Importance of Urban and Non-urban Nutrient Reductions

Katrina Kessler, P.E. | Assistant Commissioner
February 18, 2020
Outline – Nutrients in waters

1. Why important to reduce nutrient losses?
2. Conditions & trends
3. Sources – urban & ag important
4. We’ve made progress, but there’s more we need to do
5. Minnesota’s nutrient reduction strategy addresses both urban and agricultural sources
Why important? Local lake & stream impairments

Effects:
- less oxygen for fish
- toxic blue-green algae
- recreation/economic declines

693 lakes impaired

814 river miles impaired
Why important?  Downstream water algae blooms

**Lake Pepin**
Needs 35% P reduction

**Lake Winnipeg**
Needs 50% N & P reduction in Red River

**Gulf of Mexico**
Needs 45% reduction of both N and P to reduce hypoxic zone to 1/3 current size

- **Lake Pepin**: 35% from a 2008-17 baseline
- **Lake Winnipeg**: 50% from a late 1990’s baseline
- **Gulf of Mexico**: 45% from a 1980-96 baseline
Why important?  Aquatic life nitrate toxicity

Lab results show some species harmed by 5 to 20 mg/l nitrate-N.
Levels commonly found in southern MN streams.
Nitrate as a biological stressor

MN stream monitoring shows nitrate as one factor that negatively affects the biological health of our waters

• 286 of 756 (38%) biologically impaired reaches have nitrate as one stressor
Why important?  Drinking water – local wells

Private Wells

110+ townships have over 10% of wells exceeding nitrate standard

Community water systems

13 with nitrate over 10 mg/l
26 with nitrate 5-10 mg/l
Why important? Drinking water – surface waters

Examples

City of Fairmont, Minnesota

MN headwaters to Iowa Rivers
Des Moines and Cedar Rivers
Examples of economic hits

- lost nutrients to water = lost fertilizer value
- Recreation and tourism in MN & Canada
- Well water treatment for nitrate
- Shell-fish industry in the Gulf of Mexico
Nutrient River conditions and trends

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River phosphorus concentration 10-year trends

Highest phosphorus in west & south

P decreasing or
Non-significant trend

Trend methods correct for river flow variability
Mississippi River phosphorus concentration decreased from 1999-2018 but flow increase makes P load trends non-significant.

Phosphorus Concentration \times \text{Flow} = \text{Load}

- 20 - 50% decrease in concentration
- 40% increase in flow
- NS: Non-significant trends

4-7 inches more rain per year in Southern MN
River nitrate concentration 10-year trends

Highest nitrate in southern MN

Nitrate increasing or no significant trend

Corrected for flow variability

2008-2017
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Statewide sources to rivers differ for N & P

Source: MPCA & UMN 2013

Source: MPCA et al., 2014
Sources and pathways vary by region

Nitrogen to Rivers

**Minnesota River Basin**
- Cropland Groundwater: 18%
- Cropland Tile Drainage: 67%
- Crop Runoff: 4%
- Forest: 1%
- Other NPS: 2%
- Atmospheric: 3%
- Point Sources: 5%

**Lower Mississippi River Basin**
- Cropland Groundwater: 57%
- Cropland Tile Drainage: 23%
- Crop Runoff: 9%
- Forest: 2%
- Atmospheric: 2%
- Point Sources: 5%
Important to reduce Urban sources of N & P

**Nitrogen**
- Cropland groundwater baseflow: 30%
- Cropland tile drainage: 37%
- Forests: 7%
- Atmospheric: 9%
- Wastewater: 9%
- Urban Stormwater: 1%
- Septic: 2%
- Feedlot runoff: <1%

**Phosphorus**
- Cropland: 37%
- Wastewater point sources: 17%
- Forest & grasses: 8%
- Urban & road runoff: 8%
- Atmospheric: 10%
- Septic/feedlots: 6%
- Streambank erosion: 14%

Source: MPCA & UMN 2013
Source: MPCA et al., 2014
Important to reduce Cropland N & P losses

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Agricultural progress

- Historic P reduction progress through conservation
  - 48% agricultural P reduction to Minnesota River Basin during decades prior to 2006 (CEAP)
  - 23% modeled agricultural P reduction statewide 1997-2013 (NRS)

- Nitrogen Use Efficiency for corn increased by over 40% since early 1990's (MDA)

- MN Agricultural Water Quality Certification
  - Over ½ million acres certified, and growing
Wastewater nutrient discharges – 2000 to 2018

P

>70% reduction

Nitrogen (kg)

Mississippi River Basin
Lake Superior
Lake Winnipeg

Mississippi River Basin
Lake Superior
Lake Winnipeg

2018
2015
2014
2012
2010
2008
2006
2004
2002
2000
2018
2015
2014
2012
2010
2008
2006
2004
2002
2000
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018

Phosphorus (kg)
Other urban progress

• Lawn fertilizer phosphorus restricted since 2004
  • Turf N & P fertilizer about 2% of all fertilizer

• Urban stormwater runoff program regulates:
  • 2000-2500 construction projects per year
  • 250+ municipalities
  • >3900 industrial permits
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Minnesota’s Nutrient Reduction Strategy

Finalized in 2014 by 11 orgs.
Public review in 2013

https://www.pca.state.mn.us/water/nutrient-reduction-strategy
Most watersheds have completed strategies or in-progress.
How many new BMP acres needed to achieve 2025 milestones? (statewide scenario for both N & P)

- Reduced tillage & soil conservation: 4.9 M
- Crop nutrient mgmt efficiencies: 6.3 M
- Drainage water storage/treatment: 0.6 M
- Perennials - fuel, forage, food, buffers & set-aside: 0.5 M
- Cover crops - relay, intercrop, winter annuals: 1.9 M

Plus advance:
- Urban Wastewater
- Urban runoff
- Septic systems
Concluding remarks

• We’ve made a lot of progress over the decades (especially with phosphorus) but we still have a long ways to go.

• We are working hard to avoid leaving a pollution legacy that our children and grandchildren will have to address.

• Nutrients are statewide problem and it requires all citizens and business sectors to be involved with solutions.
  • Ag/urban partnerships are increasing – let’s continue working together
Questions?
• Note: We could add the next few slides about Minnesota’s nutrient reduction strategy, but for the sake of time, we probably should just leave them out of this talk and defer to Glenn’s talk.
Wastewater nitrogen – typically 10-25 mg/l

Average cropland tile-drainage nitrate concentrations (8-30 mg/l) are similar to city wastewater.

Source of tile-drainage nitrate range (MDA monitoring of Discovery Farms & other sites)
Mississippi River Phosphorus Goals

- **Wastewater**: 33% reduction
- **Cropland**: 45% reduction
- **Other**

1997: 4,600 tons
2014: 2,500 tons
2025: (estimated)
New BMP acreages for milestones & final goals

Huge scale of new acreages needed

Million acres of cropland affected

- Reduced tillage & soil conservation: 5
- Crop nutrient mgmt efficiencies: 6
- Drainage water storage/treatment: Final goals
- Perennials - fuel, forage, food, buffers & set-aside: Final goals
- Cover crops - relay, intercrop, winter annuals: Final goals

Final goals
<table>
<thead>
<tr>
<th>Major basin</th>
<th>2014 to 2025 (Milestones)</th>
<th>“final” goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mississippi River</td>
<td>12% for P (of pre-2000 baseline loads)</td>
<td>45% &amp; meet MN lake &amp; river standards</td>
</tr>
<tr>
<td></td>
<td>20% for N</td>
<td></td>
</tr>
<tr>
<td>2. Red River &amp; Lake Winnipeg</td>
<td>10% for P</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>13% for N</td>
<td></td>
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<tr>
<td>3. Lake Superior</td>
<td>No net increase from 1970’s</td>
<td></td>
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<tr>
<td>Statewide Groundwater/</td>
<td></td>
<td>Meet 1989 Groundwater Protection Act Goals</td>
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<tr>
<td>Source Water</td>
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Minnesota’s nutrient reduction strategy to address both urban and agricultural sources

- Brief overview of the strategies for both urban and agricultural sources
- Brief mention of watershed WRAPS and 1W1P efforts to reduce urban and ag sources
• Question and A
Change in nitrogen loads between 2005 and 2018

Effluent nutrient data are not widely available for the Nutrient Reduction Strategy baseline years so 2005 is used for display.

Kilogram change since 2005
- Decrease >100k
- Decrease 0-100k
- Increase 1-100k
- Increase >100k

Basin
- Gulf of Mexico
- Lake Superior
- Lake Winnipeg

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Percent reduction goal</th>
<th>Baseline (MT)</th>
<th>Target (MT)</th>
<th>Current level (MT)</th>
<th>Progress towards goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gulf of Mexico</td>
<td>20%</td>
<td>9,600</td>
<td>7,680</td>
<td>12,460</td>
<td>38% needed</td>
</tr>
<tr>
<td>Lake Winnipeg</td>
<td>13%</td>
<td>300</td>
<td>261</td>
<td>935</td>
<td>72% needed</td>
</tr>
<tr>
<td>Lake Superior</td>
<td>No net increase</td>
<td></td>
<td></td>
<td>1,122</td>
<td>-</td>
</tr>
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Phosphorus and phosphorus-free lawn fertilizer used\(^2\) statewide

![Bar chart showing the comparison of phosphorus-free and with phosphorus lawn fertilizer usage from 2003 to 2006.](chart.png)

- **Start of metro area restrictions:** 2003
- **Start of statewide restrictions:** 2004

- 2003: Phosphorus-Free 44%, With Phosphorus 56%
- 2004: Phosphorus-Free 45%, With Phosphorus 55%
- 2005: Phosphorus-Free 21%, With Phosphorus 79%
- 2006: Phosphorus-Free 18%, With Phosphorus 82%
FWMC
flow-weighted mean concentration

T. Phosphorus
FWMC
flow-weighted mean concentration

T. Phosphorus
Percent of watersheds in cropland
High nitrate water in highly tiled watersheds
20-year phosphorus trends - showing improvements

Phosphorus concentrations (flow-corrected)

28 sites
21 – decreasing 15-55%
6 - no significant trend
1 - increase
20-year nitrate trends do not show many improvements

Nitrate concentrations (flow-corrected)

28 sites
3 – decreasing
11 - no significant trend
14 - increasing
Lake Clarity Trends

Source: MPCA 2019
Phosphorus in Rivers (20 years - corrected for flow variability)

1999 – 2018 Trends (QWTREND)

Mississippi R., Anoka
-26%

Minnesota R., Jordan
-17%

Mississippi R., Red Wing
-21%

Source: Metropolitan Council

-50% at Winona
QWTREND 1997-2017

Source: MPCA
Nitrate in rivers (20 year - adjusted for flow variability)

1999 – 2018 Trends (QWTREND)

- Mississippi R., Anoka +34%
- Minnesota R., Jordan NS
- Mississippi R., Red Wing +34%

Source: Metropolitan Council

Resampled Seasonal Kendall Results
90% Significance Flow Corrected
Nitrate + Nitrite
1998-2017

Trend Significance
- **SIGNIFICANT DECREASING**
- **SIGNIFICANT INCREASING**
- **NO SIGNIFICANT TREND**
- >50% CENSORED

Source: MPCA
Minnesota Average Annual Precipitation, by Decade

1895-1899 Average: 25.72"

1990-2018 Average: 28.15" (9.5% wetter)
Clean Water Fund Projects 2010 - 2019

Projects by Major Basin

- 2,390 Projects
- 41 Projects
- 3,585 Projects
- 119 Projects
- 571 Projects

Graph showing the percentage of lakes meeting goals from 2008 to 2017.
Lake Assessments (Aquatic Recreation Use - AQR)
Eutrophication - Phosphorus, Chlorophyll, and Secchi Transparency

Percent Assessed Lakes Supporting AQR

- >80
- 60 - 80
- 40 - 60
- 20 - 40
- 0 - 20
- Watersheds With No Assessed Lakes
Stream nitrate monitoring

- Very low: <1 mg/L
- Low
- Medium: 3-5 mg/l
- High
- Exceeds 10 mg/l
Annual Total Nitrogen Loads to the Gulf

- Annual Loads
- Flow-normalized Loads
- Provisional Flow-normalized Loads
- 95% confidence interval

(Baseline Average 1980-96)

(5-year moving average)

(20% Reduction Target)

(45% Reduction Target)
**Coastal Goal**
By 2035, reduce 5-year running average size of the Gulf hypoxic zone to 5,000 km²

**Interim Target**
20% reduction of N & P loading from the MARB by 2025

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(N. Rabalais, LSU/LUMCON & R. Turner, LSU)
River nutrient concentrations vary greatly across MN.
Mississippi River Phosphorus Goals

Phosphorus reduced into Mississippi River 1997-2013

Note: 48% agric. P reduction to Minnesota River Basin during decades prior to 2006
Based on National Conservation Effects Assessment Project (USDA 2010).