ROOT RIVER FIELD TO STREAM PARTNERSHIP

Pesticide Project

FIELD TO STREAM PARTNERSHIP

The Root River Field to Stream Partnership (RRFSP) is a multi-organizational effort to evaluate agricultural practices and water quality at multiple scales and landscape settings. The strategic selection of these study watersheds allows the findings to be applied to similar areas across southeastern Minnesota.

PESTICIDE PROJECT

In 2012, the Minnesota Department of Agriculture (MDA) began testing for 51 different pesticide chemicals at the three RRFSP stream outlets. Samples were analyzed by the MDA Laboratory. These data were paired with surveyed pesticide application records. This handout summarizes pesticide results from eight years; 2012-2019.

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DEPARTMENT OF AGRICULTURE

CLEAN WATER LAND & LEGACY AMENDMENT

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PESTICIDE MONITORING

The MDA Pesticide and Fertilizer Management Division has been monitoring pesticides in Minnesota surface water since 1991. Pesticide water quality samples were collected from three small watershed monitoring stations in the Root River Watershed from 2012-2019 as a special study.

Crystal Creek, one of the three small watersheds monitored during this study.

PESTICIDE DETECTIONS

- **Pesticide active ingredients (AIs) were detected in all three watersheds every year**, with one exception. Pesticides were not detected in Crystal Creek in 2017.
  - Active ingredients are the chemicals in pesticides that kill, control or repel pests.
- A total of **656 pesticide samples** were analyzed from 2012-2019 among the three watersheds.
- **11** different pesticide AIs or pesticide AI degradates were detected (out of up to 51 analyzed).
- In all three streams, the herbicides **acetochlor**, **atrazine**, **dimethenamid**, **metolachlor** and **propazine**+ and the degradates of the herbicide atrazine (**deisopropylatrazine** and **desethylatrazine**) were detected at least once.
  - These pesticides (and degradates) are typical of other surface water pesticide detections around the state of Minnesota.
- **Detection frequency** (DF) refers to the number of samples collected versus the number of times a pesticide was detected**. The parent AIs atrazine, metolachlor and acetochlor had the greatest detection frequency**.
  - Among all three watersheds, the eight-year atrazine DF ranged from 37-85%, metolachlor from 28-85% and acetochlor from 11-31%.

ELEVATED CONCENTRATIONS

- **28 samples** out of 656 samples collected over eight years had concentrations that were above an aquatic life numeric water quality reference value.
- Elevated concentrations typically occurred in **May** and **June** over a short duration, lasting less than **21 hours**.

Pesticide and nutrient sample bottles collected as part of the pesticide project.

- To exceed a Minnesota chronic reference value, the concentration must be elevated for a specified duration of time, generally **96 hours** (4 days).
- Watersheds and years where pesticide concentrations were elevated above a numeric reference value include:
  - **Headwaters** (South Branch of the Root River)**:** acetochlor (2013, 2014, 2018, 2019), atrazine (2014, 2019), bifenthrin (2013), chlorpyrifos (2017♦) and metolachlor (2019).
  - **Crystal Creek**: acetochlor, metolachlor and tebupirimfos (phostebupirim) (2013).
  - **Bridge Creek:** acetochlor (2013*, 2014, 2018) and atrazine (2013*).

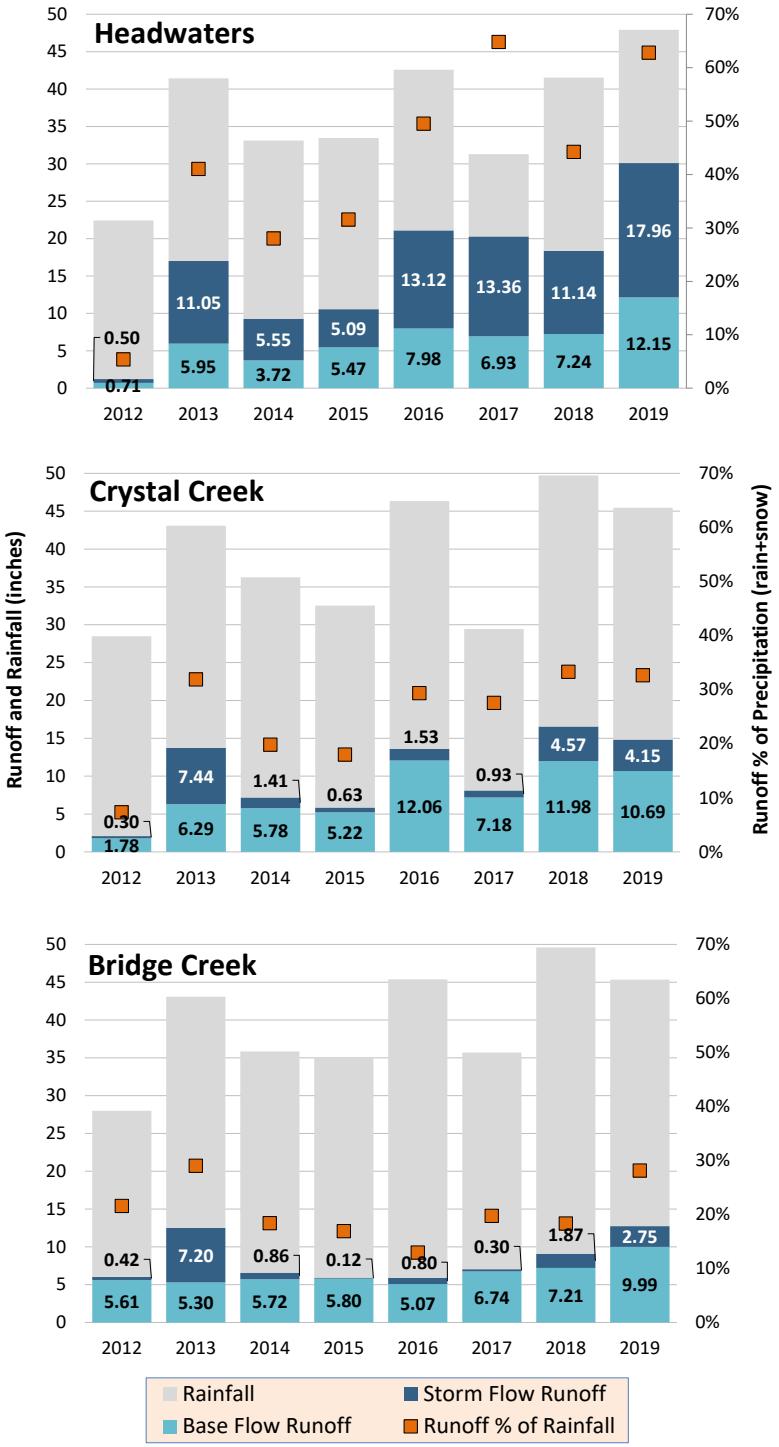
\+ Propazine is not registered for use in Minnesota. Detections occurred in tandem with elevated atrazine concentrations and are considered an impurity of atrazine product formulations. For further information, see the finalized Root River Pesticide report.

* Above a Minnesota chronic (4-day) standard.

♦ Exceeded both Minnesota chronic (4-day) and Minnesota maximum (acute) standards.

RUNOFF AND PRECIPITATION

- Over the eight years monitored, the average precipitation was **near normal to slightly above**: Headwaters at **-2%**, Crystal Creek at **6%** and Bridge Creek at **8%** above normal. It was a mix of dry and wet years (40% below normal to 35% above normal). Overall, annual and growing season rainfall averages continue to increase which may have implications for pesticide loss and delivery to Minnesota streams.
- **Runoff** was highest in the **Headwaters**, even though it was not monitored year-round.
- **Runoff (8-year average):**
  - Headwaters: 15.99 inches
  - Crystal Creek: 10.24 inches
  - Bridge Creek: 8.22 inches
- **Storm flow** is elevated flow from rainfall or snowmelt. Storm flow as a percentage of total runoff varied from 58% in the Headwaters (more direct connection from the landscape to the stream with artificial drainage) down to 22% and 17% in Crystal Creek and Bridge Creek (spring-fed), respectively.
- **The proportion of precipitation measured as runoff varied across the three watersheds.** Overall, the Headwaters measured over twice as much runoff as a percentage of precipitation (rain+snow) compared to Bridge Creek (median 43% versus 19%). In addition to land use, geology and soil-type differences, the subsurface agricultural drainage network in the Headwaters Watershed is likely an important factor affecting water movement from the landscape to the stream.

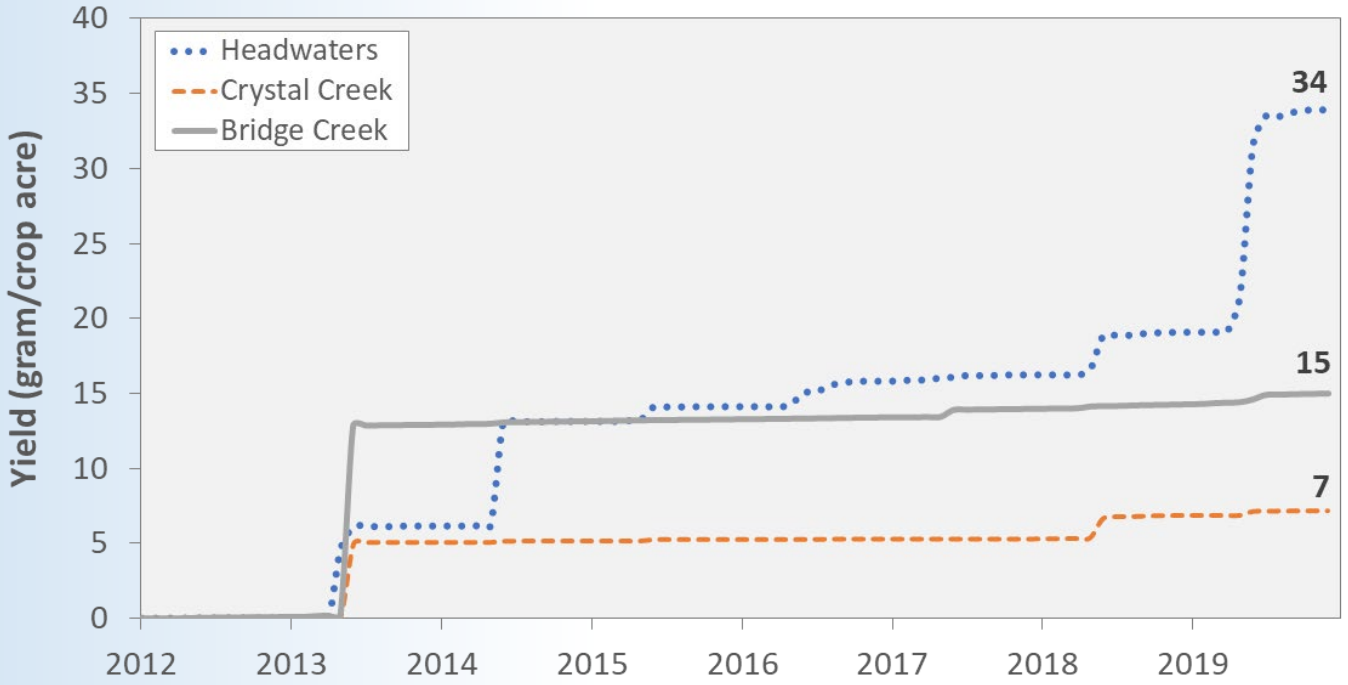


Base flow and storm flow annual runoff (inches) compared with annual rainfall in the Headwaters, Crystal Creek and Bridge Creek Watersheds.

PESTICIDE LOSSES

Summary of all three watersheds

- **Pesticide loading was greatest in June (75%),** followed by May (14%) and July (5%). This generally coincided with the time when most herbicides were being applied, crops were not fully established (less water uptake and more bare soil) and there were high intensity rainfall events.
- **88%** of pesticide loading occurred during periods defined as **storm flow**.
- **Individual years stood out as large contributors to overall pesticide loading.** 2013 accounted for 67% of the Crystal Creek load and 85% of the Bridge Creek load when compared to the eight-year total pesticide loads. For the Headwaters, 2019 made up 44% of the eight-year pesticide load.
- The months with the highest pesticide loading all occurred when the monthly rainfall was 17% to 167% **above** the 30-year monthly Normal precipitation (1991-2020).
- Overall, **one percent or less** of the total active ingredient pesticides surveyed in the study watersheds as being applied were detected in the water quality samples collected from the three streams.



2012-2019 cumulative pesticide yield (grams per crop acre) for the Headwaters, Crystal Creek and Bridge Creek Watersheds (1 gram is equal to 0.0022 lb.). Only a few years or months accounted for most of the cumulative pesticide loss. 94% of all pesticide losses occurred in May, June and July and typically during months with rainfall that measured 17-167% above the 30-year Normal (1991-2020).

Headwaters Watershed

- The total cumulative pesticide loss was **193 lbs** (34 grams/crop acre) with 91% of that total occurring in four out of eight years (2013 – 35 lbs, 2014 – 40 lbs, 2018 – 16 lbs, 2019 – 85 lbs).
- Out of 96 monitored months, **six months** accounted for **82%** of the total pesticide load.
- On average, **95%** of the total pesticide load occurred in May (23%), June (65%) and July (7%).
- **91%** of the pesticide losses happened during periods defined as **storm flow**. More research is needed to better understand the proportion of loss through sub-surface drainage versus surface pathways.

Crystal Creek Watershed

- Lowest pesticide losses compared to the other two watersheds. The total cumulative pesticide loss was **44 lbs** (7 grams/crop acre).
- There were **no pesticide detections** in 2017.
- 2013 was unique for pesticide loading in that over **95%** of the total annual load occurred within the month of June.
  - June 2013 was 5.34 inches above the 30-year Normal for precipitation and accounted for 67% (31 lbs.) of the total pesticide load measured in the watershed for the entire study period.
- **98%** of the pesticide loading occurred in May through July (**91%** in **June** alone).
- Flow periods defined as **storm flow** accounted for **79%** of the total pesticide losses on average.

Bridge Creek Watershed

- Loads in Bridge Creek were similar to Crystal Creek in that the majority of the pesticide loading occurred in 2013.
- The total cumulative pesticide loss in Bridge Creek was **87 lbs** (15 grams/crop acre).
- **85%** of the eight-year cumulative pesticide load occurred in 2013 (74 lbs).
  - June 2013 was 5.84 inches above the 30-year Normal for precipitation, resulting in 98% of the pesticide losses in 2013.
- **One month** out of the 96 monitored months comprised **84%** of the entire pesticide load over the eight-year period.
- **89%** of the pesticide losses occurred during the month of **June** (94% from May through July).
- **92%** of the pesticide loading occurred during periods defined as **storm flow**.

PESTICIDE APPLICATIONS

- **92%** of farmers in the monitored watersheds were surveyed (44/48) for pesticide use information from 2012-2017. Crop retailers and sales agronomists were also surveyed.
- Over **8,700** individual pesticide applications were documented, with **80** different pesticide products and **51** active ingredients applied among the three watersheds.
- Pesticide records were available for an average of **82%** of crop acres within the Headwaters, Crystal Creek and Bridge Creek Watersheds.
- **98%** of the surveyed pesticide active ingredients applied were **herbicides**.
- From 2012-2017, an estimated total of **23,500 lbs** of pesticides were applied in the Headwaters, **32,416 lbs** in Crystal Creek and **23,341 lbs** in Bridge Creek. On a total mass basis, the specific analytical method run by the MDA Laboratory for this project was able to analyze **27%** (Headwaters - 6,463 lbs), **50%** (Crystal Creek - 16,060 lbs) and **35%** (Bridge Creek - 8,281 lbs) of the total surveyed pounds of pesticide active ingredients applied.
    - It is important to note that glyphosate made up most of the difference between what was surveyed as being applied and what was not analyzed (62% in the Headwaters, 43% in Crystal Creek and 57% in Bridge Creek).

Headwaters (glacial till landscape)

Crystal Creek (karst landscape)

Bridge Creek (bluffland landscape)

KEY TAKEAWAY This study provided a unique opportunity for the collection of pesticide use and water quality data that enhances our understanding of pesticide use and transport in three small watersheds of the Root River Watershed. The results indicated that pesticide losses were generally low (less than 1% of applied product) and concentrations rarely exceeded established reference values. Pesticide losses were highly seasonal with most pesticide transport to streams occurring during the month of June, following herbicide applications to fields. The results further reinforce the need to minimize runoff from agricultural lands during this critical time. With an increasing trend towards higher annual rates of precipitation and more intense rainfall events early in the growing season, it may not always be possible to avoid applications during these high-risk time periods. For this reason, farmers could consider targeting additional layers of protection such as grassed waterways and edge of field prairie strips to help reduce runoff and pesticide delivery.

Scan the QR code for further information on **pesticide best management practices**.

Scan the QR code for the full **Root River Field to Stream Partnership Pesticide Project** report.

Scan the QR code for the **Stream Power Index** tool.

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