 2020



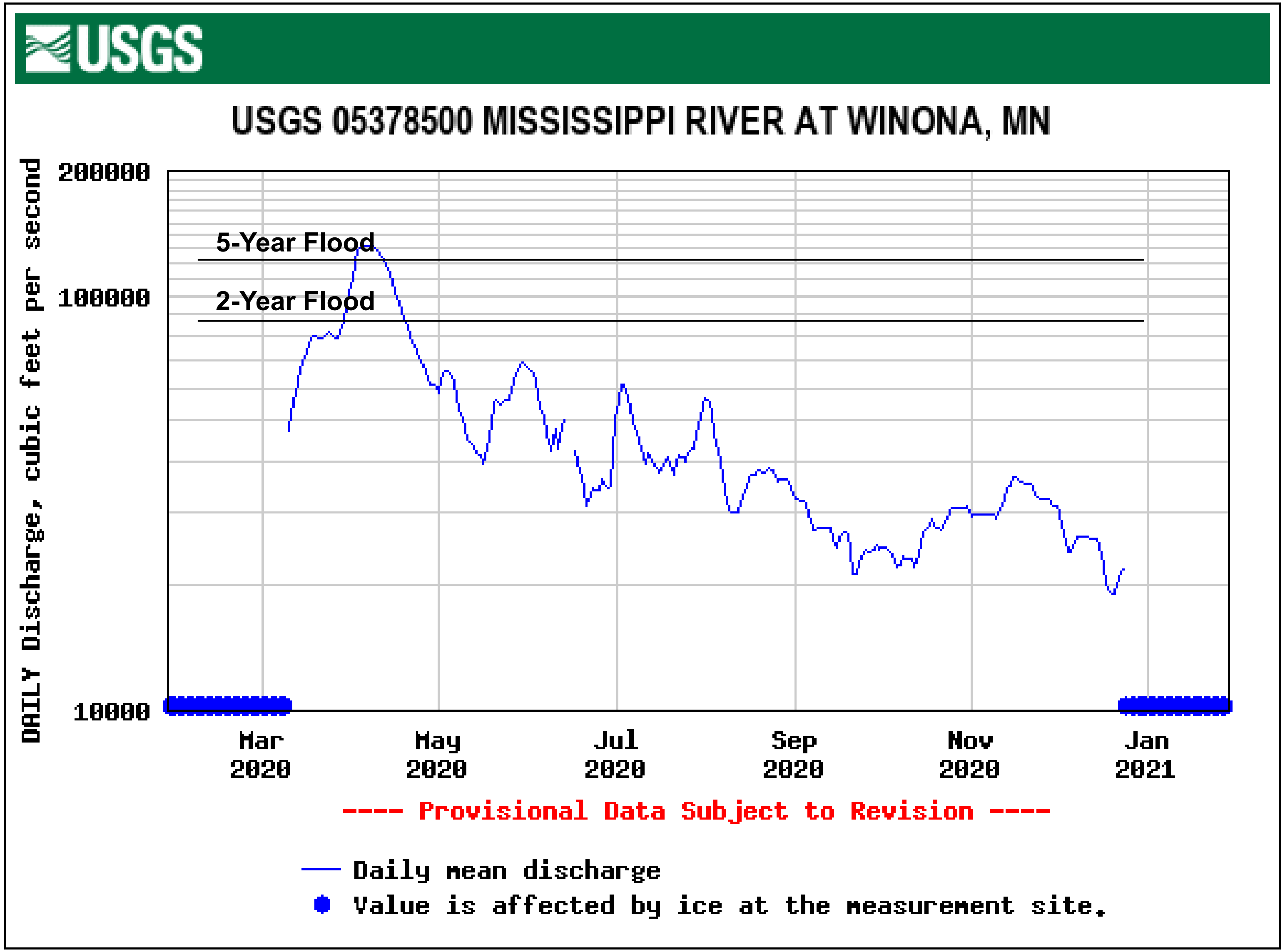
MISSISSIPPI RIVER



Average Calendar Year Discharge at Winona
1943 to 1980 = 28,950 cfs
1981 to 2020 = 37,820 cfs (30 % increase)

2016, 2017, 2018, 2019, 2020 = 48,700, 47,960, 48,900, 71,520, 47,850 cfs
2010 to 2020 is wettest decade on record

MISSISSIPPI RIVER, 2020



SEDIMENT MEASUREMENTS CHIPPEWA RIVER AT DURAND AND PEPIN

District/Other USACE PDT Members

St. Paul – Bryan Peterson, Steve Tapp, Dan Cottrell, Jon Hendrickson, Alex Nelson

ERDC – David Abraham, William Butler

Leveraging/Collaborative Opportunities

1. 2017 – 2020 Collect data, calibrate methods & equipment
2. 2020 Scientific Investigations Report, USGS
3. USACE Navigation and RSM funding

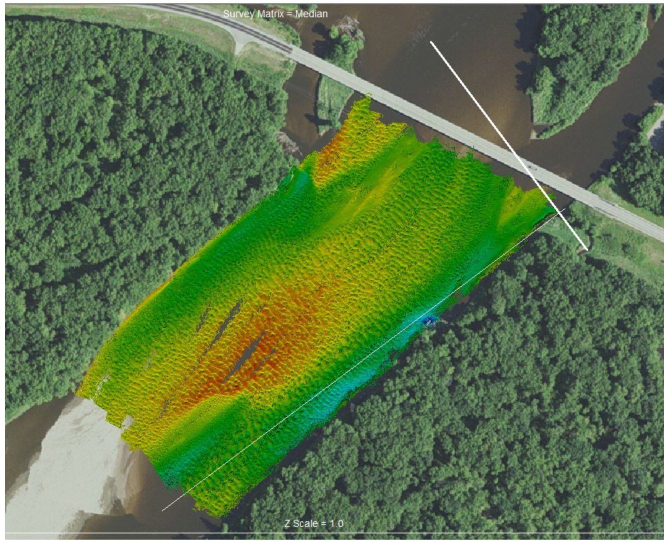
Stakeholders/Partners

Jeff Ziegeweid, Will Lund, Joel Groten, USGS Minn.

Dave Dean, USGS Grand Canyon Research Center

Dan Buscombe, Northern Arizona State University

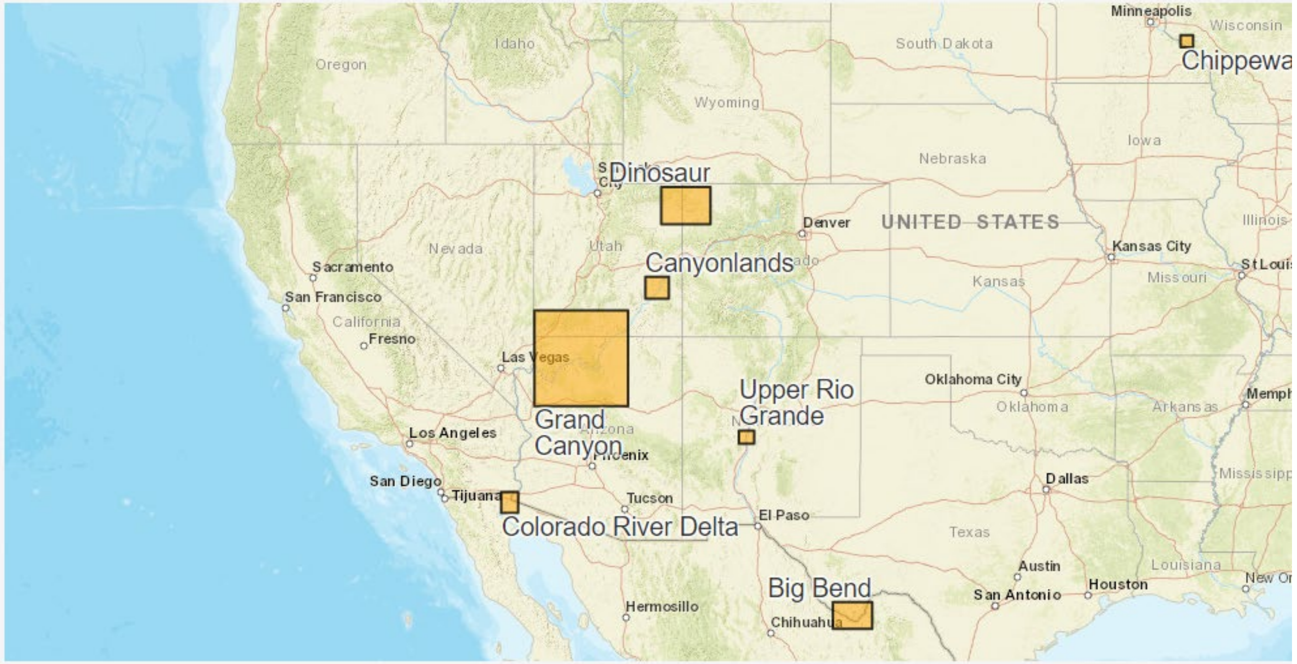
Faith Fitzpatrick, Joe Shuler, USGS Wisc.



HTTPS://WWW.GCMRC.GOV/DISCHARGE_QW_SEDIMENT/?

Discharge, Sediment, and Water Quality Monitoring

Home > Discharge, Sediment and Water Quality



- Gage height
- Q
- Water Temp
- Total suspended sediment concentration
- Susp silt and clay concentration
- Susp sand concentration
- Susp sand median grain size
- Instantaneous suspended silt and clay load
- Cumulative suspended silt and clay load
- Instantaneous suspended sand load
- Cumulative suspended sand load
- Calculated Instantaneous sand bedload
- Calculated cumulative Sand bedload

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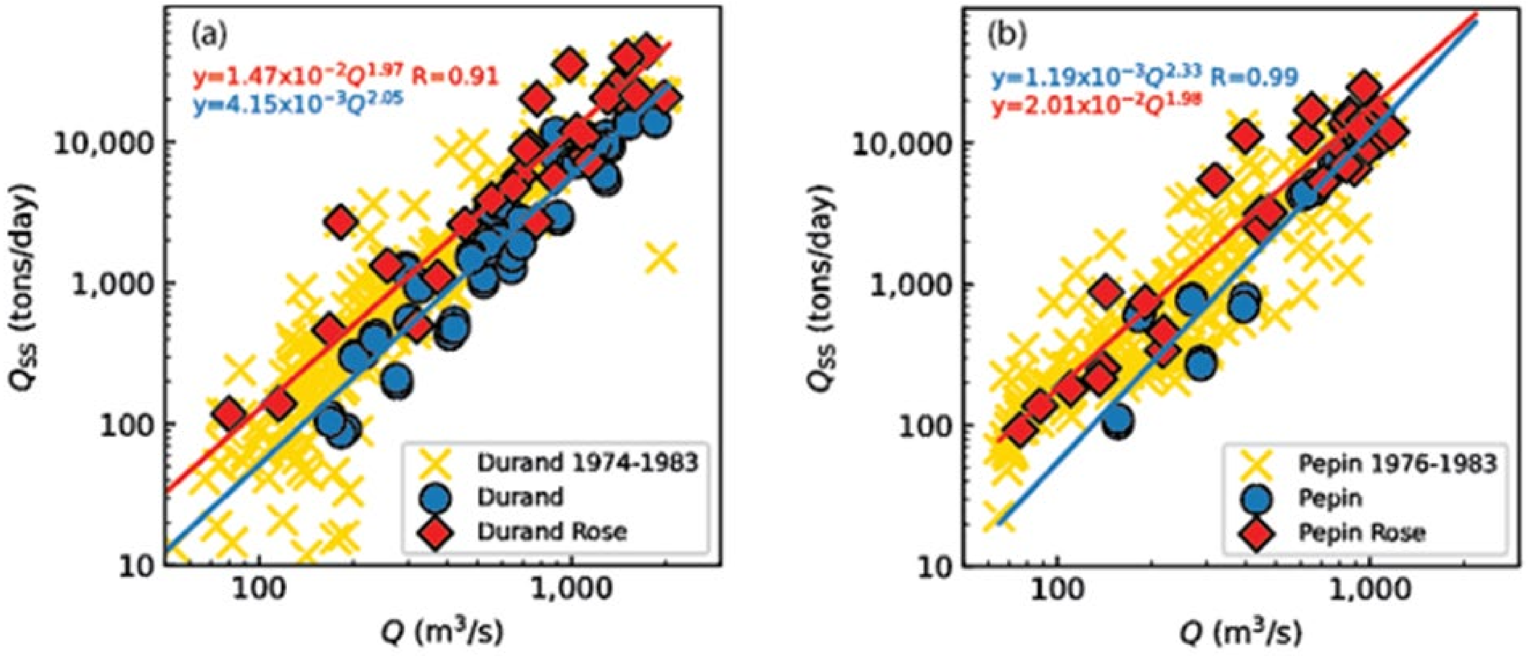
SUSPENDED SAND LOAD VERSUS WATER FLOW RELATIONSHIP HAS DECREASED

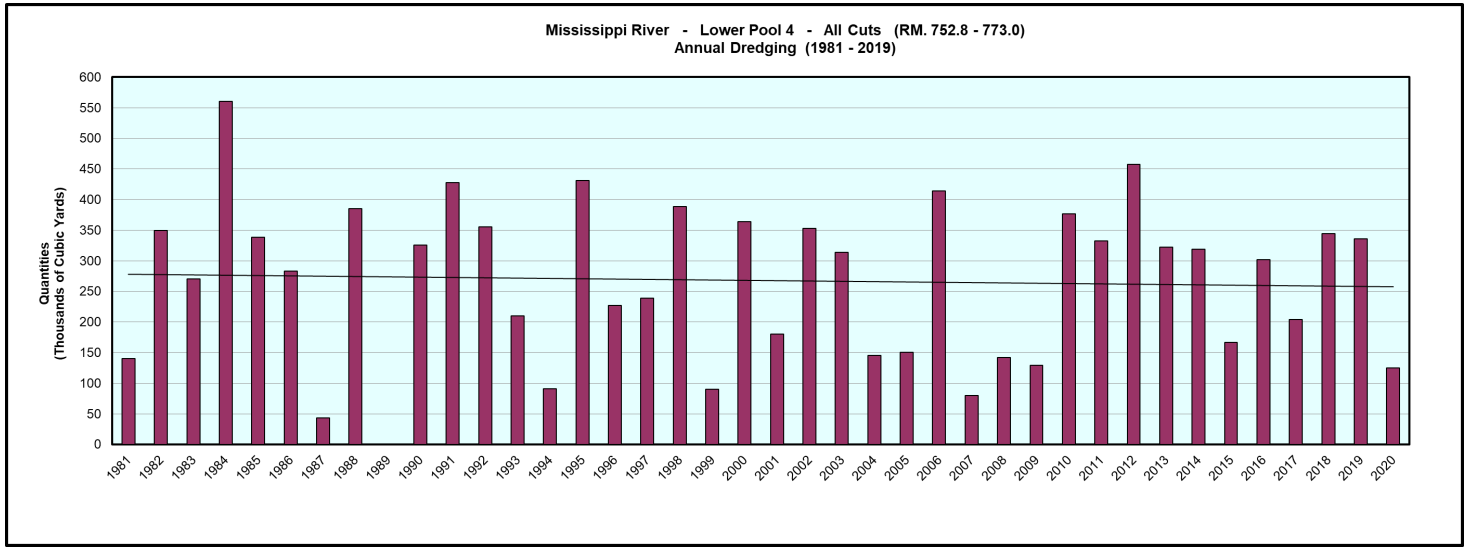


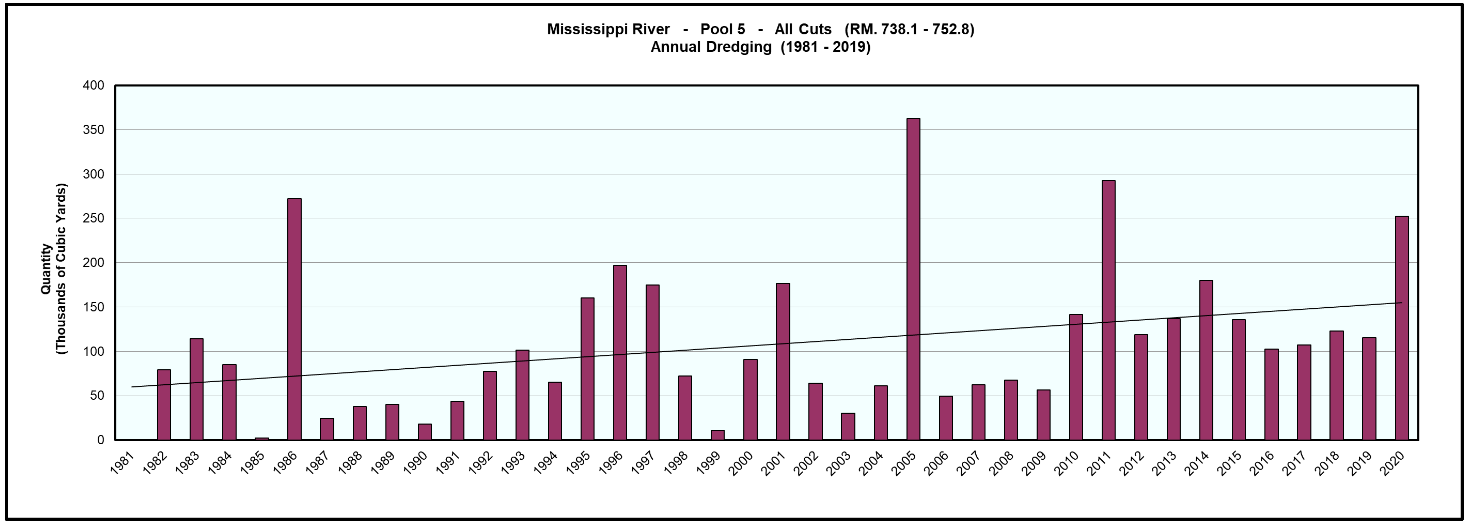
BUT THIS ISN'T REFLECTED IN CHANNEL RESPONSE. WHY???

DREDGING TRENDS: LP4 FLAT, P5 INCREASING

Annual dredging volumes have not decreased.

In lower pool 4 the trend is flat, while in pool 5, dredging volumes are increasing.





ARE SEDIMENT SOURCES CHANGING?

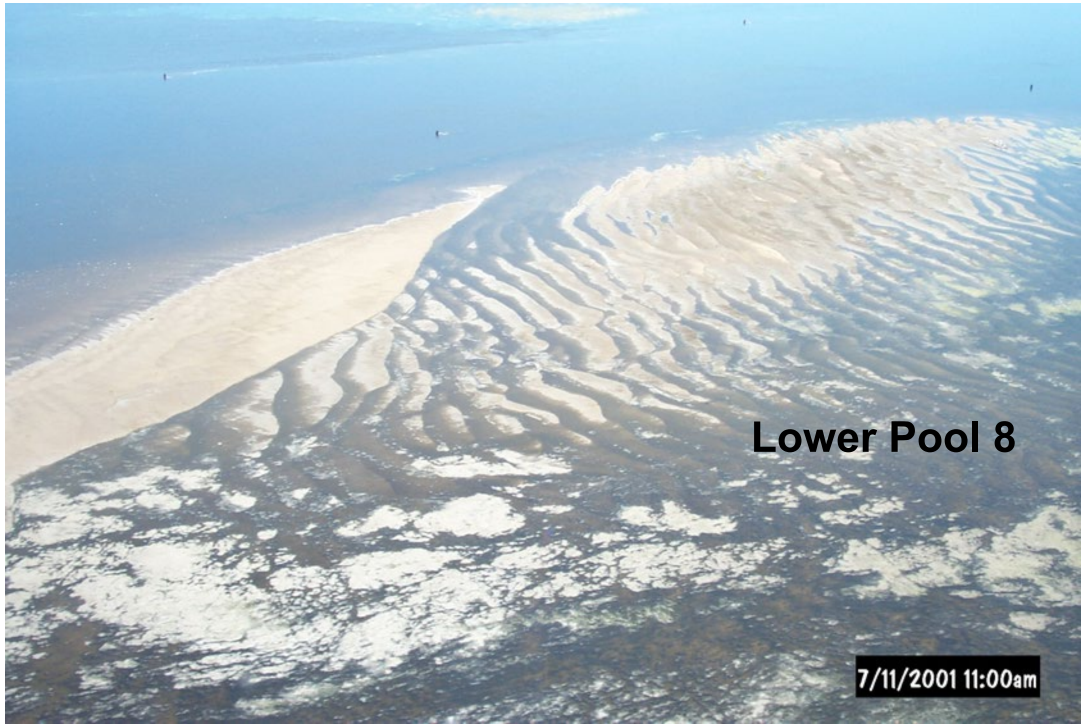
Long duration floods may deliver more sediments, but this isn't obvious on the Chippewa River

Tributary sediment loads are decreasing but channelized lower tributary valleys are an effective sediment conduit.

Bank Erosion – USACE, Nav Study (1997) concluded that 14% of river banks on the UMR were eroding. Cumulative Effects Study (USACE, 2000) assumed bank erosion balanced by in-channel sediment sinks. Have high flow rates increased bank erosion?

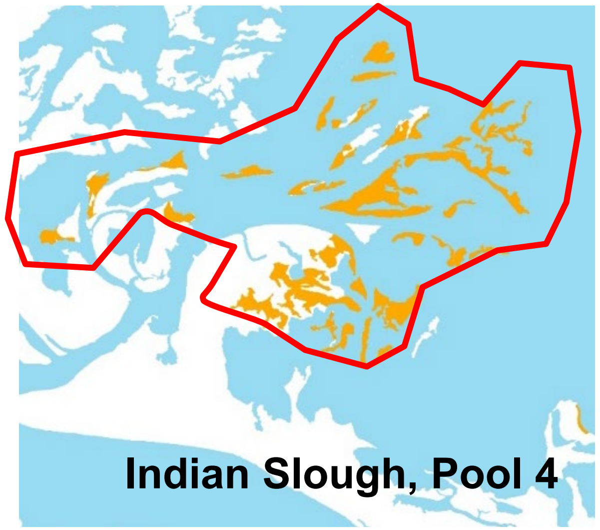
SEDIMENT SINKS ARE DECREASING

Many projects constructed in the last 3 or 4 decades have reduced flow connections with backwater areas. This has reduced sediment transport to backwater sediment sinks.



SEDIMENT SINKS

- Secondary channel measurements at several sites indicate that flow to backwaters decreases as sediment deltas expand.
- Pool 7 is Probably Most Significant Example to Date
  - Outdraft
  - Shift in Dredging
  - Greater sand loads to Pool 8??
- Delta expansion is occurring in many backwaters



Hydrogeomorphic units

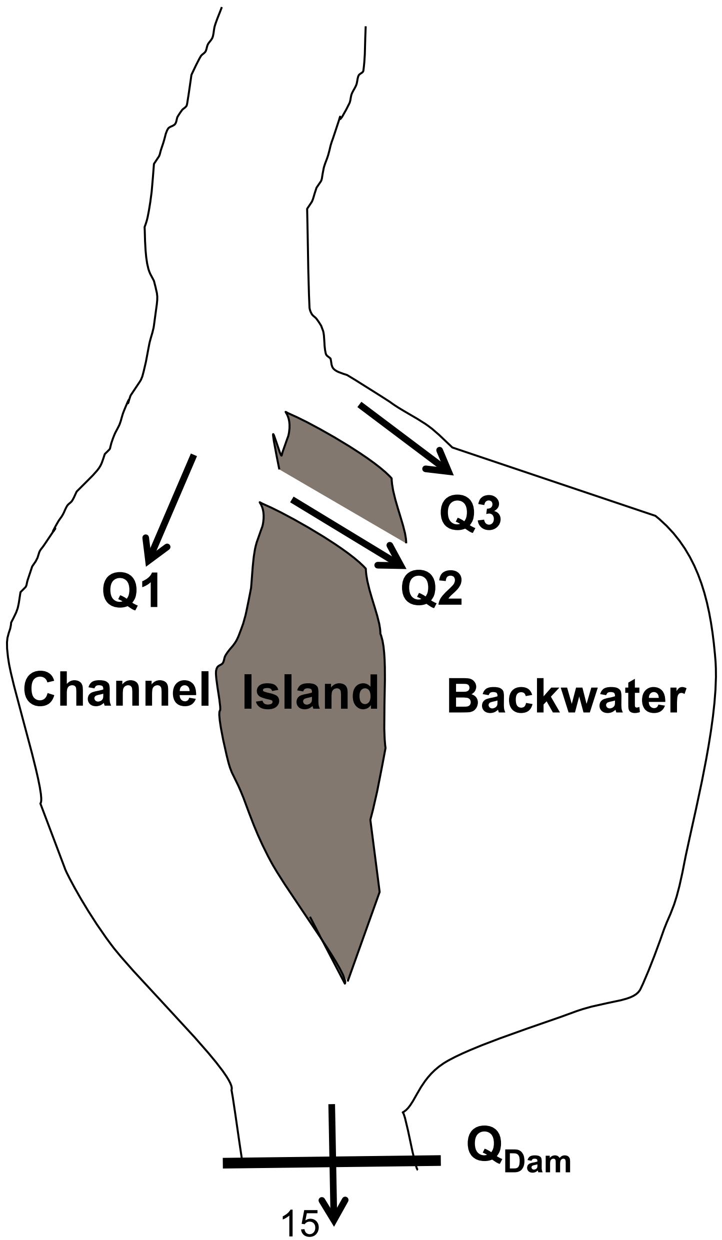
Rogala, USGS

WATER EXCHANGE

In this example, the water exchange ratio between the channel and the backwater is

$(Q_2 + Q_3)/Q_{dam}$ where Q = river flow

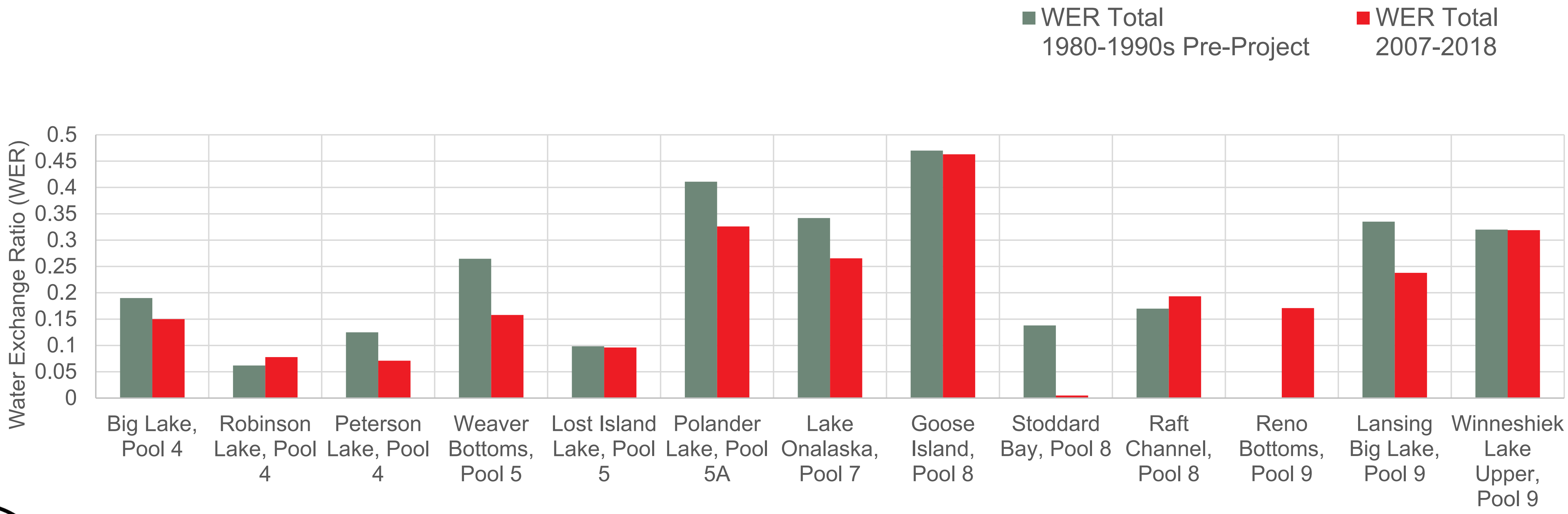
Expressed as a ratio or percentage



BACKWATER SEDIMENT SINKS ARE DECREASING

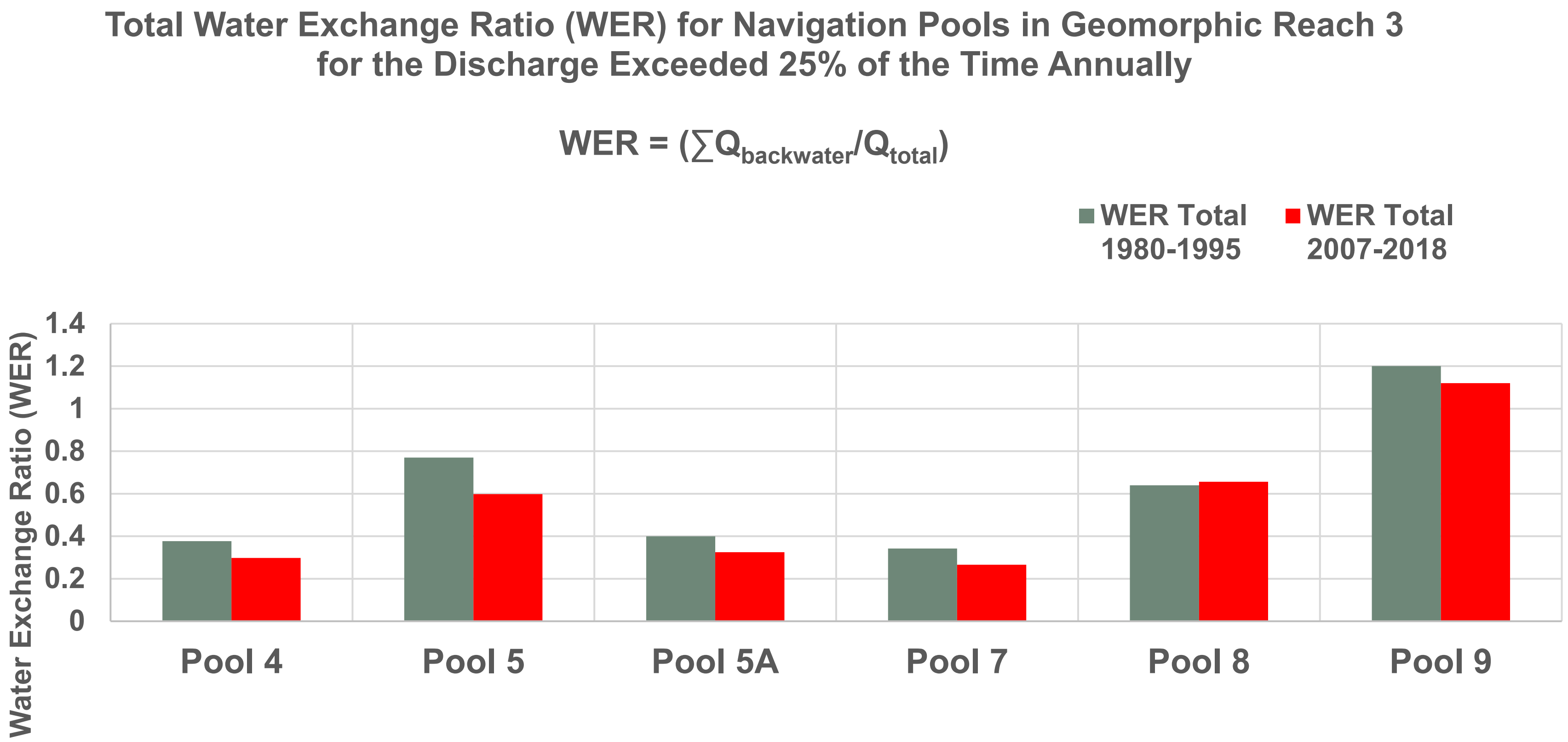
Change in Water Exchange Ratio (WER) Backwaters in Geomorphic Reach 3 for the Discharge Exceeded 25% of the Time Annually 1980-1990s time period to 2007-2018 time period

$$WER = (\sum Q_{side\ channel}/Q_{total})$$



Data processing funded by UMRR Science in Support of Management

WATER EXCHANGE RATIO, GEOMORPHIC REACH 3



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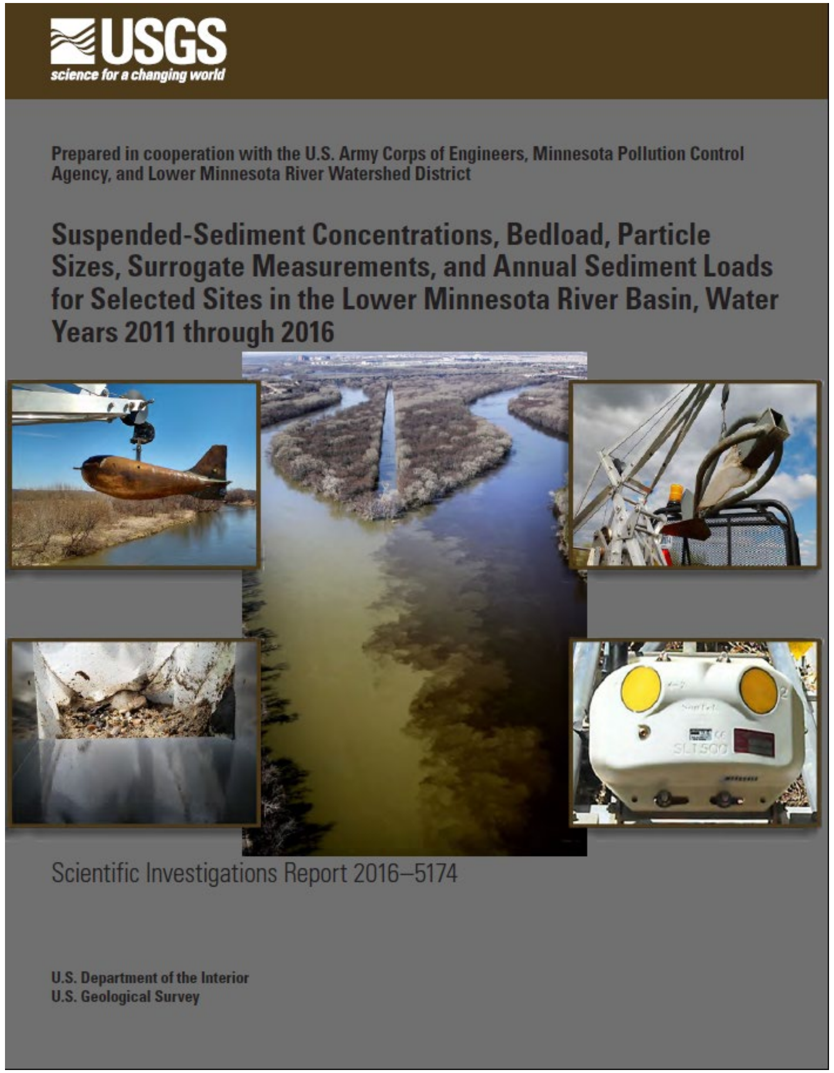
Minnesota River Surrogate Metric: Acoustic Backscatter



Groten, J.T., Ellison, C.A., and Hendrickson, J.S., Suspended-Sediment Concentrations, Bedload, Annual Sediment Loads, Particle-Sizes, and Surrogate Measurements for Selected Sites in the Lower Minnesota River, 2011 through 2014: U.S. Geological Survey Scientific Investigations Report 2016–5174, 29 p.

Data indicates:

- Minnesota River Sand Load is 250,000 yd3/yr.
- Minn. River dredging is 21,000 yd3/yr or 8.4% of total sand load.

2021 EFFORTS

- Secondary channel measurements offer the best indicator of the complex geomorphic changes that are occurring.
- Chippewa River sediment monitoring will continue.
- Minnesota River sediment monitoring?? Gaging platform was destroyed in 2019 flood.
- Considering adding a Mississippi River sediment gaging station near St. Paul

DISCUSSION?

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Questions?