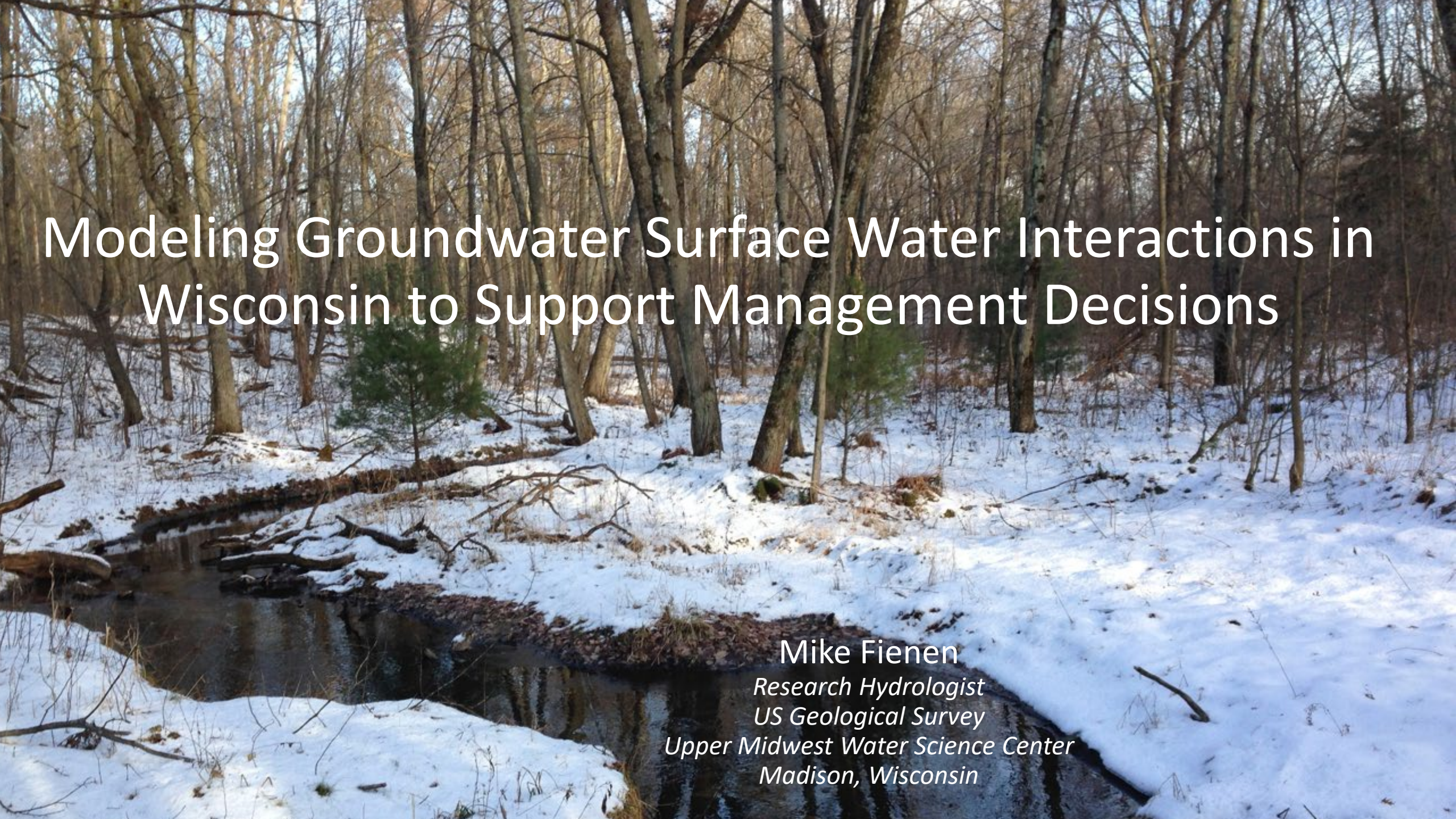
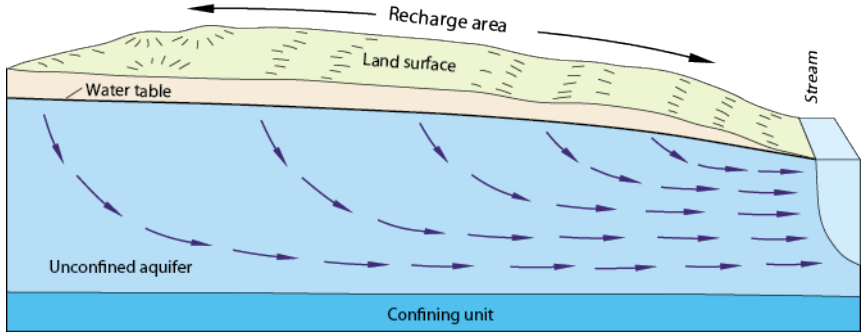
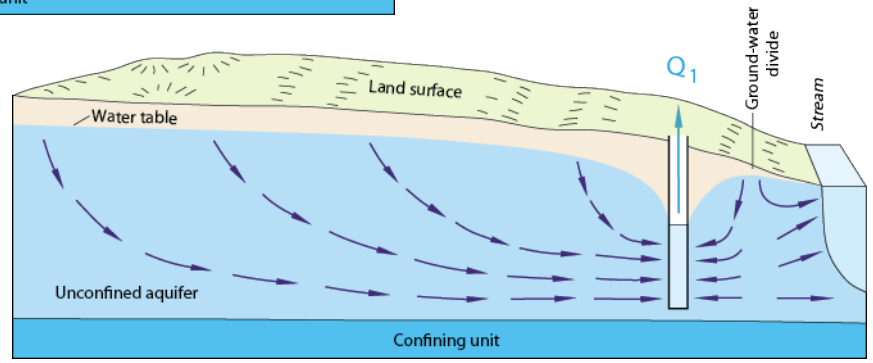


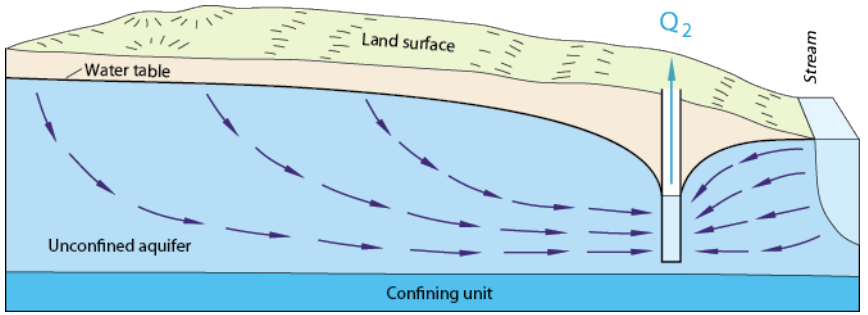
Modeling Groundwater Surface Water Interactions in Wisconsin to Support Management Decisions

Mike Fienen
Research Hydrologist
US Geological Survey
Upper Midwest Water Science Center
Madison, Wisconsin

Groundwater / Surface Water Interactions 101







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Lakes

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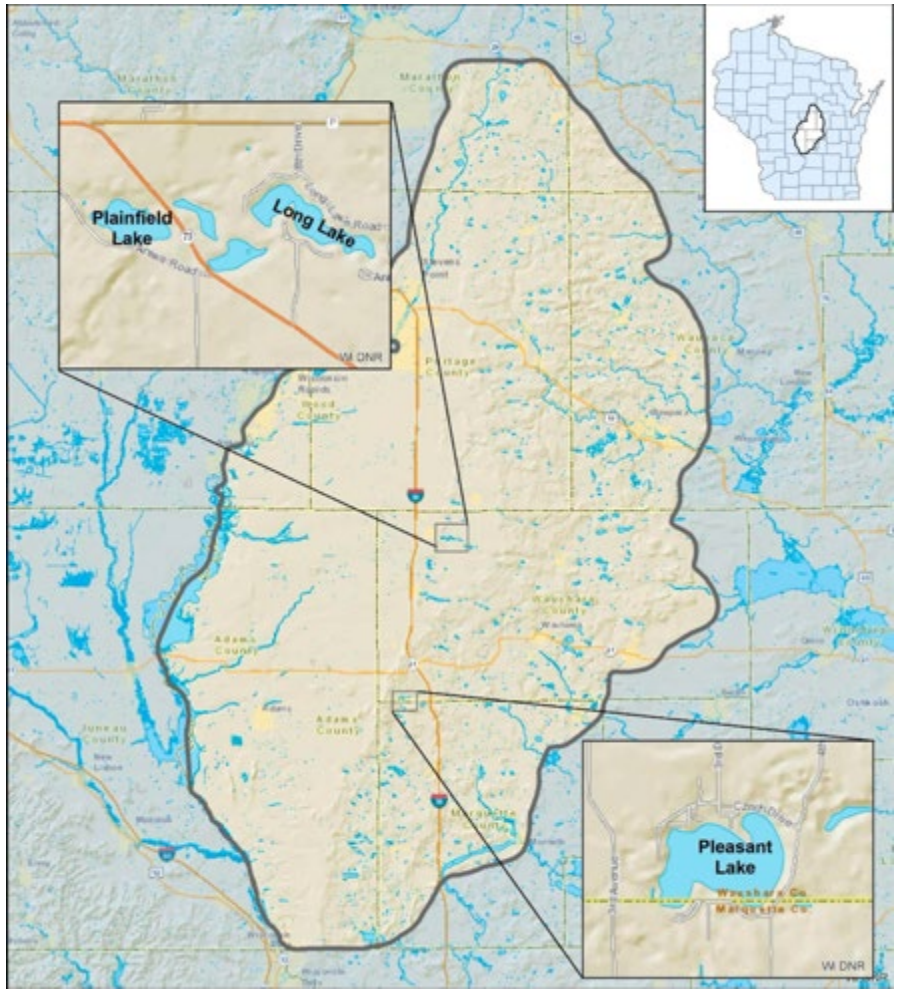
Wisconsin Central sands lake study

WI 2017 Act 10

“determine whether existing and potential groundwater withdrawals are causing or are likely to cause a significant reduction…of the navigable lake’s …water level below its average seasonal levels.”

3 lakes: Plainfield, Long, Pleasant



Fienen et al. (2022) doi:10.3133/sir20225046

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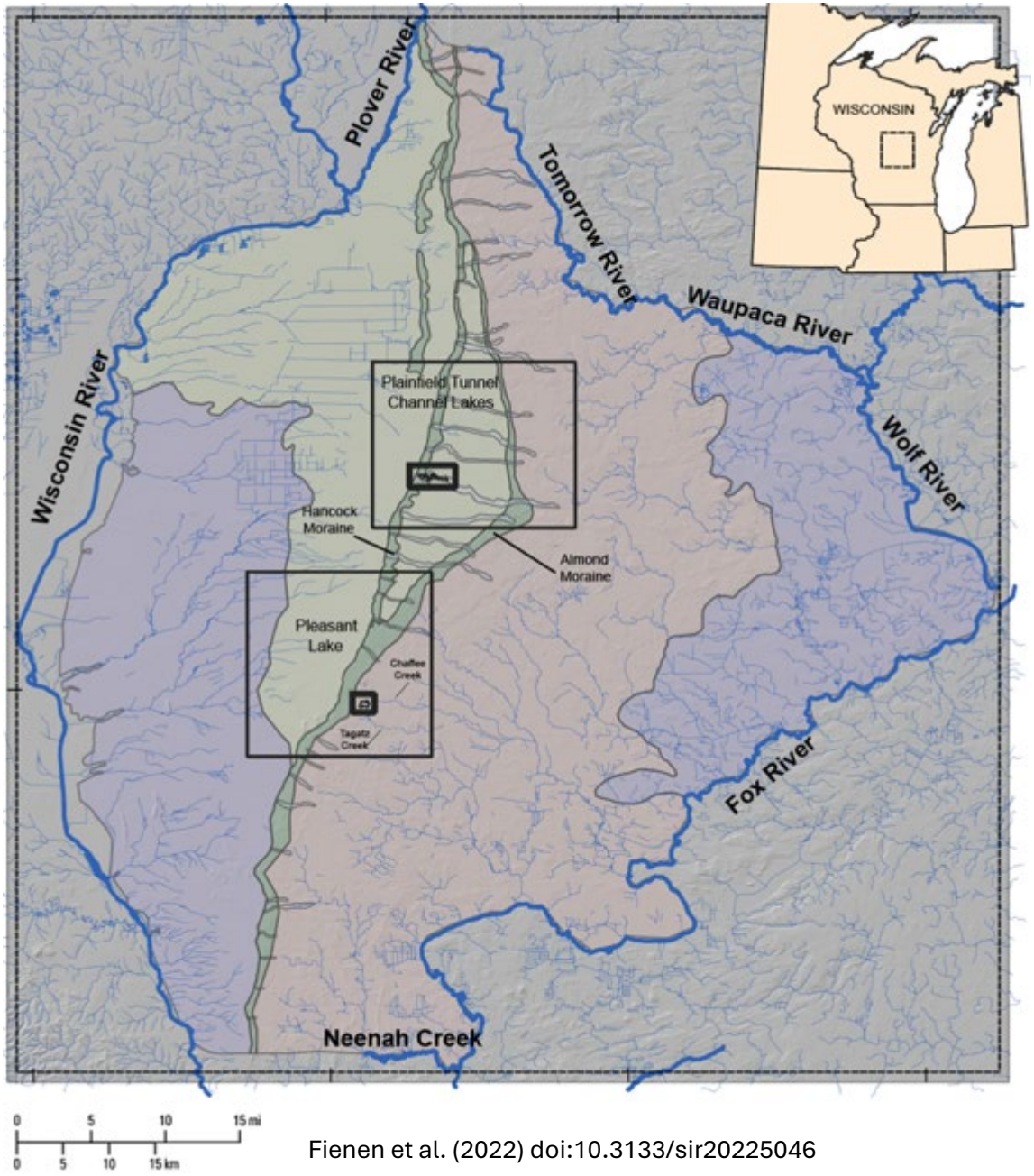
Multi-scale integrated modeling

- Regional model to extend to major hydrologic boundaries (MODFLOW-NWT)
- Two two-level coupled dynamic LGR-style inset models around the lakes (MODFLOW 6)
- Inset models inherit static boundaries from the regional model



Fienen et al. (2022) doi:10.3133/sir20225046

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Is there a smoking gun? Or are cumulative impacts important to understand interactions?

Orange line is the lake stage over tim
under current irrigation

Parcel by parcel, we switch from irrig
to the “no irrigation” alternative, rank
distance from Long Lake (orange sta

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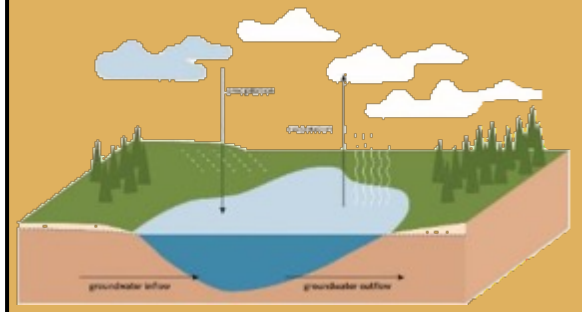
Conceptual Understanding of Seepage Lakes



Groundwater Flow Model

Groundwater Withdrawal Scenarios

No Irrigated Agriculture

Current Irrigated Agriculture

Potential Irrigated Agriculture

Lake Ecosystem Response

Human Uses

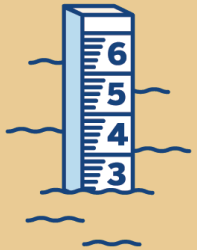
Fish

Aquatic Plants

Water Chemistry

Field Data Collection

Hydrostratigraphy
Water Levels
Streamflow
Water Use Data
Lake Ecosystem



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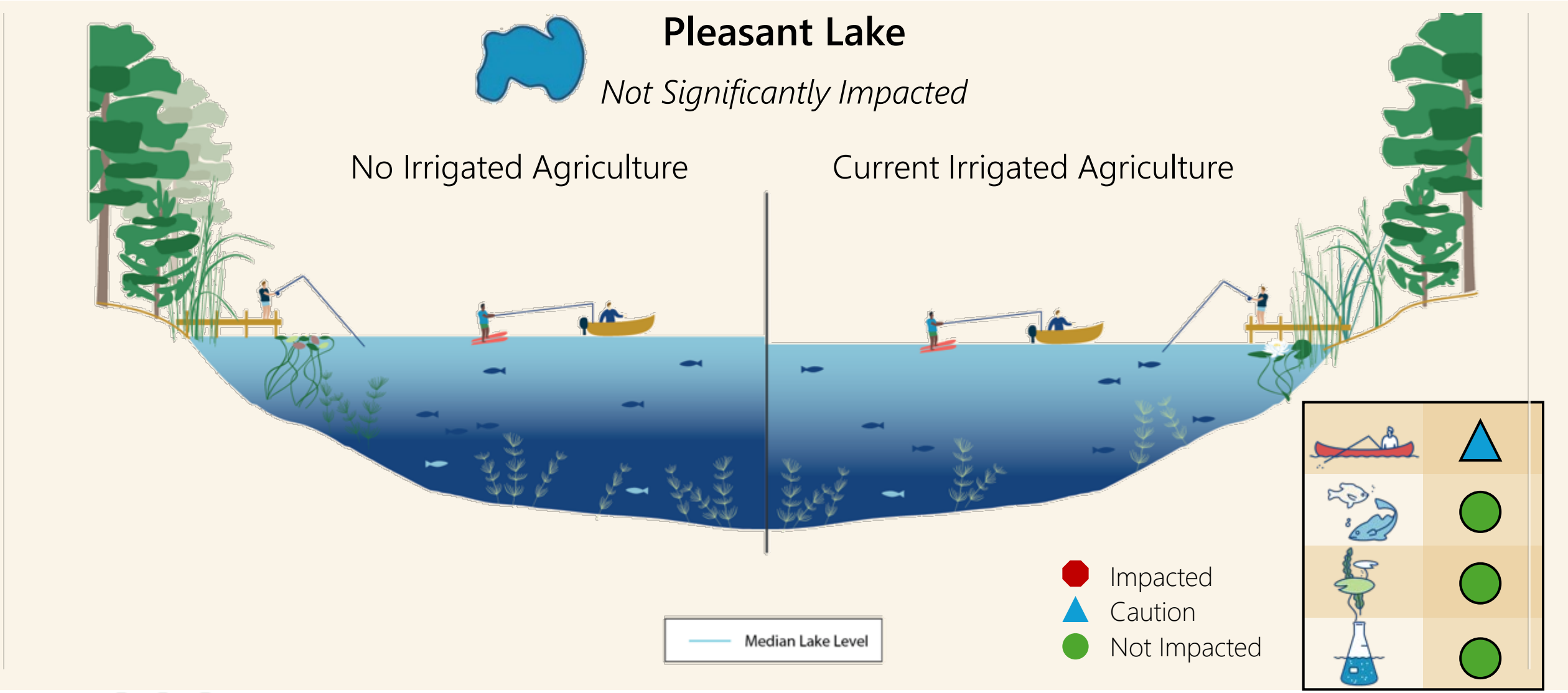
https://dnr.wisconsin.gov/topic/Wells/HighCap/CSLStudy.html

IMPACT CONCLUSIONS FOR PLEASANT LAKE



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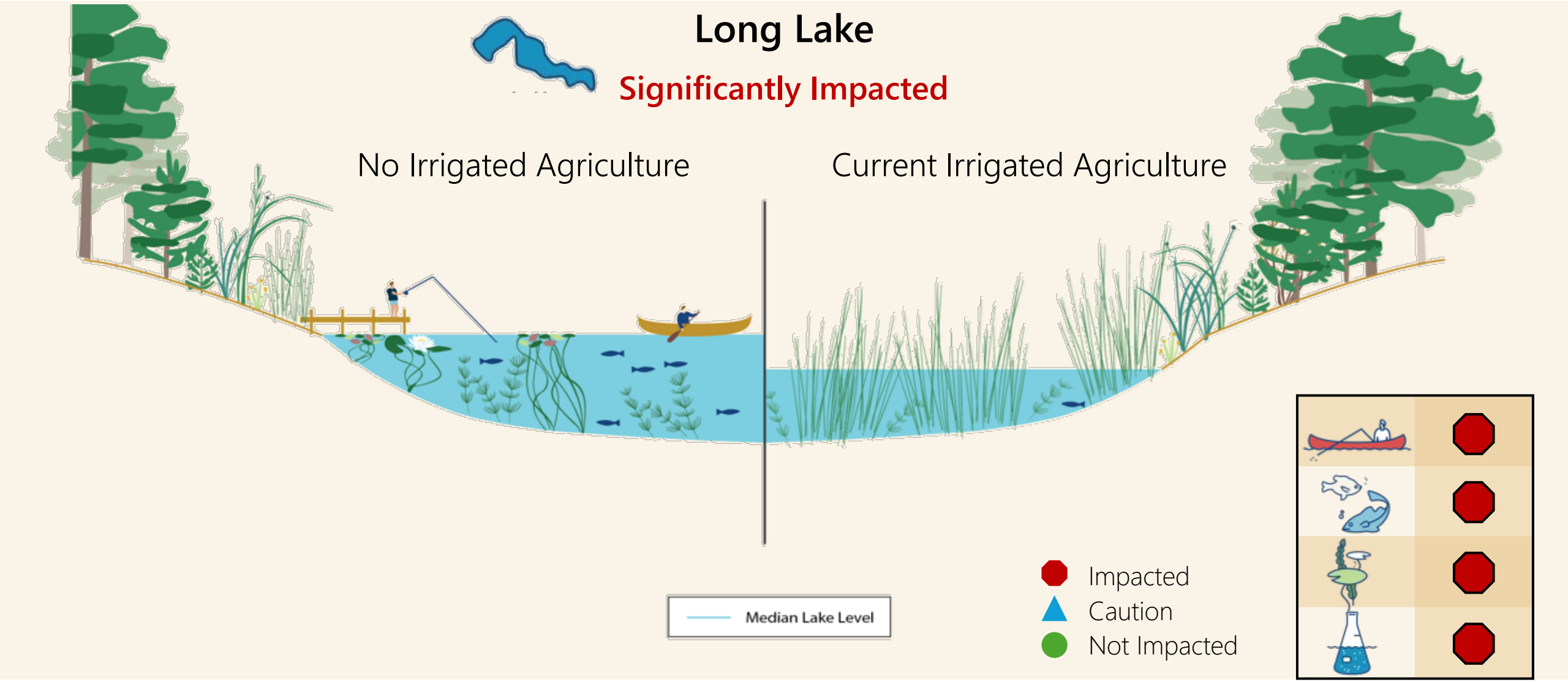
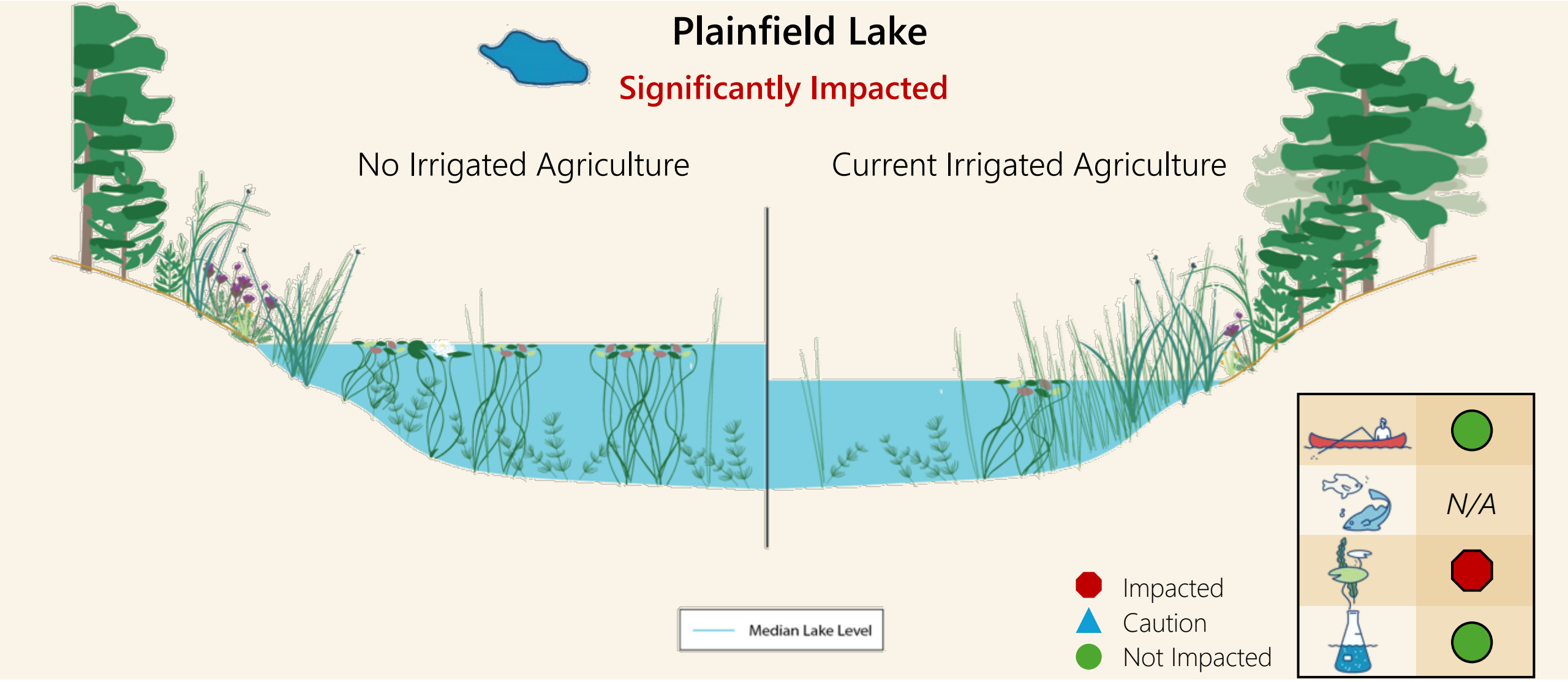
https://dnr.wisconsin.gov/topic/Wells/HighCap/CSLStudy.html

IMPACT CONCLUSIONS FOR LONG LAKE



https://dnr.wisconsin.gov/topic/Wells/HighCap/CSLStudy.html

IMPACT CONCLUSIONS FOR PLAINFIELD LAKE



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https://dnr.wisconsin.gov/topic/Wells/HighCap/CSLStudy.html

Streams

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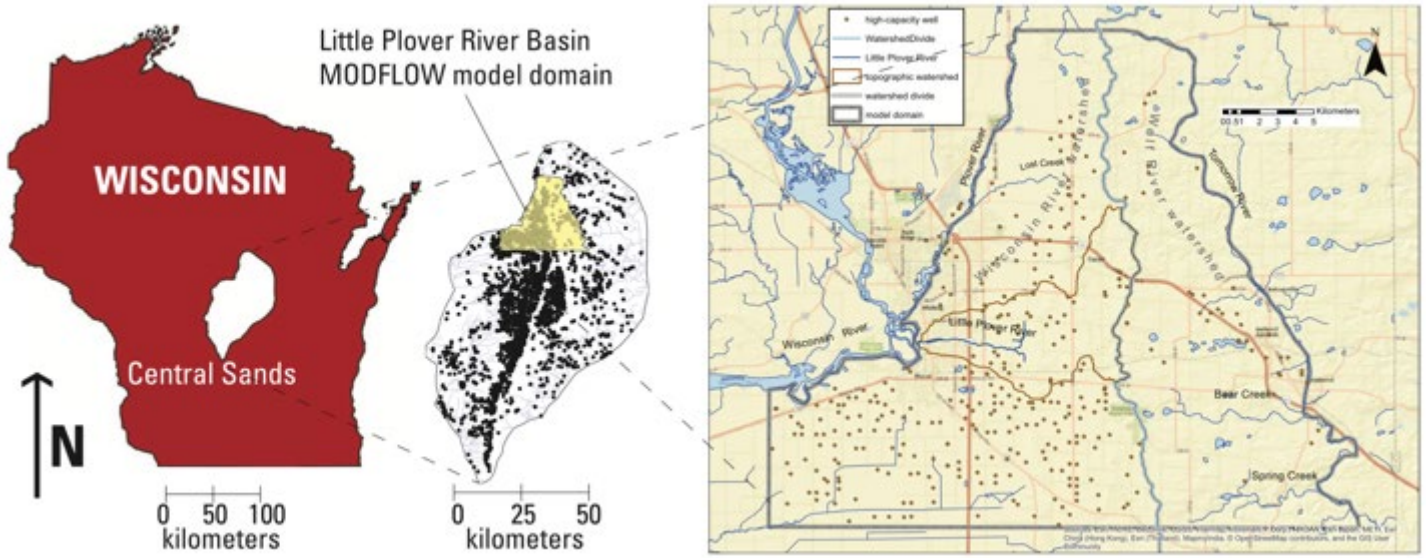
Management optimization for ecological flows in the Little Plover River, Wisconsin



BEFORE THE

DEPARTMENT OF NATURAL RESOURCES

In the Matter of the Establishment of)
Public Rights Stage(s) / Flow(s) for the Little) IP-WC-2009-00223
Plover River, Portage County.)

FINDINGS OF FACT AND ORDER

The Department, under the authority granted pursuant to s. 31.02, Stats., and in response to a request of the following conservation groups; River Alliance of Wisconsin, Wisconsin Wildlife Federation and Trout Unlimited, herein establishes a minimum Public Rights Flow(s) (PRF) for the Little Plover River (LPR) located in Portage County, whereby the PRF may not be lowered, with exception to natural changes in precipitation (droughts). The PRF is that water quantity or level necessary to protect public rights and interests in the LPR.

CONCLUSIONS OF LAW

The department has authority under Section 31.02 (1), Wis. Stats. to regulate and control the levels and flow of water in the interest of public rights in navigable waters, and in accordance with the foregoing Findings of Fact, to issue an order establishing a public rights flow(s) for the Little Plover River.

The Department has complied with Section 1.11, Wis. Stats., Wisconsin's Environmental Policy Act and chs. NR 102, 103 and 1.95, Wis. Adm. Code.

ORDER

THE DEPARTMENT THEREFORE, ORDERS:

The public rights flow for the Little Plover River at Kennedy Road is 1.9 cfs.
The public rights flow for the Little Plover River at CTH R is 4.0 cfs.
The public rights flow for the Little Plover River at I39 is 5.8 cfs
The public rights flow for the Little Plover River at Hoover Road is 6.8 cfs.

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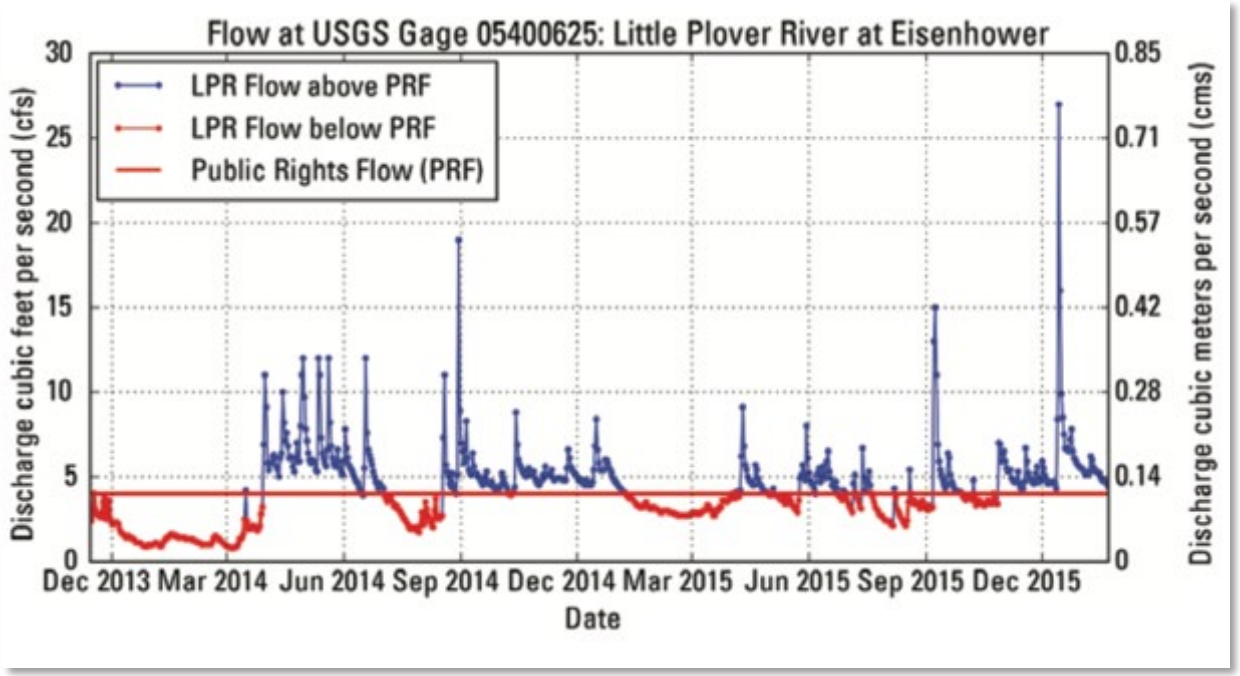
Fienen et al. (2017) doi:10.1111/gwat.12536

The Little Plover often drops below public rights flow – sometimes it goes dry



Little Plover River in 2019
Photo from Dr. George Kraft, UW Stevens Point

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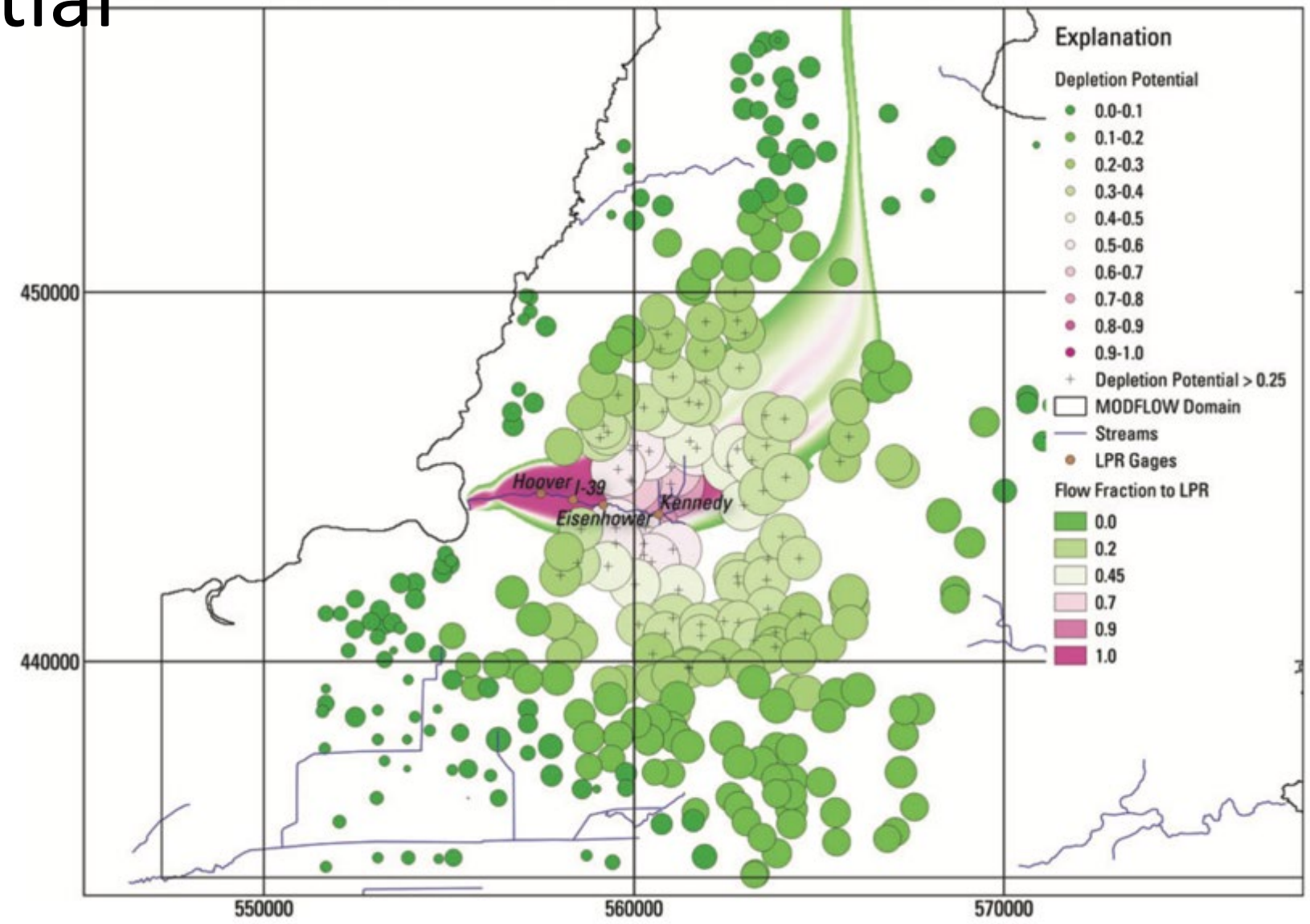
Using a model to map out depletion potential



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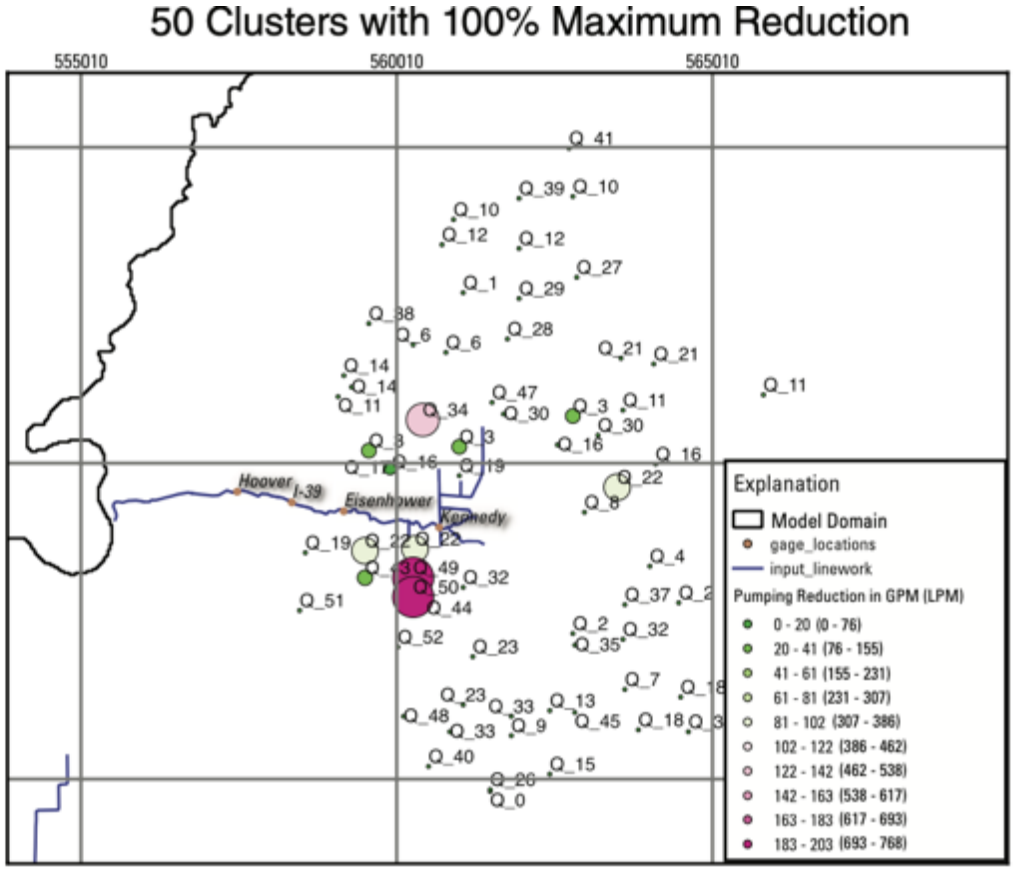
Management Optimization – sequential linear programming



Scenario	Total Pumping Reduction
All wells equal reduction	30%
Maximum reduction per well 35%	26%
Maximum reduction per well 100%	20%

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Thanks! Here are some references

Central Sands Lake Study:

USGS report:
https://pubs.usgs.gov/publication/sir20225046

WI DNR Website and report:
https://dnr.wisconsin.gov/topic/Wells/HighCap/CSLStudy.html

Little Plover River Streamflow Depletion:

WGNHS Report:
https://home.wgnhs.wisc.edu/little-plover-river-groundwater-model/

Groundwater Paper:
https://ngwa.onlinelibrary.wiley.com/doi/abs/10.1111/gwat.12536

Follow on work in the Little Plover River Watershed:
https://www.wisconsinwetlands.org/updates/what-is-lprwep/

1960s Little Plover River Movie (this is amazing – worth 20 minutes of your time!)
https://youtu.be/GW9cYdIT8iM?si=3yU3d8JtaYPyPbmU

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