Quantifying Sediment Sources in the Pickering Creek
(leave ppt, switch to live view of story map)
Erosion Rates on Cropland, 1982-2007, by Farm Production Region (Tons per Acre per Year)

33% reduction in sediment yield/acre in 25 years, local adoption of no till and BMPs ongoing.

National Totals:
- 1982: 7.3
- 1987: 6.9
- 1992: 5.7
- 1997: 5.0
- 2002: 4.9
- 2007: 4.8

Erosion rates include both water (sheet & rill) and wind erosion rates.

Map ID: 10979
Data Source:
2007 National Resources Inventory
U.S. Department of Agriculture, Natural Resources Conservation Service

Map Source:
U.S. Department of Agriculture, Natural Resources Conservation Service
Resources Inventory and Assessment Division, Washington, DC December 2009
Multiple trends in the Pickering are driving changes in water quality over the past 50 years.

- Increasing forest cover acres, increase in riparian forest, and increase in forest biomass per forest acre.
- Decreasing ag lands acres and decreasing soil loss per acre.
- Increasing urban and suburban development.

The Biological Condition Gradient: Biological Response to Increasing Levels of Stress

Levels of Biological Condition

Level 1. Natural structural, functional, and taxonomic integrity is preserved.

Level 2. Structure & function similar to natural community with some additional taxa & biomass; ecosystem level functions are fully maintained.

Level 3. Evident changes in structure due to loss of some rare native taxa; shifts in relative abundance; ecosystem level functions fully maintained.

Level 4. Moderate changes in structure due to replacement of some sensitive ubiquitous taxa by more tolerant taxa; ecosystem functions largely maintained.

Level 5. Sensitive taxa markedly diminished; conspicuously unbalanced distribution of major taxonomic groups; ecosystem function shows reduced complexity & redundancy.

Level 6. Extreme changes in structure and ecosystem function; wholesale changes in taxonomic composition; extreme alterations from normal densities.

Multiple trends in the Pickering are driving changes in water quality over the past 50 years.

Figure from The Biological Condition Gradient – a conceptual model depicting stages of biological condition responses to an increasing stressor gradient – Davies and Jackson (2006)
Multiple trends in the Pickering are driving changes in water quality over the past 50 years.
What are the main stressors? What data should we be collecting?

• **Stormwater flows** from runoff are a strong departure from reference condition.
• **Sediment** from stream bank erosion—aka legacy sediments
• **Sediment** in runoff
• **Other NPS** in runoff, including de-icers, present but poorly understood.
• **Temperature increases** from poor riparian coverage and decreased ground water flows.
• **Not WWTP.** Permitted treatment plant discharges into the Pickering are essentially absent.

*Mayfly is very cost effective for collecting good quality data at watershed outlets.*
SWAT modeled flow versus observed for Pickering.

- Usually validating against USGS gages; however none currently in the Pickering. USGS 01472174 was operational from 1967 to 1983. This former gage station was located just above SL135.
- Model was previously calibrated at USGS 01472157 French Creek 2010 to 2013, validated 2014 to 2106.
- Is validating well in local watersheds against USGS gages and also filed flow measurements by multiple organizations.
- Will be validating against Mayfly stations.
• High resolution model for Pickering with 303 subbasins and outlets. Four outlets are instrumented.
• First order watersheds are mostly correct—the smallest tributaries are time consuming to identify and delineate.
• Flow calibration is believed to be good but will be validated at Mayfly and multiple other sites in the watershed.
• Model is a framework for connecting Mayfly data to the rest of the watershed and for explaining observed conditions: flow, turbidity, temperature, conductivity.
Developing an hourly SWAT flow model. This will be needed to model peak flow and velocity at appropriate time scales. ETA late 2020.
One model for the Pickering—303 outlets
Modeled stormwater flows from runoff
Modeled stormwater flows from runoff with 1 meter UVM-SAL LULC
Stream bank erosion

3d model of stream bank in Pickering Creek
Former Mill Dams are common in the Pickering. These are large stores of legacy sediments.
Quantifying Sediment Sources in the Pickering -- Experimental Design

• Basic framework:
  • Quantify Inputs of suspended sediments
  • Measure Outputs of suspended sediments—Turbidity sensors
  • Compare.
  • Inputs should equal outputs!

• Quantifying inputs is challenging—very short lived events

• Across a large watershed the individual events smooth out into a consistent output signal
  • Modeled versus observed sediment is reasonable

• At reach scale, signal is less smooth
Nice mapping for Warwick furnace and charcoal circles

Spring 2018 Drone GVWA

Rapid erosion of vertical stream bank by water flow (shear, undermining of toe)

Sand, gravel and cobble deposition area on inner curve.

Sand, gravel and cobble deposition area on inner curve.

Linear bank splitting and slumping. Mechanism may be freeze/thaw cycles and wetting/drying cycles along the exposed linear face. These blocks of sediment were persistent in all imagery from 2005 forward and are apparently cohesive. 2018 imagery shows deposition on top of these blocks for about half their extent.

Stream Bank Delineations from Aerial Photography

Coordinate System NAD 1983 (2011) UTM Zone 18N
Units: Meters
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Sand, gravel and cobble deposition area on inner curve.
Section of the Pickering mainstem not associated with former mill site. Fusing multiple sources of imagery to create one dataset.
French Creek Watershed
Sediment Simulation 100 days

Example of simulated daily sediment concentration. Built 9/2013—superseded by more recent sediment models. Similar simulation for the Pickering could be compared against observed sediment at Mayflys.