OLD MANS CREEK AND CLEAR CREEK, EAST-CENTRAL IOWA – THE ROLE OF VOLUNTEERS IN A SNAPSHOT SAMPLING

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Biographical Sketches of Authors

Jacklyn Neely is the IOWATER Field Coordinator for the Iowa Department of Natural Resources. Jacklyn's primary duties include training volunteers and coordinating watershed groups. She holds a BS in biology and earth science from the University of Wisconsin. Jacklyn has participated in a variety of biological research projects including herpetological studies with the University of Wisconsin - Stevens Point, a study on caddisflies with the University of Wisconsin - La Crosse, and a fish-monitoring program with the Upper Mississippi Long Term Resource Monitoring Program, the University of Wisconsin, and the Iowa DNR. Jacklyn has been with the Iowa DNR since May 2000.

Dave Ratliff was project leader for the first snapshot of Old Mans Creek and Clear Creek in Johnson and Iowa counties in September, 2003. Dave attended the first IOWATER workshop held at Springbrook Conservation Education Center in Guthrie Center, IA and then continued his Water Quality Monitoring education to receive his Level 2 Certification. His work with the United States Geological Society allowed Dave to start K.D. Engineering in 1976, which later evolved into the development and implementation of the first Microprocessor-controlled RJE station to be built. Today, Dave still heads K.D. Engineering, which is involved in computer systems support.

Abstract

In September 2003, 50 volunteers sampled more than 50 sites throughout Old Mans Creek (245 sq. mi.) and Clear Creek (103 sq. mi.) watersheds as part of a snapshot sampling. A snapshot sampling is when multiple sites throughout a geographic area are sampled within a short period of time. While these events enable collection of baseline data and can highlight areas for follow-up monitoring, they are beneficial in getting volunteers in the IOWATER Program (Iowa's volunteer water monitoring program) involved in collecting water quality data on a watershed or county scale. This snapshot was one of the most intensive studies conducted by volunteers in Iowa, as it included chemical, physical, biological, and discharge measurements. Monitoring of 16 sites on the main stem of Old Mans Creek under low-flow conditions showed a relationship between the number of microhabitats and benthic macroinvertebrate diversity, as well as the impact of a small community's wastewater facility, located within the watershed, on ammonia, chloride, and phosphorus concentrations in the creek. Elevated chloride concentrations were also reported for Clear Creek, with chloride concentrations declining downstream in both streams. Monitoring of many of these same sites one month later revealed the same elevated chloride trend. Results from this sampling provide a baseline for future events, as monitoring of these sites will occur on a tri-annual basis (spring, summer, fall).

Introduction

On September 20, 2003, 50 volunteers sampled more than 50 sites throughout Old Mans Creek (245 sq. mi.) and Clear Creek (103 sq. mi.) watersheds as part of a snapshot sampling. A snapshot provides a picture of water quality at one point in time. The September 20, 2003 sampling event represents the first Old Mans Creek and Clear Creek Snapshot event.

For the September 20, 2003, snapshot sampling, volunteers collected data using IOWATER field methods, as well as collecting samples for analysis by the University of Iowa Hygienic Laboratory. Data collected are intended to provide a picture of water quality in Old Mans and Clear creeks under low-flow conditions.

As part of the snapshot, a total of 54 sites were monitored in Johnson and Iowa counties, (Figure 1). Table 1 summarizes the results from the sampling. All samples were collected using standard IOWATER methods or sent to the lab for analysis.

This report summarizes the water quality from the September 20, 2003 sampling of Old Mans and Clear creeks, and includes chemical, physical, biological, and habitat results.

Table 1. Old Mans Creek/Clear Creek Snapshot Sampling Results – September 20, 2003.

	Unit	Method	# of samples	Min Value	Percentiles			Max Value
					25th	50th	75th	
Water Temperature	°F	IOWATER thermometer	62	50	56	60	63	72
Chloride	mg/L	IOWATER test strip	64	<24	31	51	95	639
pH	pH units	IOWATER test strip	63	7	8	8	9	9
Nitrite-N	mg/L	IOWATER test strip	64	0	0	0	0	1
Nitrate-N	mg/L	IOWATER test strip	64	0	1	2	2	5
Dissolved Oxygen	mg/L	IOWATER Field Kit	59	5	8	10	10	12
Transparency	centimeters	IOWATER transparency tube	64	4	23	36	54	60
E. coli Bacteria	CFU/100 ml	Lab Analysis	64	90	285	430	1025	28,000
Fecal Coliform Bacteria	CFU/100 ml	Lab Analysis	64	90	393	580	1100	29,000
Nitrate+Nitrite-N	mg/L	Lab Analysis	64	<0.1	0.3	0.75	1.3	5.1
Ammonia-N	mg/L	Lab Analysis	64	<0.05	<0.05	<0.05	0.14	5.0
Total Kjeldahl Nitrogen	mg/L	Lab Analysis	64	0.3	0.64	0.97	1.65	6.4
Total Phosphorus	mg/L	Lab Analysis	64	0.1	0.16	0.23	0.46	5.5

mg/L = milligrams per liter (or parts per million - ppm)
CFU/100 ml = Colony Forming Units per 100 milliliters of water

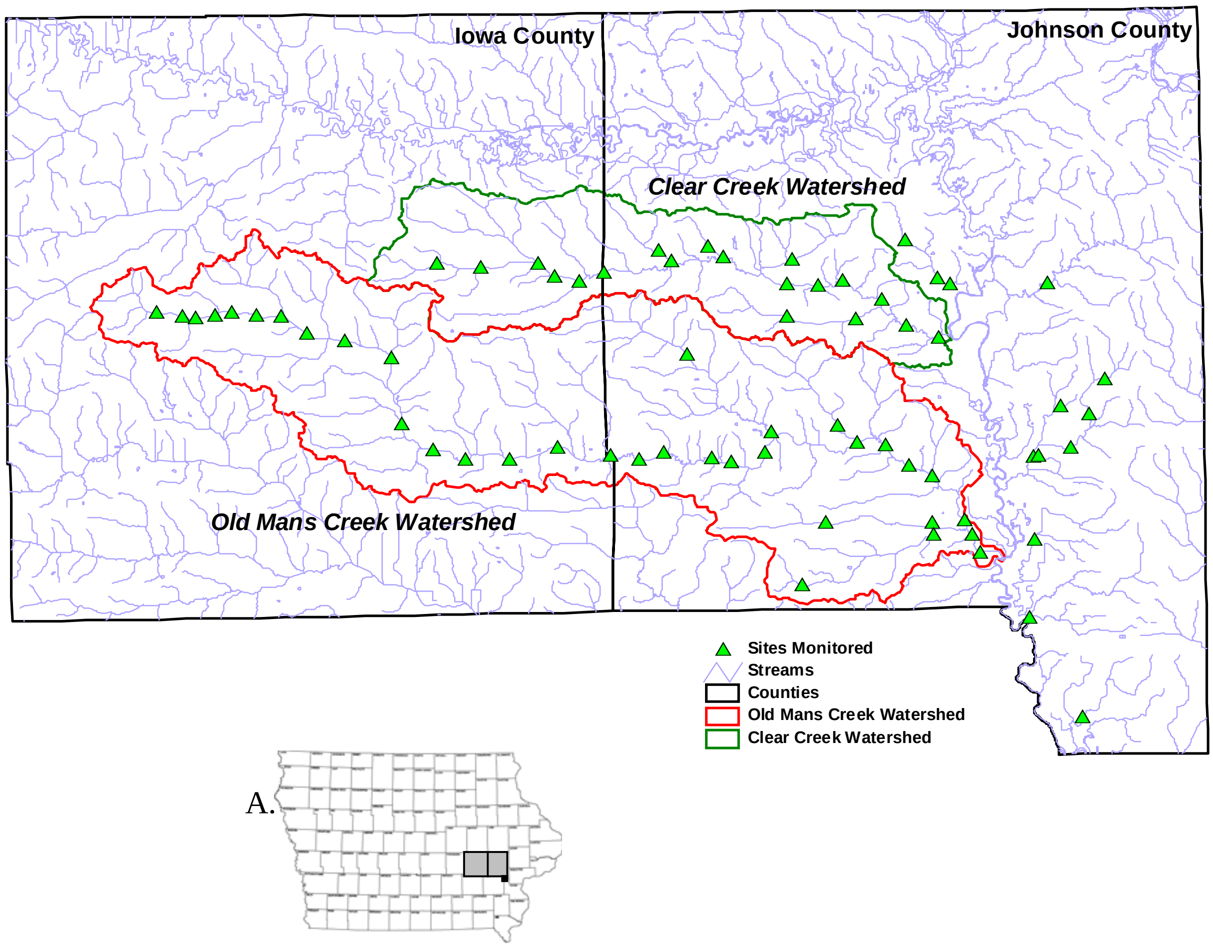


Figure 1. Location of sites sampled as part of the Old Mans Creek and Clear Creek Snapshot Sampling Event. Shaded area (A) is Iowa and Johnson counties.

Chemical and Physical Parameters

Water Temperature

Water temperature affects many of the biological, chemical, and physical processes in a stream, including the amount of oxygen gas that can dissolve in water, the rate of photosynthesis by algae and plants, as well as the metabolic rate of aquatic animals.

Water temperature was measured at 62 sites during the Old Mans Creek and Clear Creek snapshot event. Water temperatures varied from 50 to 72 degrees Fahrenheit, with the lowest temperature reported at site OMC24 which is located near the confluence of Old Mans Creek and the Iowa River, and the highest at site CC10 located on Buffalo Creek, a tributary to Clear Creek. The water temperature at the majority of sites, was between 57 and 64 degrees Fahrenheit (Table 1 and Figure 2).

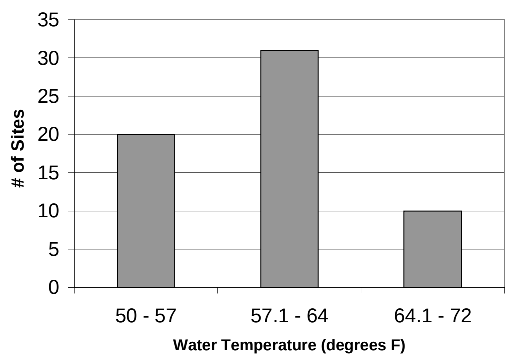


Figure 2. Histogram of water temperatures collected on Old Mans Creek and Clear Creek.

Water temperature for streams within the Old Mans Creek Watershed were cooler compared to those collected from streams statewide during September 2003 (Figure 3). A network of 85 streams statewide is monitored monthly as part of Iowa's Ambient Water Monitoring Program. Samples from these streams are tested using field meters and lab analyses, and data from these sites will be used throughout this report to provide perspective on results from the September 20, 2003 Old Mans Creek and Clear Creek Snapshot Sampling event.

Cooler temperatures for the snapshot sites relative to streams statewide likely reflect a difference in time of sampling. Statewide sites were sampled early in the month, whereas snapshot sites were sampled several weeks later.

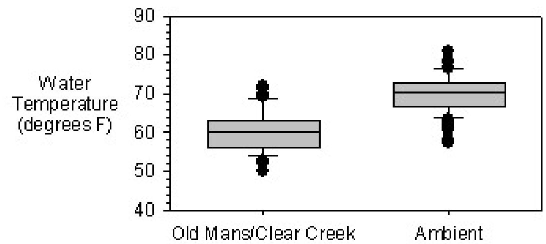


Figure 3. Box plot of water temperature data from the Old Mans and Clear Creek Snapshot and the Ambient Water Monitoring Program.

pH

pH is a measure of water's acidity. Changes in pH can be caused by atmospheric deposition of acid rain, the types of soils and bedrock that the water comes in contact with, wastewater discharges, and acid mine drainage. A pH of 7 is neutral; pH values greater than 7 are alkaline or basic, while a pH less than 7 is acidic.

Sixty-three sites were tested for pH. During the sampling, the majority of streams had a pH of 8 or 9 (Table 1 and Figure 4). The pH values are similar to what was measured during September 2003 in streams statewide as part of Iowa's Ambient Water Monitoring Program (Figure 5).

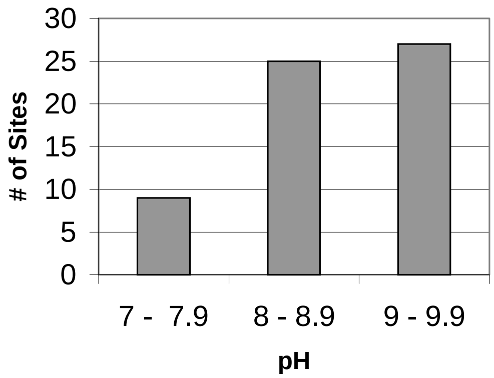


*Figure 4. Histogram of pH values collected in Old Mans Creek and Clear Creek***.**

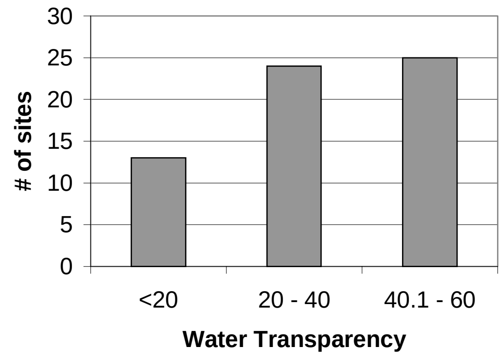


Figure 6. Histogram of transparency of Old Mans Creek and Clear Creek.

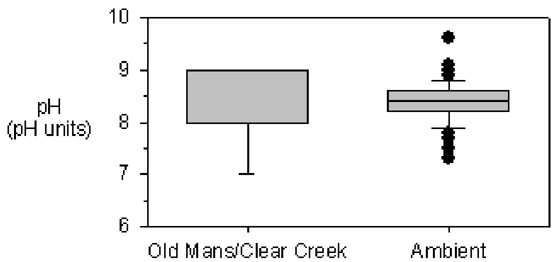


Figure 5. Box plot of pH values collected in Old Mans Creek and Clear Creek Snapshot and the Ambient Water Monitoring Program.

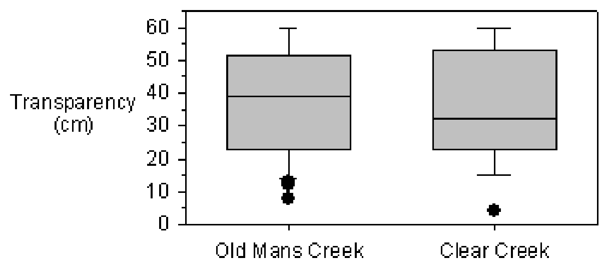


Figure 7. Box plot of transparency collected from Old Mans Creek and Clear Creek.

Transparency

Transparency is a measure of water clarity and is affected by the amount of material suspended in water. As more material is suspended in water, less light can pass through the water, making it less transparent (or more turbid). These materials include soil, algae, plankton, and microbes.

Transparency, measured at 64 sites, ranged from 4 to 60 centimeters with a median of 36 centimeters (Table 1 and Figure 6). Higher transparency readings were measured on Old Mans Creek compared to Clear Creek (Figure 7).

Thirteen sites sampled in September had a transparency less than 20 centimeters, while two of those sites were less than 10 centimeters. Thirteen sites had transparency readings of 50 or greater.

Dissolved Oxygen

Dissolved oxygen levels in a stream can be affected by a number of variables, including water temperature, season of the year, time of day, stream flow, presence of aquatic plants, dissolved or suspended solids, and human impacts. Oxygen enters a stream through diffusion from the surrounding air and as a product of photosynthesis from aquatic plants. Oxygen in a stream can be consumed through respiration by aquatic plants and animals, and by the decomposition of organic matter.

A total of 59 sites were sampled for dissolved oxygen, with a median of 10 mg/L

(Table 1 and Figure 8). No sites had a value less than 5 mg/L; the water quality standard for warm water streams in Iowa. There were 10 sites with values of 12 (dissolved oxygen was measured using IOWATER methods which has a maximum reading of 12). These sites were scattered throughout the two watersheds; however, five sites near the headwaters of Clear Creek had low dissolved oxygen levels.

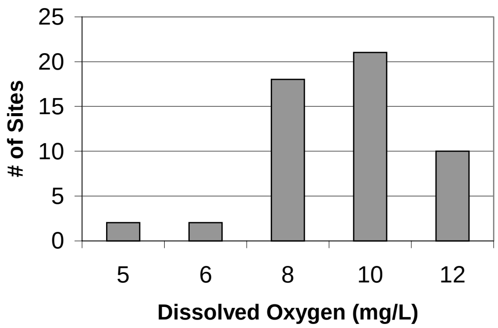


Figure 8. Histogram of dissolved oxygen levels in Old Mans Creek and Clear Creek.

Nitrite-N and Nitrate-N

Nitrogen is a necessary nutrient for plant growth, and includes both nitrite- and nitrate-nitrogen. Too much nitrogen in surface waters, however, can cause nutrient enrichment, increasing aquatic plant growth and changing the types of plants and animals that live in a stream. Sources of nitrogen include soils; human and animal wastes; decomposing plants; and fertilizer runoff from golf course, lawns, and cropland.

A total of 64 sites were tested for nitrite-N using test strips that are used by volunteers as part of the IOWATER Program. More than half of the sites detected no nitrite-N, while most of the remaining sites had nitrite-N of 0.15 mg/L (Table 1 and Figure). Only one site, located at the headwaters of Clear Creek, had nitrite-N of 1 mg/L.

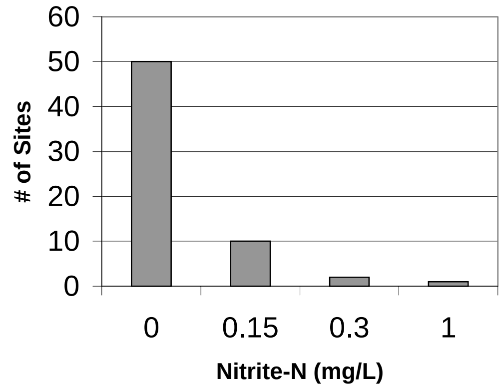


Figure 9. Histogram of nitrite-N concentrations in Old Mans Creek and Clear Creek.

A total of 64 sites were tested for nitrate-N using the IOWATER test strips, with a median nitrate-N concentration of 2 mg/L (Table 1 and Figure 10). Nine sites spread throughout the two watersheds had 0 mg/L nitrate-N. No sites had nitrate-N concentrations greater than 5 mg/L.

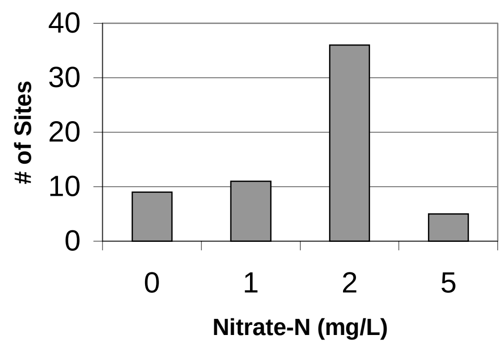


Figure 10. Histogram of nitrate-N concentrations in Old Mans Creek and Clear Creek.

Samples from the same 64 sites were also collected and analyzed for nitrate+nitrite-N in the lab. More than half of the samples had nitrate+nitrite-N concentrations of less than 1 (Table 1 and Figure 11). For six sites, nitrate+nitrite-N concentrations were below the detection limit of 0.1 mg/L. Three sites had concentrations higher than three. Two of those sites were near the headwaters of Old Mans Creek and the third was on Muddy Creek, a tributary that enters the Iowa River three miles above the mouth of Clear Creek.

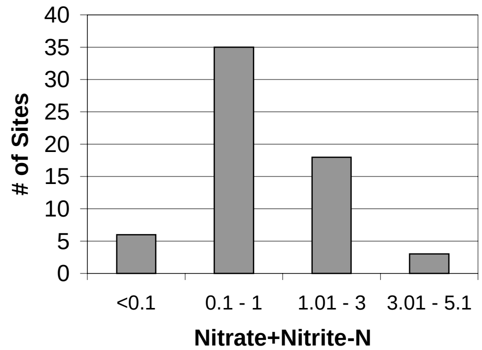


Figure 11. Histogram of nitrate+nitrite-N concentrations in Old Mans Creek and Clear Creek.

Concentrations of nitrate+nitrite-N were lower compared to the one, long-term ambient monitoring site on Old Mans Creek, a site sampled monthly since 2000 (Figure 12). The long-term data for the Old Mans Creek site had an average concentration of nitrate+nitrite-N of 7.4 mg/L, compared to 1.1 mg/L for the snapshot sites.

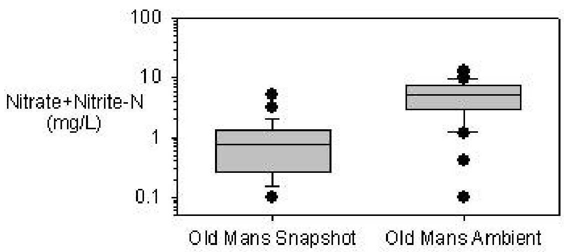


Figure 12. Box plot of nitrate+nitrite-N concentrationsfor sites in Old Mans Creek watershed collected during the snapshot compared to the one long-term monitoring site on Old Mans Creek.

Kjeldahl nitrogen and ammonia-N were analyzed on the same 64 samples. Median concentrations of total Kjeldahl nitrogen and ammonia-N were 0.97 mg/L and less than 0.05 mg/L, respectively (Table 1). Results show levels similar to concentrations in streams sampled statewide in September 2003 (Figures 13 and 14).

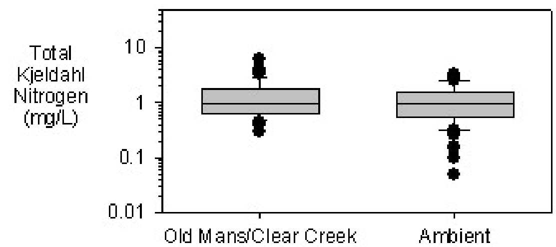


Figure 13. Box plot of total Kjeldahl nitrogen concentrations from the Old Mans and Clear Creek Snapshot and the Ambient Water Monitoring Program.

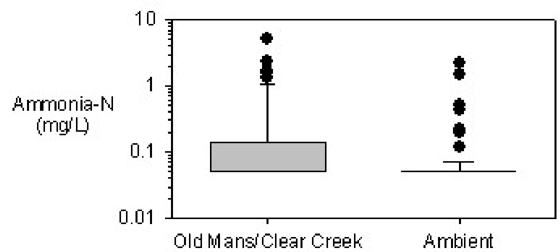


Figure 14. Box plot of ammonia-N concentrations from the Old Mans and Clear Creek Snapshot and the Ambient Water Monitoring Program.

Phosphorus

Phosphorus is a necessary nutrient for plant growth. Too much phosphorus in surface waters, however, can cause nutrient enrichment, increasing aquatic plant growth, and changing the types of plants and animals that live in a stream. Sources of phosphorus include certain soils and bedrock; human and animal wastes; detergents; decomposing plants; and runoff from fertilized lawns and cropland.

A total of 64 sites were sampled for total phosphorus. Concentrations ranged from 0.1 to 5.5 mg/L, with a median of 0.23 mg/L (Table 1 and Figure 15). These concentrations are similar to concentrations in streams sampled statewide in September (Figure 16).

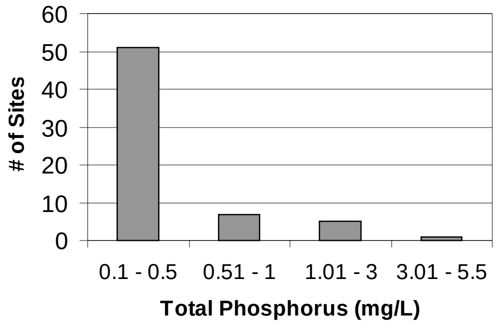


Figure 15. Histogram of total phosphorus concentrations in Old Mans Creek and Clear Creek.

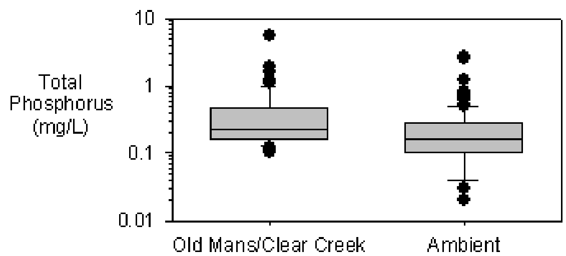


Figure 16. Box plot of total phosphorus concentrations from the Old Mans and Clear Creek Snapshot and the Ambient Water Monitoring Program.

One site on Old Mans Creek had a concentration of 5.5 mg/L. This site also had the highest concentration of total Kjeldahl nitrogen (6.4 mg/L) and ammonia-N (5 mg/L) and is located downstream of a small community's wastewater treatment facility. All three of these parameters show the same trend of a sharp increase in concentrations from the stream site above the community to the stream site below, followed by a gradual decrease in concentration downstream (Figure 17).

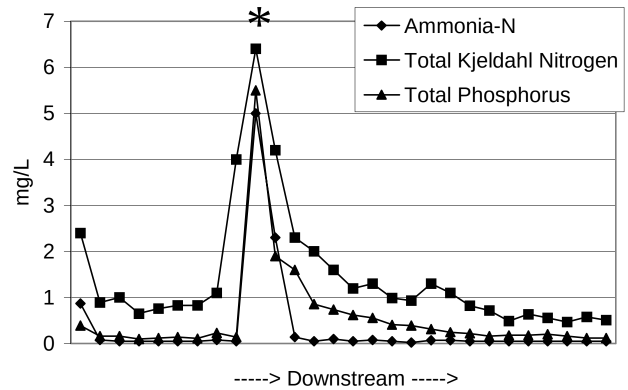


*Figure 17. Line graph showing ammonia-N, total Kjeldahl Nitrogen and total phosphorus concentrations in Old Mans Creek; *represents the site downstream of the community.*

Chloride

Chloride is a component of salt, and is a measure of human or animal waste inputs to a stream. Potential sources of chloride to a stream include direct input from livestock, septic system inputs, and/or discharge from municipal wastewater facilities. During winter months, elevated chloride levels in streams may occur as a result of road salt runoff to nearby streams.

Chloride concentrations in Iowa streams are typically in the 20 to 40 mg/L range. A total of 64 sites were monitored for chloride during the snapshot, and the majority of sites had a chloride concentration greater than 40 mg/L (Table 1 and Figure). These concentrations are high when compared to concentrations collected statewide in September 2003 (Figure 19).

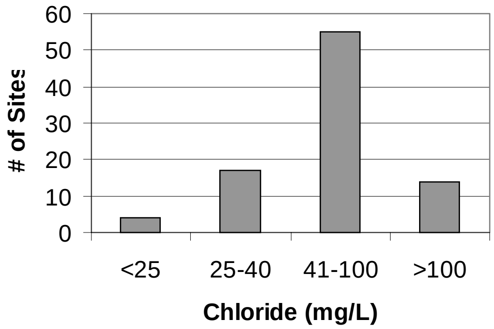


Figure 18. Histogram of chloride concentrations in Old Mans Creek and Clear Creek.

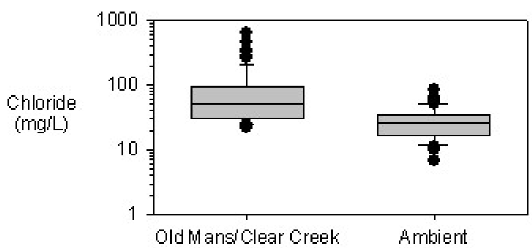


Figure 19. Box plot of chloride concentrations from the Old Mans and Clear Creek Snapshot and the Ambient Water Monitoring Program.

Chloride concentrations on Old Mans Creek show a trend similar to ammonia-N, total Kjeldahl Nitrogen, and total phosphorus. Chloride concentrations increase sharply directly downstream of a small community's wastewater treatment facility on Old Mans Creek and then gradually decrease downstream (Figure 20). The highest concentration of chloride on Old Mans Creek (136 mg/L) occurred at the site directly downstream of the community. A re-sampling of these sites on Old Mans Creek in October 2003 showed the same trend. This trend is also observed in the Clear Creek watershed; high chloride concentrations at the headwaters (>639 mg/L) and a decrease in concentrations downstream (Figure 21).

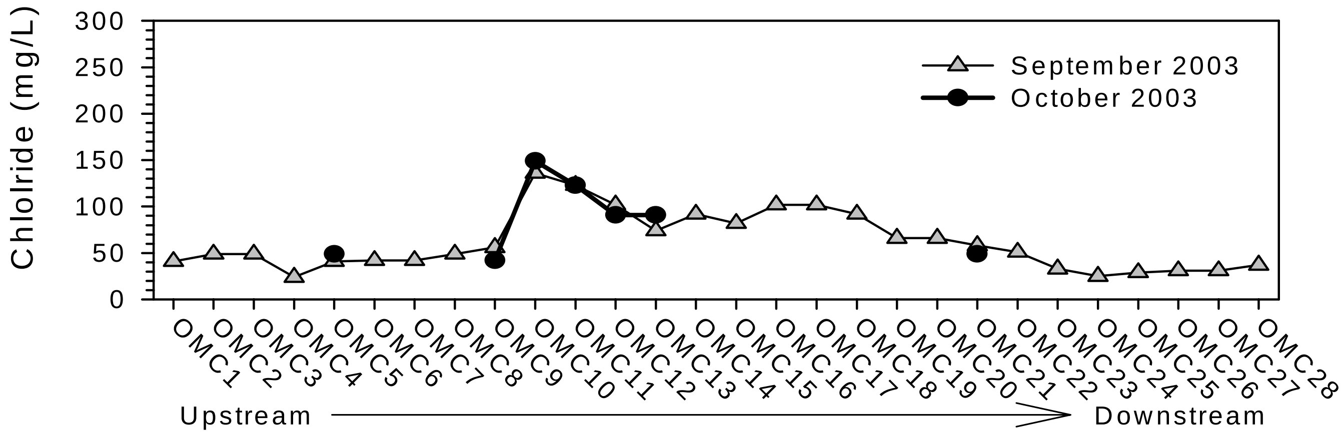


Figure 20. Line graph showing elevated chloride concentrations downstream of a small community in Old Mans Creek.

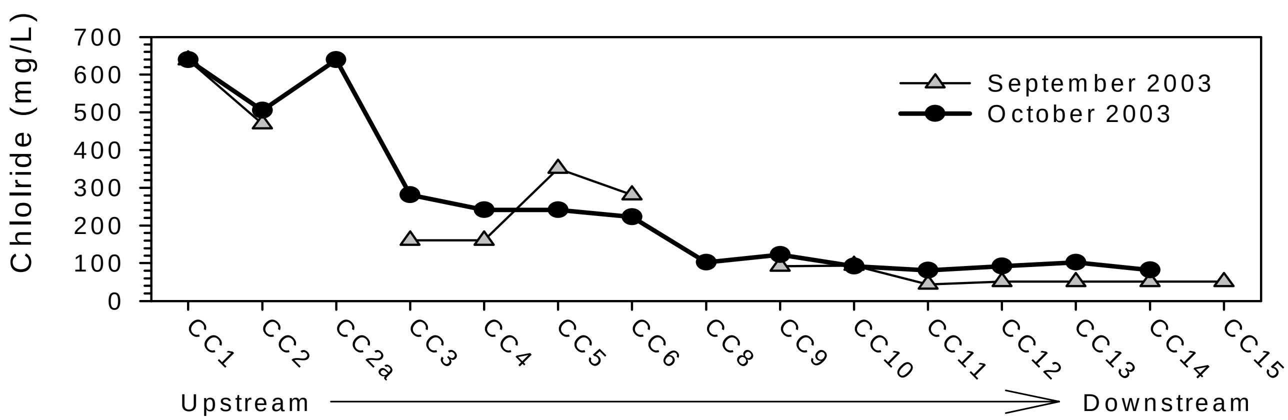


Figure 21. Line graph showing high chloride concentrations at the headwaters of Clear Creek. (Note: the y-axis scale on this graph is greater than Figure 20)

***Escherichia coli* and Fecal Coliform Bacteria**

E. coli and fecal coliform bacteria are types of bacteria present in the gastrointestinal tract of warm-blooded animals. These bacteria are called "indicator bacteria" because by themselves, they do not cause illness, but their presence suggests that disease-causing organisms or pathogens may be present. As the number of indicator bacteria rises in water, so does the likelihood that pathogens are present. The most frequent sources of pathogens are sewage overflows, malfunctioning septic systems, animal waste, polluted storm-water runoff, and boating wastes. The presence of these bacteria suggests that a pathway exists for a relatively fresh source of human or animal waste to enter the stream. Bacteria levels are reported in Colony Forming Units per 100 milliliters (CFU/100 ml).

Iowa's water quality standard for *E. coli* bacteria applies to Class A swimmable waterbodies. The one-time maximum value is 235 CFU/100 ml or the geometric mean, a measure of five samples collected in a 30-day period, is 126 CFU/100 ml. Neither Old Mans Creek nor Clear Creek are Class A swimmable waterbodies, however, these standards can provide perspective on what bacteria levels are high or low.

Water samples were analyzed for *E. coli* and fecal bacteria, with *E. coli* bacteria counts ranging from 90 to 28,000 CFU/100 ml (Table 1), and fecal coliform bacteria counts ranging from 90 to 29,000 CFU/100 ml (Table 1). Both *E. coli* and fecal bacteria levels from the snapshot sites were elevated compared to the one, long-term ambient monitoring site on Old Mans Creek, and levels measured in streams statewide in September 2003 (Figures 22, 23, 24 and 25).

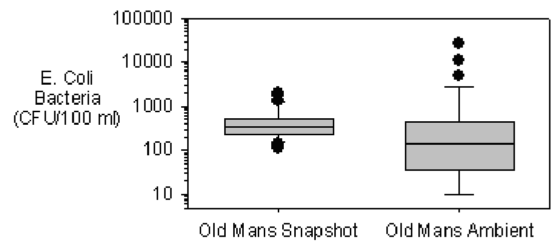


Figure 22. Box plot of E. coli bacteria levels for sites in Old Mans Creek watershed during the snapshot compared to the one long-term monitoring site on Old Mans Creek.

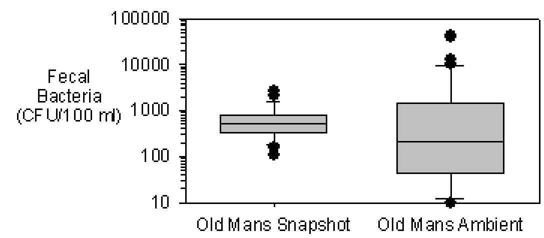


Figure 23. Box plot of fecal bacteria levels for sites in Old Mans Creek watershed during the snapshot compared to the one long-term monitoring site on Old Mans Creek.

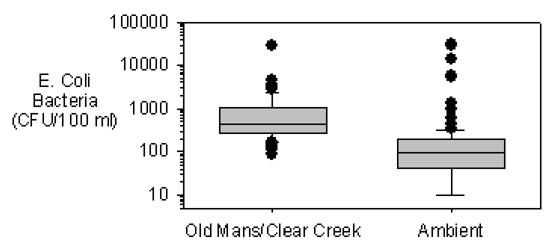


Figure 24. Box plot of E. coli bacteria levels for sites in Old Mans and Clear Creek watersheds during the snapshot compared to the one long-term monitoring site on Old Mans Creek

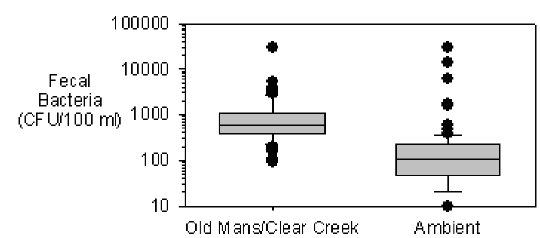


Figure 25. Box plot of fecal bacteria levels for sites in Old Mans and Clear Creek watersheds

during the snapshot compared to the one long-term monitoring site on Old Mans Creek.

Water Odor

Water odor was recorded at 63 sites. All but four sites reported no odor to the water (Figure 26). One site was reported as having a "fishy" smell and two sites had a "sewage or manure" smell.

Figure 26. Histogram of water odor in Old Mans Creek and Clear Creek.

Water Color

Water color was recorded at 63 sites. Water was clear at 43 sites, brown at 24, and green at 11 (Figure 27). Cloudy water was noted at one site near the headwaters of Old Mans Creek and at one site on Dirty Face Creek, and a tributary to Old Mans Creek had an oily sheen.

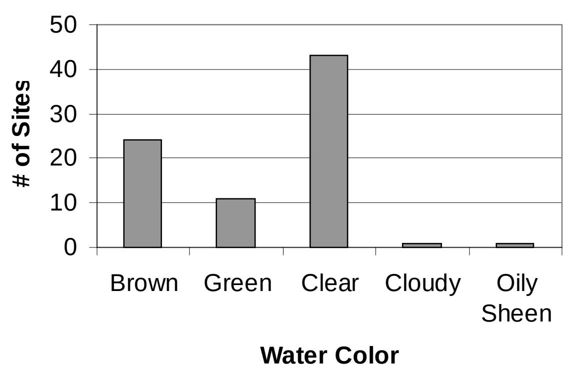


Figure 27. Histogram of water color in Old Mans Creek and Clear Creek (Note: more than one color category can be indicated for a site).

Biological and Habitat Parameters

Benthic Macroinvertebrates

The most common method for assessing the biological health of a stream is to use benthic macroinvertebrates. Benthic macroinvertebrates are aquatic insects, clams, crustaceans, leeches, snails, and worms. Tolerances of these organisms to pollution have been established, therefore, the types of benthic macroinvertebrates present can be used as an indicator of stream health. It is also important to look at the number of species or diversity of organisms identified. The higher the diversity, the healthier the stream. For the snapshot sampling, the IOWATER Level One benthic macroinvertebrate key was used to identify benthic macroinvertebrates.

A total of 16 sites on Old Mans Creek were monitored for benthic macroinvertebrates during the two weeks before and after the snapshot. The number of species identified at these sites ranged from three to 14 (Figure 28).

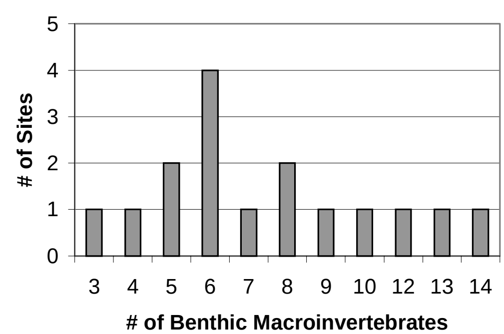


Figure 28. Number of species identified at sites on Old Mans Creek.

Figure 29 shows the range of quality of benthic macroinvertebrates collected from each sites. The stacked bar graph shows the number of high quality, medium quality, and low quality benthic macroinvertebrates present at each site.

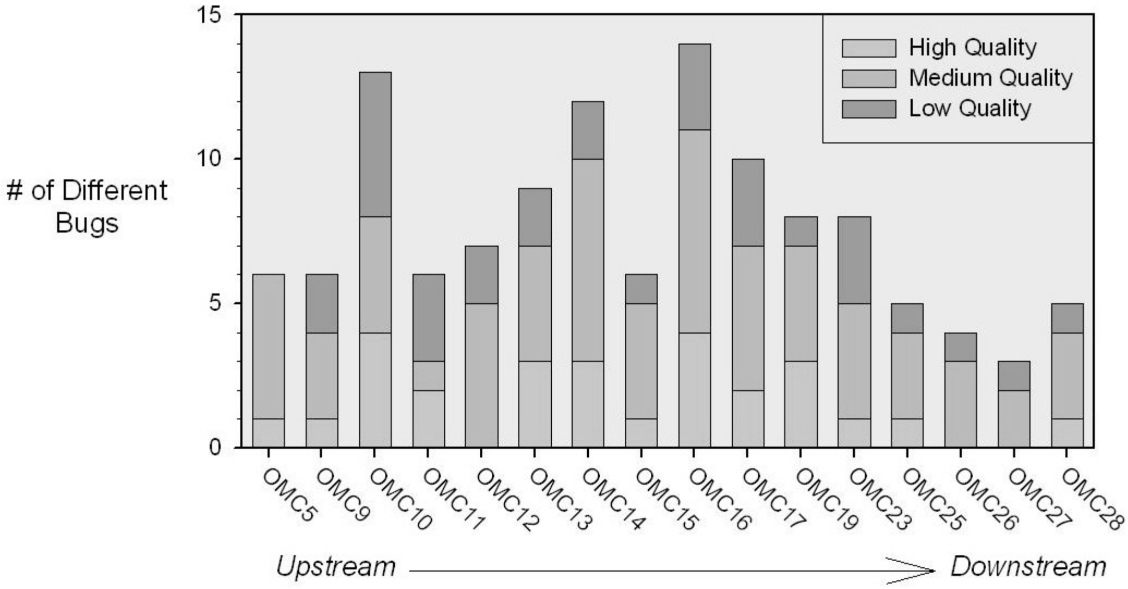


Figure 29. Range of quality of bugs identified on Old Mans Creek

Of the benthic macroinvertebrates identified at all sites, more than 50 percent are classified as middle quality organisms (Figure 30). Only 22 percent of the benthic macroinvertebrates were high quality organisms.

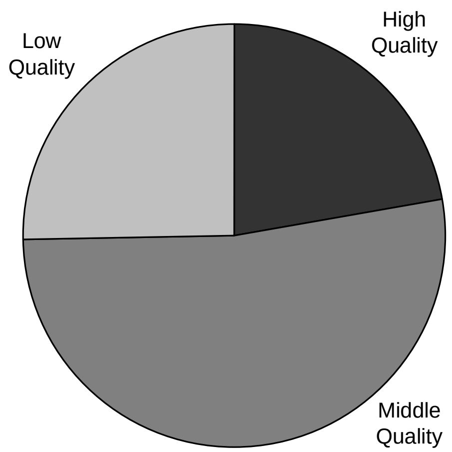
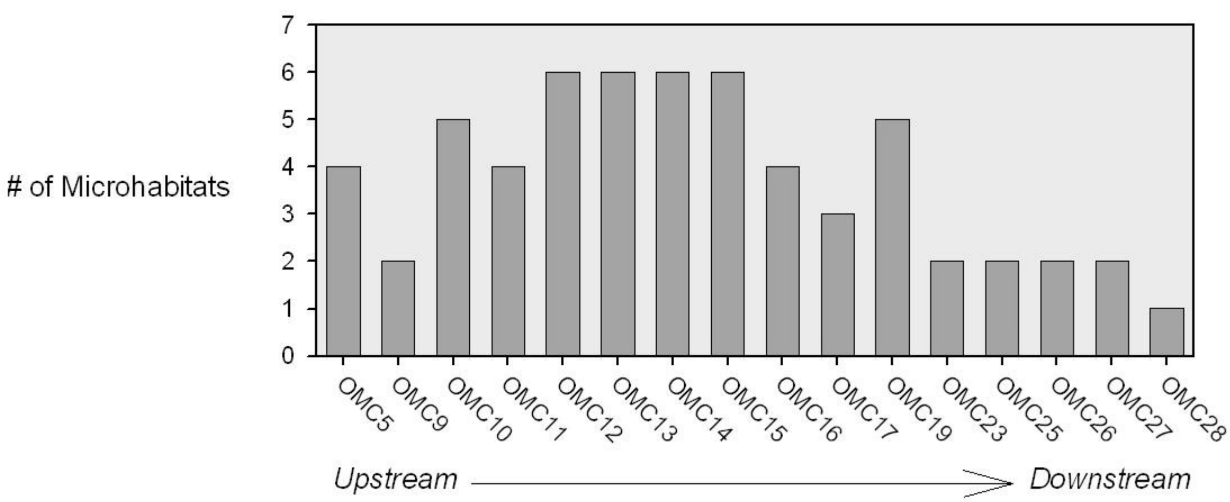


Figure 30. Pollution tolerances of benthic macroinvertebrates identified.

Habitat

Stream habitat is the space occupied by living organisms. With the IOWATER habitat assessment, observations are made on the vegetation that occurs in and around the stream, as well as the types of rocks and sediments on the stream bottom and the different types of microhabitats present. These habitat characteristics can affect the biological communities in the stream, as well as affect chemical measurements made at a stream.

The types and number of microhabitats in a stream are very important to the quality and the type of aquatic life that may be present. Microhabitats are smaller habitat units within a stream's typical riffle, run, or pool habitats. The numbers and types of microhabitats were recorded at the 16 sites where biological data were collected. Figure 31 shows the number of microhabitats present. The microhabitats most commonly reported were overhanging vegetation, undercut banks, logjams, root wads, and fallen trees.



Figures 29 and 31, when considered together, show a relationship of decreasing number of microhabitats and decreasing diversity of macroinvertebrates from upstream to downstream. Areas of the stream where there are not a variety of places to live (microhabitats) can not support a high number of benthic macroinvertebrate species.

Summary

More than half of the parameters tested during the Old Mans Creek and Clear Creek snapshot sampling had similar results to Iowa's Ambient Water Monitoring Program. Temperature, nitrate+nitrite-N, chloride, *E. coli* bacteria, and fecal bacteria, however, varied from the ambient sites. All of these parameters had higher concentrations than the ambient sites except water temperature, which was cooler.

Several chemical parameters, including ammonia-N, chloride, total Kjeldahl Nitrogen, and total phosphorus, showed a trend from upstream to downstream sites on Old Mans Creek. Concentrations increased sharply from the stream site above a small community to the stream site below the community's wastewater treatment facility. Biological and habitat data showed that the number of microhabitats decreased from upstream to downstream, and the diversity of benthic macroinvertebrates decreased from upstream to downstream.

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