Hydrograph Separations can Identify Contaminant-Specific Pathways for Conservation Targeting in a Tile-Drained Watershed

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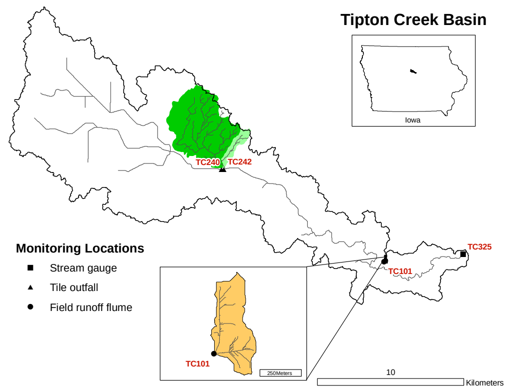
1

Objective: To demonstrate how hydrograph separations at nested scales can identify sources of nitrate, phosphorus, *E. coli*, and sediment in a stream, and thus help determine how conservation practices could be targeted for water quality improvements on a contaminant-specific basis.

2

Setting: North-central Iowa - glacial terrain, tile drainage.



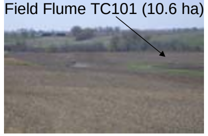
Monitoring conducted at:

Two tile outfalls

TC240 (1700 ha)

TC242 (156 ha)

Field Flume TC101 (10.6 ha)



Stream TC325 (19,850 ha)

Watershed attributes

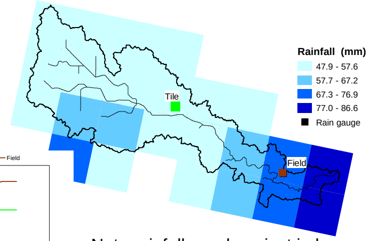
Corn/soybean rotations, livestock production

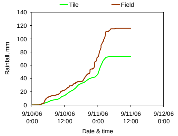
Farmed wetlands (potholes)

Glacial uplands drain through alluvial valley

3

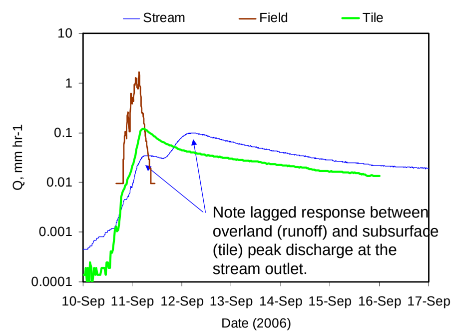
Rainfall event, Sept 9-10, 2006: Radar-estimated distribution of rainfall, and amounts measured in rain gauges.





Note rainfall was heaviest in lower watershed, but reasonably uniform across upper watershed.

4 Hydrologic responses at TC101, TC240, and TC325



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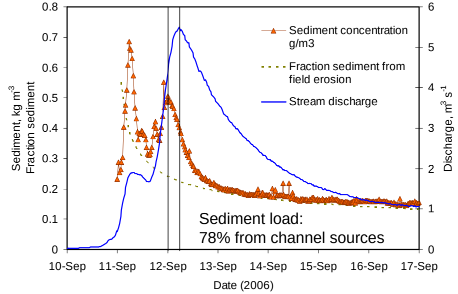
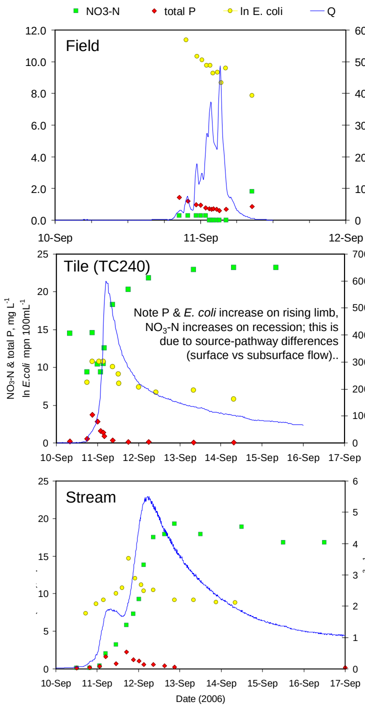
Sediment at TC325: Estimated by calibrated turbidity meter; source separation estimated using ^{7}Be:^{210}Pb ratios.



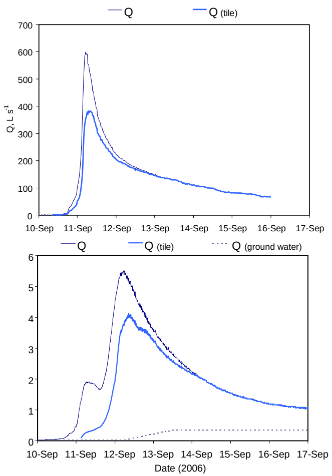
Nutrients & *E. coli*



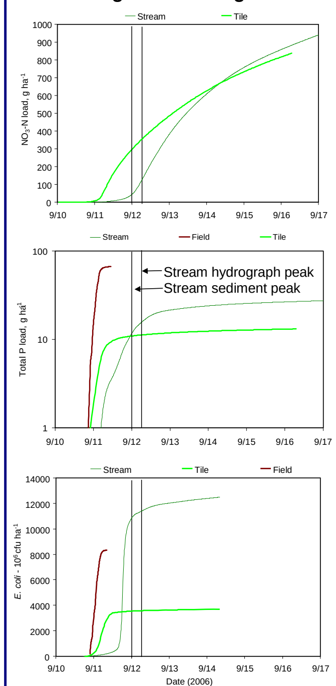
Hydrograph separations 6

Changes in tile NO_3-N (mg L^{-1}) were used to separate surface (inlet) and drainage (tile) water using a mixing model. At the outlet, groundwater flow was separated graphically, then runoff and tile sources were separated by a NO_3-N mixing model.

Site/Description	Q	Runoff	Tile	Groundwater
	---------- mm	----------	----------	----------
TC240 & TC242 - Tile outfall (areal mean)	4.10	0.52	3.58	0
TC101 –Field flume	5.28	5.28	0	0
TC325 –watershed outlet	5.93	1.26	4.07	0.60



Comparing contaminant loading rates among sites 7



Discussion 8

- Results must be viewed in the context of a late summer storm, with mature crop cover and dry antecedent conditions. This muted the hydrologic response (Q=6 mm) to a significant storm event (P>50 mm) (❸❹).
- On a unit-area basis, P loads from the monitored tiles were about one half that observed at the outlet, and *E. coli* loads were about one third of the outlet's (❼). The timing of the tile loads of these two contaminants were synchronous, and occurred early in the event. This implicates surface intakes, which drain surface water from farmed wetlands, as an important source of P to surface waters in this watershed.
- At TC325, sediment (❺), total P and E. coli loads (❼) all began to attenuate before peak discharge, by about 6 hours. The early sediment peak is attributed to the stream bed becoming scoured of fines. Bank failures did not contribute to late sediment load of this event due to dry initial conditions and a peak discharge that was only half of bank-full Q. Bed sources dominated sediments, & are inferred a significant source of P and *E. coli*.
- NO_3-N loads, as anticipated, were associated with tile discharge (❻).

Conclusions 9

- As expected, NO_3-N was dominantly sourced from tiles, and sediment was dominantly sourced from stream banks.
- However, sources of P and *E. coli* are better elucidated by this analysis than past assessments, in two respects:
  - Surface intakes draining farmed (pothole) wetlands were found to be an important source of P.
  - *E. coli* was dominated by near-and in-channel sources, with runoff and tile intake sources also contributing.
- Conservation emphases on erosion control and nutrient management in this watershed should be expanded to include vegetative practices that stabilize/restore streams and buffer surface intakes that drain potholes.
- This single event, multi-contaminant water quality analysis clarified source pathways, helping to inform a more comprehensive approach to water quality management.