Long-term Biological Monitoring at Ranch Brook
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Sentinel Stream Monitoring

The Vermont Department of Environmental Conservation (VDSEC) is conducting long term monitoring of twelve “sentinel” streams in Vermont. These reference streams are widely variable in terms of size (4.6 - 510 km²), elevation (33m - 1355m) and geographical separation. One of the longest running sentinel monitoring stations is at Ranch Brook in Stowe, VT. With a drainage area of 10 km² and an elevation of 378 m, it is one of the smallest and most pristine sentinel streams.

All twelve streams are currently being monitored on an annual basis for water chemistry, physical habitat, water temperature, and biology (fish and macroinvertebrate communities). Several sites are also being gaged for stream discharge. Through this monitoring, we hope to be able to gain an understanding of how climate change is affecting stream habitat and water quality, and how changes in these abiotic variables may cause long-term alterations in biological communities.

VTDEC collects macroinvertebrate community samples during an annual index period that runs from September 1st through mid-October. Samples are collected from riffle habitats, and sorted and identified in the laboratory. VTDEC uses biological population data, as well as a number of community variables (called metrics) to assess stream health. These metrics cover many aspects of community structure and function, including biodiversity, tolerance to pollution and ecological feeding habits. Metric values are used to determine a narrative assessment for community health, using a scale ranging from Poor to Excellent.

Habitat data collected includes water chemistry (pH, alkalinity, sulphate, earth metals, turbidity, chloride, and nutrients), riparian canopy, substrate particle size, and periphyton cover. With a continuously operating USGS gage and annual monitoring by VTDEC since 2000, Ranch Brook also has one of the best data sets in the state for assessing biological condition with stream hydrology. Continuous stream discharge data is available from the USGS gage, in addition to daily mean and annual peak discharge values.

2015 Monitoring in Summary

Figure 1 shows results for three of the eight metrics used to assess biological condition, as well as the overall assessment rating. Macroinvertebrate density at Ranch Brook was 659 individual per square metre, higher than VTDEC’s minimum biological criteria for a healthy stream. This is within the range of other reference streams and similar to the average of other small streams throughout the state. This is a significant recovery for Ranch Brook, which has shown a depressed density for several years following flooding in 2010 and 2011. Total species richness (44) was very high in 2015 compared to DEC’s minimum criteria (37), and similar to reference and statewide averages.

A “functional feeding group” refers to one of several types of ecological feeding types to which a species has evolved. Small forested streams like Ranch Brook typically have low algal growth but high quantities of leaf detritus, and populations in different functional feeding groups should reflect this. The PPCS-FPG score is based on a model that compares the distribution of functional feeding groups at a given site to what we would expect to find at a hypothetical site untouched by human activity. High scores at Ranch Brook indicate increased similarity to a typical reference stream.

High values for these three metrics, as well as the other metrics evaluated by DEC, caused Ranch Brook to get a rating of Excellent in 2015, the highest possible score. In addition to acknowledging the high ecological condition of Ranch Brook, it should also be noted that other reference sites and randomly chosen streams throughout Vermont also score very high. This is a good sign for the overall quality of headwater streams in Vermont.

Long-term Trends

Annual peak discharge during each water year (October – September) at Ranch Brook shows an interesting trend since 2010 when compared to earlier years of record. Four of the top five highest annual discharges have occurred since 2010. When this hydrological variability is plotted against macroinvertebrate density, it seems apparent that organism abundance is responding to recent high peak flows (Figure 2).

Most of the highest recorded densities were early in this period of record. Beginning around 2008, we see that densities are generally depressed in years when sampling followed a low annual peak discharge. The highest densities during this time period were recorded in 2009 and 2012, years with low peak discharges. Trendlines plotted through this data suggest an inverse relationship over time between these variables.

Despite the high discharge events, the macroinvertebrate density at Ranch Brook seems to be responding to recent high peak flows. We see a clear inverse relationship between CPOM and the number of days into the biomoitoring period (Figure 8). These results suggest that it is important to consider sites that may have been impacted by recent high peak flows.

Climate Change Implications

High precipitation events like Tropical Storm Irene and other storms that have affected Ranch Brook in recent years are expected to become more common with our changing climate. These events will lead to more variable flow and higher peak flows, which in turn cause stream beds and decreases habitat stability.

Our data suggests that small, low-productivity mountain streams like Ranch Brook may have a hard time recovering macroinvertebrate abundance in response to increased flood flows. High flow events also seem to be affecting which invertebrate populations are dominating the stream community. Hydrologic instability could also have negative effects on the fish community, either as a direct result of high flow events, or through food web dynamics resulting from lower invertebrate abundance.

It is an important finding that the timing of sampling is an important factor in the presence and abundance of taxa in these communities, though perhaps not surprising. The end to late October samples were collected after leaf fall. As autumn progresses, the resource base for macroinvertebrates at Ranch Brook shifts more heavily to a community based on breaking down leaf detritus. This kind of seasonal community shift could continue to allow us to understand how invertebrates are changing over longer periods of time as a result of climate change.

Acknowledgements

Thank you to the rest of the VTDEC biologists and technicians for developing and implementing the sentinel stream monitoring program. Special thanks to Jim Doshier for all of the above and for providing the photos for this poster.