EGLE MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

NONPOINT SOURCE PROGRAM

Livestock exclusion fencing improves bacteria levels during dry weather in Cool Creek

Nonpoint Source

Success Story

Problem:

Unlimited cattle access to Cool Creek resulted in water quality standard violations downstream from a farm during dry weather. Results and site were reported to the Michigan Department of Agriculture and Rural Development's Right to Farm Program.

Project highlights:

After decades of unrestricted cattle access at a farm, livestock exclusion fencing was installed in fall of 2020. Following the fence installation, *E. coli* results downstream of the farm were below water quality standards during dry weather events, but still exceeded standards during wet weather events. Results indicate that livestock exclusion fencing was one step towards reducing nonpoint source pollution, however, more still needs to be done to address farm runoff during wet weather events.

Results:

Michigan's Statewide *E. coli* Total Maximum Daily Load identifies both wet weather events and low flow conditions as critical conditions for impaired waters. Precipitation prior to sampling is useful in narrowing the scope of potential sources. A wet weather event is defined as 0.25 inches of rain in the previous 12 hours or 0.5 inches of rain in the previous 24 hours. When there are exceedances of *E. coli* water quality standards during a wet weather event, this indicates that *E. coli* wash into the waterbody through runoff. When there are exceedances of *E. coli* water quality standards during dry weather or during low flow, this indicates that there is a constant source. Precipitation data for the 24 hours and 48 hours prior to each sampling event were obtained from a nearby weather station

WATER BODY IMPROVED

Cool Creek (AUID number 040601030603-02) is in the Stronach Creek sub-watershed within the Manistee River watershed located in Manistee County, Michigan. Cool Creek is listed on the federal Clean Water Act Section 303(d) list of impaired waters for a Total Body Contact Recreation Designated Use Impairment due to *E. coli*.

Grants Reporting and Tracking System (GRTS) numbers: 98502318 / 98502320 (pre- and post-monitoring support, respectively)

Partners and Funding:

Michigan's Department of Agriculture and Rural Development and the Water Resources Division, Surface Water Assessment Section of the Department of Environment, Great Lakes, and Energy were involved in the monitoring and site visit. The landowners installed the fencing on their own.

(Michigan State University Extension). The relative water level was determined at each sampling event by measuring the distance in centimeters from a set point on the culvert to the surface of the river using a weighted metal tape.

All *E. coli* sampling events consisted of three samples taken from each location and the daily geometric mean was calculated for each date. Pre and post Best Management Practice (BMP) implementation monitoring consisted of 5 weeks of sampling upstream and downstream of the suspected source farm which also allowed for the 30-day geometric mean to be calculated. The Total Body Contact (TBC) standard applies from May 1 – October 31 and the Partial Body Contact (PBC) standard applies year-round. The TBC daily maximum geometric mean is 300 *E. coli* colony forming unit (CFU)/100 milliliters (mL), and the 30-day geometric mean is 130 *E. coli* CFU/100 mL. The PBC daily maximum geometric mean is 1,000 *E. coli* CFU/100 mL. Any *E. coli* concentrations that exceed the results are in violation of water quality standards. The PBC standard was met during all sampling events for both pre and post sampling.

Due to the nature of the stream pattern, the upstream and downstream sampling locations were both on the same road and allowed sampling to occur very close to the cattle access (Figure 1).

Figure 1. Aerial of Cool Creek (blue line) in 2019 with extensive livestock access, before exclusion fencing was installed. Stream is flowing east to west (yellow arrow). Red stars represent sampling locations.

Cattle were even observed in the stream during the first sampling event on July 16, 2019 (Figure 2). This was a dry weather event and upstream of the cattle, *E. coli* standards were met, but downstream from the cattle, *E. coli* concentrations exceeded the TBC standard. Livestock exclusion fencing was installed in fall of 2020 and was placed approximately 15-20 feet from the edge of the stream and restricted cattle access to Cool Creek (Figure 3).

Figure 2: Cattle observed in the stream during the July 16, 2019, sampling event when *E. coli* results exceeded the Total Body Contact water quality standard during dry weather.

Figure 3. Photograph approximately 1-2 months after exclusion fencing was installed indicates that the area next to Cool Creek had already started to revegetate.

In 2019, there were no exceedances of the TBC standard upstream of the farm (Table 1). Downstream from the farm, the TBC standard was exceeded on the first sampling event and the last sampling event (Table 2). Both exceedances occurred during a dry weather event. In 2021, there were no exceedances of the TBC standard upstream of the farm (Table 3). Downstream from the farm, the TBC standard was exceeded on the first sampling event and the last sampling event (Table 4). Both exceedances occurred during a wet weather event. Even though the exclusion fencing restricts cattle access, the pasture slopes towards the stream, so other BMP implementation would be needed to completely address the sources from the farm. The 30-day geometric mean standard was met upstream from the farm and was exceeded downstream during both years of sampling.

When the *E. coli* concentrations are compared to the change in the relative water level (relative to the lowest water level recorded during the study), the 2019 data indicate that *E. coli* was high even when there was no change in water level (Figure 4). The 2021 data indicate a strong positive relationship, meaning that *E. coli* concentrations were greatest during the times of the greatest change in water level (i.e., during a wet weather event).

Table 1: *E. coli* (CFU/100mL) data and rainfall prior to sampling events collected at the upstream site (W 12 Mile Road - East crossing) in 2019 prior to the fence being installed.

Date	Left	Center	Right	Daily geometric mean	30-day geometric mean	24-hour prior rain (in.)	48-hour prior rain (in.)	Relative water level change (cm)
7-16-19	34	49	46	42	-	0.00	0.02	2
7-23-19	28	47	30	34	-	0.00	0.00	4
7-30-19	22	26	24	24	-	0.17	0.18	3
8-6-19	27	31	28	28	-	0.63	0.63	3
8-14-19	47	49	64	53	35	0.00	0.00	0

Table 2: *E. coli* (CFU/100mL) data and rainfall prior to sampling events collected at the downstream site (W 12 Mile Road - West crossing) in 2019 prior to the fence being installed (results highlighted in yellow are exceedances of the Total Body Contact water quality standard).

Date	Left	Center	Right	Daily geometric mean	30-day geometric mean	24-hour prior rain (in.)	48-hour prior rain (in.)	Relative water level change (cm)
7-16-19*	365	272	461	358	-	0.00	0.02	3
7-23-19	72	76	80	76	-	0.00	0.00	4
7-30-19	33	40	60	43	-	0.17	0.18	2
8-6-19	157	130	137	141	-	0.63	0.63	4
8-14-19	172	345	980	388	145	0.00	0.00	0

***Cattle observed in stream at time of sampling**

Table 3: *E. coli* (CFU/100mL) data and rainfall prior to sampling events collected at the upstream site (W 12 Mile Road - East crossing) in 2021 after exclusion fence installation.

Date	Left	Center	Right	Daily geometric mean	30-day geometric mean	24-hour prior rain (in.)	48-hour prior rain (in.)	Relative water level change (cm)
7-13-21	453	166	252	266	-	0.61	0.61	9
7-20-21	41	47	54	47	-	0.00	0.00	1
7-27-21	65	78	82	75	-	0.17	0.17	1
8-3-21	47	30	35	36	-	0.00	0.05	0
8-10-21	162	153	264	187	91	0.93	1.09	11

Table 4: *E. coli* (CFU/100mL) data and rainfall prior to sampling events collected at the downstream site (W 12 Mile Road - West crossing) in 2021 after exclusion fence installation (results highlighted in yellow are exceedances of the Total Body Contact water quality standard).

Date	Left	Center	Right	Daily geometric mean	30-day geometric mean	24-hour prior rain (in.)	48-hour prior rain (in.)	Relative water level change (cm)
7-13-21	525	573	399	493	-	0.61	0.61	5
7-20-21	45	131	43	63	-	0.00	0.00	2
7-27-21	88	93	105	95	-	0.17	0.17	0
8-3-21	58	56	73	62	-	0.00	0.05	0
8-10-21	543	480	441	486	155	0.93	1.09	5

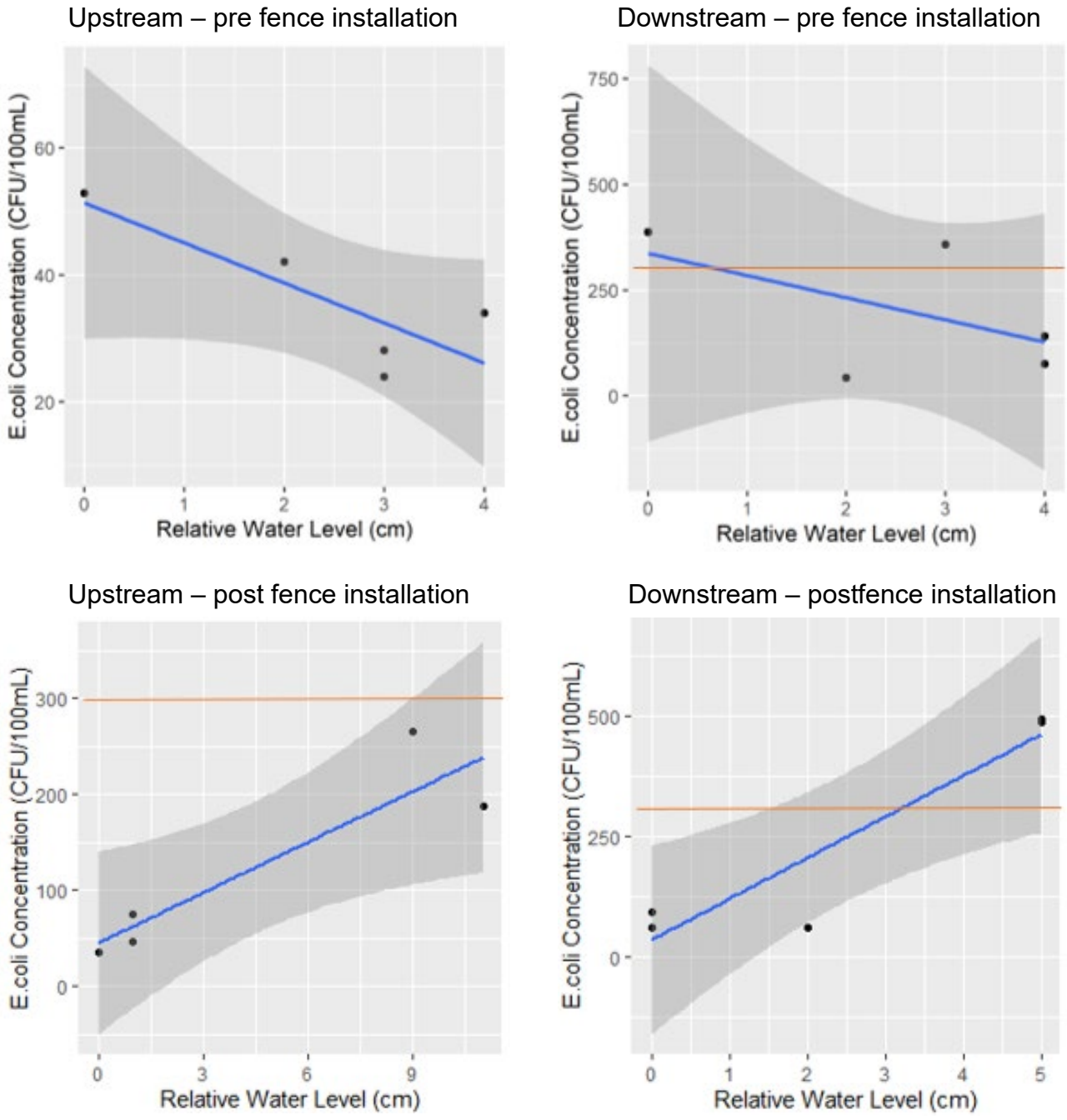

Figure 4. Relationships between E. coli and relative water level.

The top graphs in Figure 4 represent 2019 data which was prior to exclusion fence installation and the bottom graphs represent 2021 data which was after implementation. Water levels are relative to the lowest recorded water level during the study. The blue line is the trend line while the gray shaded area shows the confidence interval (the narrower the gray band, the more confidence in the relationship). The red horizontal lines represent the daily TBC WQS. The downstream pre-installation relationship is weak, likely because the cattle enter the creek sporadically, and is unrelated to the water level. The strong relationship between *E. coli* concentration and water level in 2021 indicates that high flow (caused by wet weather) is causing elevated *E. coli* at both sites and is causing exceedances at the downstream site.

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