

Stream Runoff



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.

Phase I

Determine the range of sediment and nutrient losses associated with runoff from three small watersheds that are representative of southeastern Minnesota. Results from three study watersheds, collected over a twelve-year study period from 2010-2021 (36 site years) are summarized.

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Runoff

The percent of annual precipitation measured as runoff (runoff ratio) averaged 22-43% by each watershed. Runoff in streams includes both groundwater and surface water. For comparison, the runoff ratio in edge-of-field surface runoff averaged 7% and 32% in subsurface tile.



In-stream monitoring station at the outlet of Bridge Creek watershed in the bluffland landscape.

- In the till watershed, the percentage of streamflow as stormflow and baseflow were similar or about 50%. In contrast, 80-90% of the streamflow in the karst and bluffland watersheds occurred during baseflow conditions. These landscapes are greatly influenced by local and regional groundwater contributions.
- Significantly more runoff occurred in the till watershed (Figure 1). Differences in soils, tile drainage, land use, and stream connectivity are key factors.

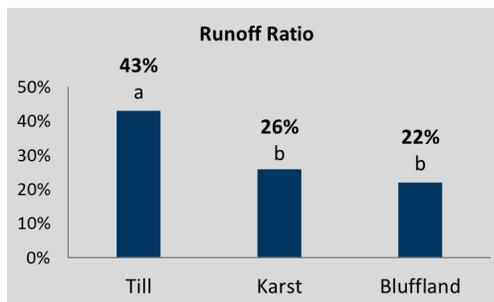


Figure 1. Average annual runoff expressed as a percentage of precipitation between three study watersheds from 2010-2021. Sites that do not share the same letter are significantly different.

High Risk Periods

- Sediment, nutrient, and pesticide loss to streams peak at varying times of the year. Understanding these risk periods is key to reducing loss.
- A disproportionate amount of runoff in May and June (30%) produced 62% of the sediment, 45% of the nutrients and 89% of the annual pesticide loss (Figure 2). Reduced tillage, grassed waterways, water/sediment basins and perennials are key practices to reduce loss during this period.

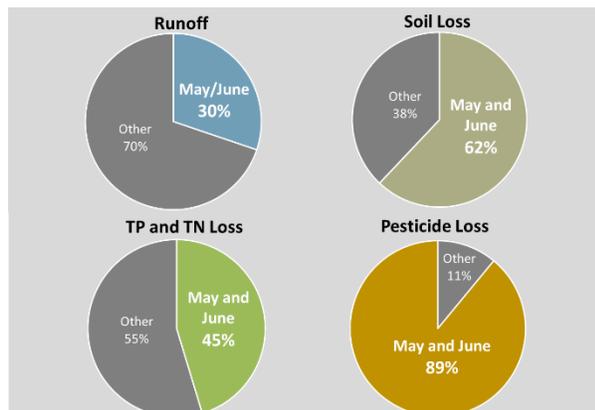


Figure 2. Timing of runoff, sediment, nutrient and pesticide loss across three small watersheds from 2010-2021. Pesticide loss reflect years 2012-2019.

Precipitation & Runoff

- **Precipitation** averaged 2% below normal (1991-2020 normal) during the study period with a mix of dry, normal and wet conditions. There were no significant differences between watersheds. 2011 was the driest year (26.5") and 2018 (47.0") was the wettest.
- **Runoff:** (includes both surface runoff and groundwater) averaged 11 inches or 30% of annual precipitation with an average of 69% occurring during baseflow conditions. Runoff ratios in the karst and bluffland were similar, but significantly higher in the till watershed.
- **May and June** accounted for 30% of the annual runoff.

Sediment Loss

- **Average sediment loss:** 633 lb/ac. (0.32 tons/ac.) with an average range of 325 to 1,097 lb/ac by each watershed. There were no statistical differences between watersheds on an annual basis, but when analyzed by storm event the bluffland had significantly higher sediment, phosphorus (TP and DOP) and organic N loss.
- **May and June** accounted for 62% of the annual loss. During this critical time, fields were prepared for planting, but not at full canopy. Reduced tillage, grassed waterways, water and sediment control basins and perennials are key practices.
- **Sediment fingerprinting** indicates 60-70% of the sediment in the karst and bluffland watersheds is derived from agricultural fields. In contrast, field sediment sources measured at the outlet of the Root River is 44%. Sediment at this large scale is largely sourced from stored sediment in floodplains and transported from streambank erosion sites.

Total Phosphorus Loss

- **Average total phosphorus (TP) loss:** 0.9 lb/ac with an average range of 0.6 to 1.2 lb/ac by each watershed. Dissolved phosphorus (not attached to sediment) represented 24% of TP loss.
- **May and June** accounted for 45% of the TP loss.
- **Phosphorus and Sediment connection:** There is a strong relationship and for every 1,000 lb/ac. of sediment loss, 1.2 lb/ac. of TP is lost.

Total Nitrogen Loss

- **Total Nitrogen (TN):** includes ammonia, nitrate and organic forms. TN loss averaged 26 lb/ac with an average range of 11 to 43 lb/ac with significant differences between each watershed, with descending losses from west to east.
- **May and June** accounted for 39% of the TN loss.
- **Nitrate-N:** around 90% of the nitrogen measured in the till and karst watersheds was in the nitrate form. Due to higher soil loss, a smaller proportion of nitrate, 63%, was measured in the bluffland.
- **Groundwater transport:** There's a poor relationship between soil loss and TN indicating that most nitrogen at the watershed scale is transported to streams with groundwater.
- **Key Practices:** Fine-tuning nitrogen rates, split applying nitrogen, crediting legumes and manure, growing perennials, and using cover crops are important practices to reduce nitrate loss to groundwater.

12-Year Average Annual Loss, 2010-2021

Sites that do not share the same letter are significantly different at the 0.05 level

RUNOFF

11 in. (30% of annual precip.)

Till - 14 inches, 43% (a)

Karst - 10 inches, 26% (b)

Bluffland - 8 inches, 22% (b)

SEDIMENT

633 lb/ac

Till - 477 lb/ac (a)

Karst - 325 lb/ac (a)

Bluffland - 1,097 lb/ac (a)

TOTAL PHOSPHORUS

0.9 lb/ac

Till - 0.8 lb/ac (a)

Karst - 0.6 lb/ac (a)

Bluffland - 1.2 lb/ac (a)

TOTAL NITROGEN*

26 lb/ac

Till - 43 lb/ac (a)

Karst - 23 lb/ac (b)

Bluffland - 11 lb/ac (c)

*Monitoring years 2013-2021



Root River Field to Stream Partnership



Minnesota Department of Agriculture
Minnesota Agricultural Water Resource Center
The Nature Conservancy

Mower SWCD
Fillmore SWCD
Root River SWCD