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The Effect of Waste Water Treatment Plant effluent on ^{15}N concentrations in Macroinvertebrate Populations in Stream of Discharge

Abstract

The study was concentrated on the invertebrate families of Diptera and Trichoptera to test for increased N-15 isotope concentrations. Cedarville Wastewater Treatment plant released effluent into a stream nearby, the point of the study was to determine if the N-15 isotope concentrations increased downstream of effluent release. The results proved that the N-15 isotope concentrations increased downstream of effluent release into the stream.

Introduction

Isotopes change as elements cycle through a food web increasing trophic levels. Therefore, they increase our understanding of element cycles. Isotopes are present in organisms and they bioaccumulate in organisms as they increase in higher levels of the food web. Stable isotopes are able to provide both chemical and physical information about particular elements through the cycling of chemicals in the food web (Fry 1987).

Nitrogen is mainly present in the atmosphere as N_2. The ^{15}N increases as depth increases, since particulate N decomposes and is taken up by plants and the sea. Nitrogen isotopes can serve as indicators of particular organisms original habitats and how they have been misplaced by geological processes. Nitrogen isotopic ratios increase as organisms continue to consume each other moving the N through the trophic levels (Fry 1987). As a

result, of positive correlation of trophic levels to ^{15}N values N have become an important tool in the construction of food webs for organisms (Kilham 2004).

Many wastewater treatment plants release high concentrations of nitrogen with their effluent into nearby streams. Nitrogen is a difficult element to remove from the waste water without an expensive tertiary system added to the treatment plant. Waste water treatment plants are inadequately designed to provide protection to the environment from their effluent (Fry 1997). Trough a study in Antarctica, after four years of sewage release into the ocean the animals have shown sewage-derived nitrogen and carbon isotopes in their guts (Conlan et. al. 2006).

Aquatic organisms break down the carbon and nitrogen in predictable ways it is possible to predict their food webs (Kilham 2004). Aquatic Diptera are used in determining water quality in many water assessment programmes (Arimoro 2006).

Waste Water Treatment Plant in Cedarville release effluent into the stream through a culvert that runs underneath the road. Effluent ^{15} N from human waste, therefore, effluent could be increasing the ^{15}N isotope concentration in the water, causing an increase concentration within the macroinvertebrate community of the stream.

Material and Methods

Sampling was conducted in Cedarville, Michigan. Cedarville, Michigan was located in the Upper Peninsula of Michigan east of Interstate 75. The study was concentrated on the N-15 isotope concentration of the effluent of the Waste Water Treatment.

Sampling of the Waste Water Treatment Plant effluent was conducted both upstream and downstream of the release of effluent into the stream. Organisms collected for the sampling was invertebrate orders Dipteral and Trichoptera. At the stream, there was a culvert that the effluent was released into the stream. The first day, Specimens of diptera and trichoptera were collected downstream of the covert and at the Cedarville Bay. Second day, Specimens of diptera and trichoptera were collected both upstream and downstream of the covert. Diptera was collected by disrupting the substrate by jumping around in front of the dip net, Allowing sediment, and diptera to enter the dip net for sorting. With the sediment and diptera collected in the dip net, the dip net contents were emptied into the collection pan for sorting and collection of the individual diptera. Tricoptera was collected by the process of walking downstream to woody debris, and picking off the tricoptera with their casings. Specimens collected through the following methods were placed into whirly packs with 75% Ethyl alcohol concentrate for transport to back to the Biological Station.

Back at the Biological Station, the specimens were placed in a pan according to the sites collected. Specimens were distributed evenly on the pan, and then the pan was placed into an oven. Oven was set to 60+/- 5 degrees Celsius for three days. Pans were removed from the oven. Specimens were placed into jars labeled by site and order. Finally, the specimens were taken to the chemical laboratory of the University of Michigan Biological Station in Pellston for N-15 isotope and $N\text{-}NO_3$ testing.

After all the field and lab work was completed, Statistical analyzes were ran to determine the similarities and differences among the different sites in relation to each other. A

graph was developed to show the ^{15}N isotope ratio for each site in relation to other sites. Post Hoc Test was developed to show the differences in each site in relation to each of the other sites in relation to ^{15}N isotope concentrations.

Results

The average N^{15} isotope concentrations increased as measurements were taken further downstream of the effluent (Fig 1-1). Therefore, the hypothesis that the wastewater treatment plant was releasing N^{15} into the stream has been validated. To support the graph, there were statistics programs ran from SPSS, to generate comparisons of sites. Pos-Hoc test was ran in SPSS, that showed the a significant difference between the following sites: 1 and 3, 1 and 4, 2 and 4. While the there is no significant difference between the following sites: 2 and 3, and 3 and 4. Sites 1 and 2 seemed to be more different than sites 2 and 3. Sites 2 and 3 seemed to be slightly similar, since they were both taken next to the culvert. Site 2 was upstream of the culvert and site 3 was downstream of the culvert. Site 3 and 4 seemed to be very similar to each other (Table 1-1).

Discussion

N^{15} values can increase as the effluent was being released since the water movement was moving downstream toward the bay. Sites 1 and 2 were located upstream of the culvert. Sites 1 was located about 15 – 30 meters upstream, and site 2 was located 1 – 5 meters upstream. Sites 3 and 4 were located downstream of the culvert. Site 3 was located 1 – 5

meters downstream and site 4 was located 10 – 20 meters downstream. The p-value calculated at 0.05. Sites 1 and 2 can be slightly different because of disturbance between the two sites. Site 1 was 15-30 meters upstream, and about 5 – 10 meters upstream there was a pile of soil next to the stream. Site 2 and 3 could be slightly similar to being close proximity to each other at the culvert. Site 2 was close to the culvert and was able to receive some of the effluent if effluent was to reverse.

According to Kilham (2004), they conducted a study on elevated ^{15}N levels in areas with septic tank usage in an urban setting. They found that there was a positive link between elevated ^{15}N isotopes in food webs and areas of watershed with septic tank usage. Conlan et. al. (2006) also found increased ^{15}N isotopes at the effluent release, but declined further down stream of effluent release. However, Jordan et. al. (1997) noticed a decline in ^{15}N of the water after wastewater treatment due to an unknown source.

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