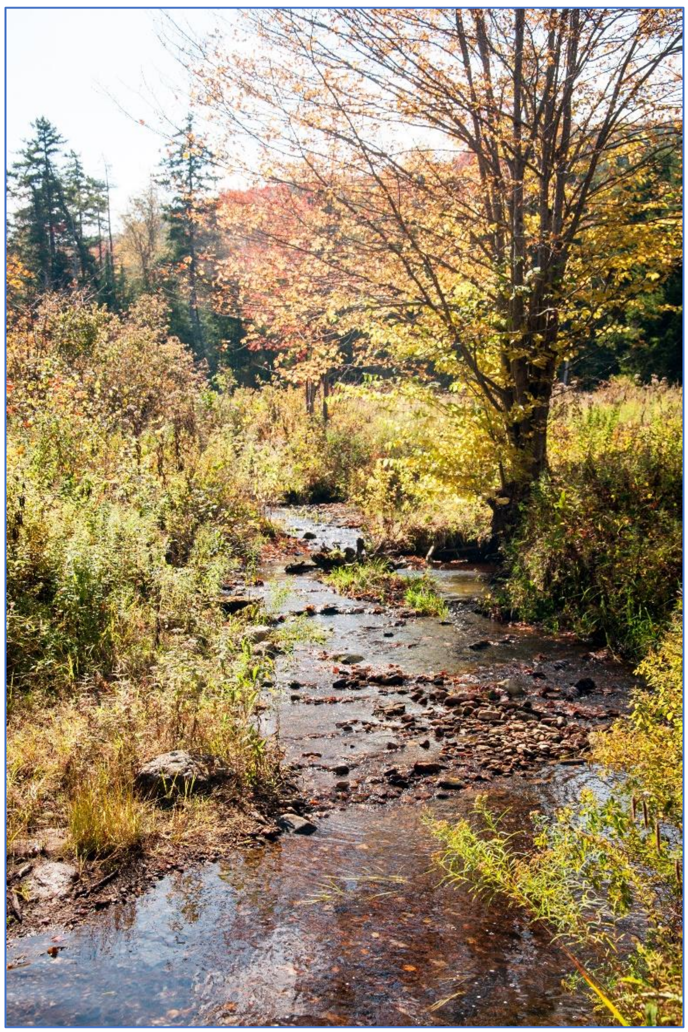
A Probabilistic Assessment of Vermont's Wadeable Streams (2013-2017)

Prepared by the Monitoring, Assessment and Planning Program
Watershed Management Division, Vermont Department of Environmental Conservation
June 2019



INTRODUCTION

The Vermont Department of Environmental Conservation Watershed Management Division's (WSMD) goals are to protect, maintain, enhance and restore Vermont's aquatic resources. The WSMD has outlined these management goals in its Surface Water Management Strategy, and has identified the ten major stressors that can impede the achievement of these goals.

Vermont biologists assessing the South Branch Wells River (Groton, VT)

Monitoring is the WSMD's primary tool for determining the overall condition of the State's water bodies and understanding which stressors are having an impact on water quality. The WSMD has conducted macroinvertebrate and fish monitoring throughout Vermont's wadeable streams since 1986. Biological communities are influenced by stressors at local and watershed scales, making them a powerful tool for providing a holistic assessment of stream health. Communities are rated on a scale of *Poor* to *Excellent*, as outlined in the Vermont Water Quality Standards, and water chemistry, habitat, land use, and other data are gathered to help understand the biological condition.

Historically, biomonitoring resources have primarily been directed towards streams that have a specific management interest. Examples of this **targeted** monitoring include the bracketing of point-source discharges, tracking the restoration efficacy of impaired streams, and the collection of long-term data from reference sites to understand the effects of climate change. In 2002, the WSMD began to integrate **probabilistic** monitoring into its biomonitoring program, a design that focuses on randomly selected sites. Unlike the targeted approach, this allows for an unbiased assessment of the overall biological condition of wadeable streams throughout the State. Additionally, we can use this design to track statewide changes in biological condition over time and to compare Vermont data to regional and national surveys being conducted by the US Environmental Protection Agency (USEPA).

Statewide probabilistic survey	Total sites sampled	Coinciding national survey
2002-2006	77	NEWS (2003-2004)
2008-2012	73	NRSA (2008-2009)
2013-2017	78	NRSA (2013-2014)

Table 1: Statewide surveys and corresponding regional or national surveys. The New England Wadeable Stream (NEWS) survey was a regional precursor to the national assessments.

SAMPLING DESIGN AND SITE SELECTION

Vermont probabilistic stream surveys are designed to overlap with the National River and Stream Assessment (NRSA) surveys that occur every five years (Table 1). Site locations for both surveys are provided by the USEPA in a single list and are selected from the National Hydrography Dataset using a stratified random design. While the NRSA only requires 20 unique Vermont sites for use in regional and national assessments, the statewide survey is designed to target an additional 55 sites (for a total of 75) to specifically evaluate the condition of Vermont’s rivers and streams (Figure 1). If sites are within the “target” population (i.e. defined channel; perennial; wadeable; not immediately downstream of a pond/lake outlet) they are included in the survey, otherwise the site is dropped and replaced with a subsequent overdraw site.

Strictly adhering to the NRSA timeframe and methodology would allow for the best comparison of national results to statewide stressors and biological condition. However, diverting resources from Vermont’s longstanding biomonitoring program to statewide probabilistic surveys required a compromise in the sampling design. Therefore, the 75 randomly selected sites are sampled and assessed using Vermont protocols. While NRSA sampling is done over two consecutive years, statewide survey sites are sampled over a 5-year period that coincides with Vermont’s rotational basin monitoring. These changes limit the ability to directly compare to NRSA results but allow for better utilization of the data in a statewide management context.

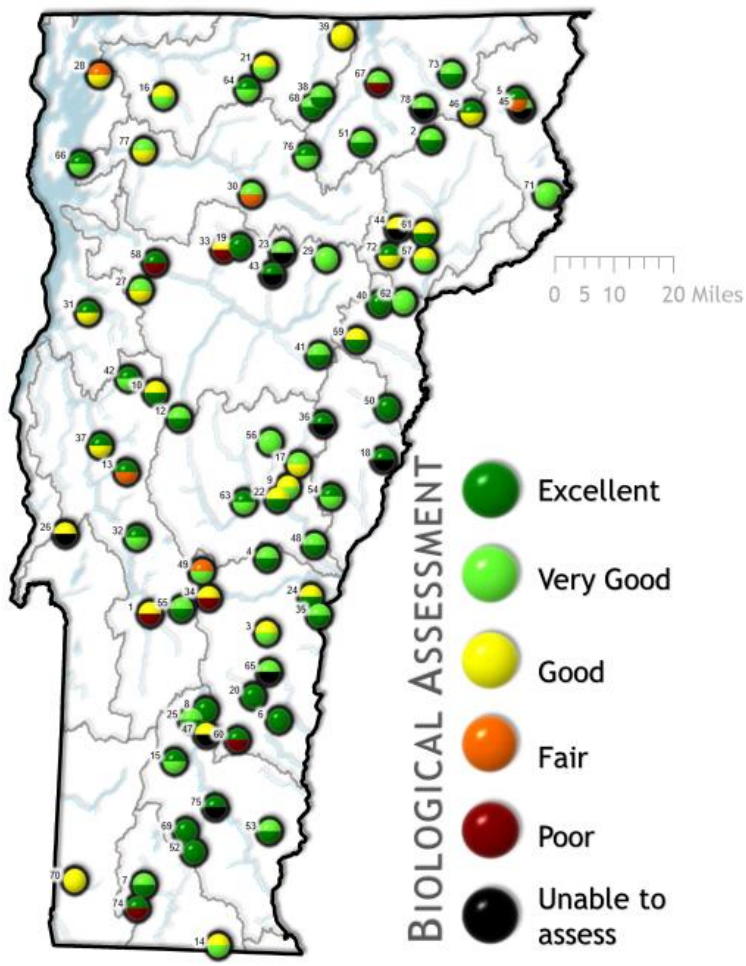


Figure 1: Site locations for the 2013-2017 probabilistic stream survey. Numbers correspond to site information in the appendix. The top half of each circle relates to macroinvertebrate assessments, and the bottom half relates to fish assessments.

DATA COLLECTION AND ASSESSMENT

Detailed information on biomonitoring field and lab methods can be found in the Watershed Management Division (WSMD) Field Methods Manual and Quality Assurance Project Plan. Water chemistry data and detailed habitat observations were collected at all sites in conjunction with biological sampling. This was done to better understand what environmental stressors may be affecting communities.

Vermont biologists performing a fish survey using a backpack electrofisher at Stark Brook (St. Johnsbury, VT)

Macroinvertebrate composite samples were collected from riffle habitats in moderate and high gradient streams, and from best available habitat (e.g. macrophytes, woody debris) in low gradient streams. Invertebrates were subsampled and separated from detritus in the lab, and all organisms were identified by experienced taxonomists to the lowest practical level (typically genus or species). Taxonomic data was used to calculate a suite of community metrics.

Each macroinvertebrate sample was assigned to one of five stream community types based on stream gradient, size, and other physical variables. For three moderate to high gradient stream types, threshold values for eight metrics are used to assess the community on a scale from *Poor* to *Excellent*. For the two low gradient stream types, an Index of Biotic Integrity (IBI) comprised of ten metrics is used in the assessment. Detailed descriptions of the stream community types and applications of macroinvertebrate metrics and IBI's can be found in the WSMD's biocriteria development documentation, and in Appendix G of the Vermont Water Quality Standards (VWQS). Macroinvertebrate assessment ratings can include "half steps" (e.g. *Good/Very Good*), however, to simplify analyses and comparisons in this survey the more basic five-tiered basic rating scale (*Poor, Fair, Good, Very Good,* and *Excellent*) was used.

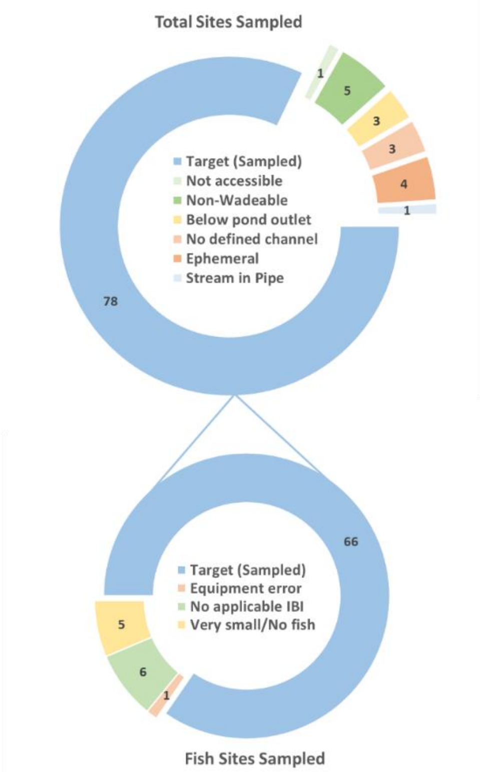


Figure 2: A breakdown of sites evaluated for the survey compared to sites sampled. While 78 sites were sampled for macroinvertebrates, not all these sites could be assessed for fish.

Fish communities are surveyed using backpack electrofishers within a stream reach length determined by the average wetted width. All fish collected during one pass are identified, enumerated and released. Fish communities are assessed on a scale of *Poor* to *Excellent* using one of two IBI's. Vermont's Cold Water IBI uses six community metrics and is applied to fish communities that have two to four native species. The Mixed Water IBI has nine metrics and is used for fish communities that have five or more native fish species. Fish IBI's are applied to communities found in moderate to high gradient hard bottomed streams; fish communities in low gradient streams are typically not assessed due to the lack of an applicable IBI. The fish community in many high gradient Vermont streams is limited to the presence of only Brook Trout, and therefore can't be assessed with either IBI. These streams were assessed for this report by the WSMD fish biologist using population statistics, including trout density and age class distribution. Detailed methodology for fish collection and assessment can also be found in the biocriteria development documentation and in the VWQS.

A total of 95 sites were evaluated for inclusion in the most recent statewide survey, and 78 of these were found to be within the target population and accessible (Figure 2). Of these 78 sites included in the survey, 66 were appropriate for fish surveys and assessment. Estimates and confidence intervals for percentage of Vermont stream miles in each assessment category were analyzed with help from the USEPA using the R software package "spsurvey". Results below exclude non-target streams and represent the percent of target/assessable stream miles for each biological community. The evaluation of the 2013-2017 survey results also included a re-analysis of the results from the previous two surveys. Site information and assessment ratings for the 78 streams evaluated can be found in the Appendix.

BIOLOGICAL CONDITION AND STRESSOR ANALYSIS

For macroinvertebrate communities, 73% of assessed stream miles are *Very Good* or *Excellent* (Figure 3). Streams with communities of this stature are referred to as "very high quality" (VHQ), and they reflect the reference condition, or minimal change thereto. These streams also represent potential opportunities for waterbody reclassification to a higher level of protective standards. Twenty-four percent of stream miles were found to be in *Good* condition, representing a moderate change from the reference condition, but still fully supporting aquatic biota. Only 2.6% of stream miles (two sites) scored *Fair* and no sites were *Poor* (ratings that indicate failure to meet aquatic biota criteria). Results from the fish survey show a very similar number of stream miles with VHQ communities (70%). Fifteen percent of stream miles have fish communities rated as *Good*. There were more stream miles (15%) with failing fish communities when compared to macroinvertebrates.

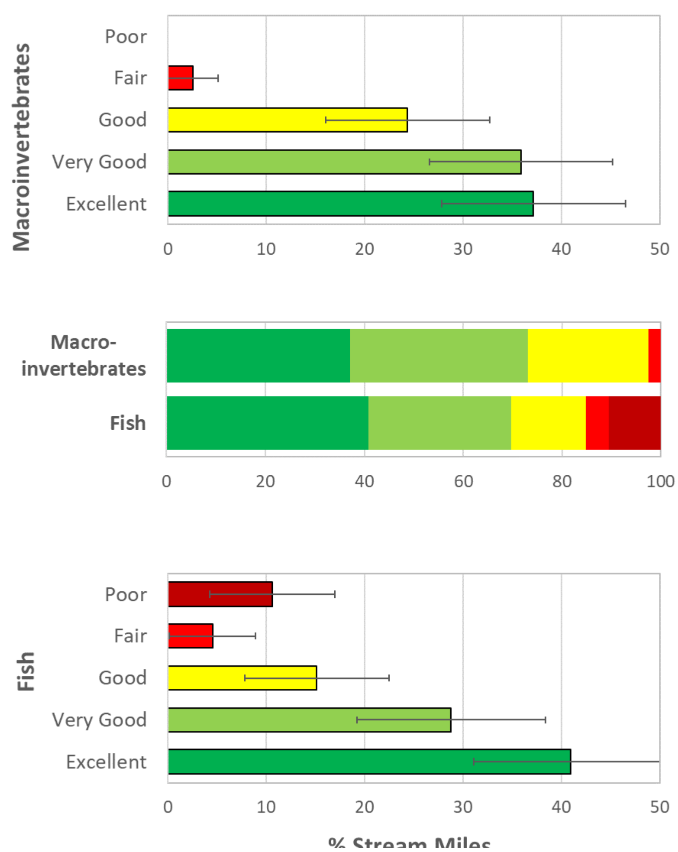


Figure 3: Percent of stream miles in each assessment category. Green categories can be combined to refer to "very high quality" waters, while red categories can be combined to indicate sites that fail to meet minimum biological criteria.

A total of 12 individual sites failed to meet aquatic biota criteria for one of the two communities, and no site had both communities fail (Table 2). State biologists reviewed biological,

Table 2: Twelve sites where one of the communities failed to meet minimum criteria for aquatic biota, and the possible stressors leading to the degraded condition. "Best Professional Judgment" indicates that one of the IBI's could not be applied, but the fish biologist was able to assess the community based on professional experience.

Location	Invertebrate Stream Type	Invertebrate Assessment	Fish IBI Type	Fish Assessment	Possible Stressors
Airport Brook	Warm Water Moderate Gradient	**Good**	Mixed Water	**Poor**	**Thermal Stress:** Significant upstream wetlands are likely increasing temperature and leading to an over-abundance of tolerant fish taxa and a lack of carnivores. Dominant invertebrate taxa are also strongly suggestive of warming.
Black Branch Nulhegan River	Medium High Gradient	**Excellent**	Mixed Water	**Fair**	**Thermal Stress:** No intolerant species or top carnivores, possibly due to warming from upstream wetlands.
Dutton Brook	Small High Gradient	**Excellent**	Best Professional Judgment	**Fair**	**Thermal Stress, Channel Erosion:** Past logging in watershed; unstable banks, moderate embeddedness, and elevated fine/gravel sediments observed. Site is located below manmade pond/wetland complex which may increase temperatures.
Jewett Brook	Slow Low Gradient	**Fair**	Mixed Water	**Good**	**Encroachment, Nutrient Loading:** Very high density of cultivated fields adjacent and upstream of site (80% agriculture in watershed). Land use is causing near total loss of forested riparian zone, and extremely elevated nitrogen (5.1 mg/l) and phosphorus concentrations (161 ug/l).
Lamoille River	Warm Water Moderate Gradient	**Very Good**	Best Professional Judgment	**Fair**	**Encroachment:** Stream reach is straightened and confined between fields and roads, with a very narrow riparian buffer, likely affecting habitat quality.
Little River	Medium High Gradient	**Good**	Mixed Water	**Poor**	**Channel Erosion, Thermal Stress, Encroachment:** Stream has undergone channelization and loss of riparian zone as a result of encroachment from roads and farms adjacent to and upstream of site.
Madden Brook	Small High Gradient	**Good**	Best Professional Judgment	**Poor**	**Channel Erosion:** Evidence of high flows and scour, sampling within three years of an extreme flow event that may have decreased brook trout densities in this small watershed.
Roaring Brook (Killington)	Small High Gradient	**Fair**	Cold Water	**Very Good**	**Channel Erosion, Toxic Substances:** Stream is below ski resort development, and upper reaches are listed as impaired for stormwater and erosion. Chloride levels were also high (74 mg/l).
Snipe Island Brook	Small High Gradient	**Excellent**	Cold Water	**Poor**	**Channel Erosion, Land erosion:** Stream follows dirt road, and there has been significant logging in watershed. Elevated fine/gravel sediments were observed during habitat assessment.
South Branch Williams River Trib #7	Small High Gradient	**Excellent**	Cold Water	**Poor**	**Thermal Stress, Nutrient Loading:** Significant onstream ponds and wetlands in watershed, and elevated phosphorus concentrations (36 ug/l). Invertebrate community also suggests benign enrichment.
Trout Brook (Brownington)	Small High Gradient	**Very Good**	Cold Water	**Poor**	**Thermal Stress:** Significant upstream wetlands are likely increasing temperature and leading to an over-abundance of tolerant fish taxa and a lack of carnivores. Some common invertebrate taxa are also suggestive of warming.
West Branch Deerfield River	Medium High Gradient	**Excellent**	Cold Water	**Poor**	**Thermal Stress, Acidity:** Wetland complexes and taxa present suggest warming. Chemical parameters (alkalinity, pH, aluminum) indicate possible acid stress.

chemical, physical habitat and geographical data for each of these 12 sites to pinpoint one or more of the ten stressors from the Surface Water Management Strategy (SWMS) that may be leading to a degraded biological condition. For the two sites with failing macroinvertebrate communities, chemical stressors were readily apparent. Jewett Brook is currently listed on Vermont's 303(d) list of impaired waters due to nutrients from agricultural runoff. Roaring Brook had a high concentration of chloride and was sampled at a reach downstream of a tributary at a ski resort that is listed as impaired for stormwater runoff.

Among the ten sites with failing fish communities, channel erosion (which can substantially alter habitat quality) was the second most common stressor. Seven sites (70%) had thermal stress as a possible stressor altering fish communities. Upstream wetlands and ponds were implicated as the source of thermal stress at each of these sites, where solar radiation is likely warming open water areas. In most cases, the upstream wetlands and impoundments are natural landscape features. This suggests that while the assessments indicate thermal stress, the communities themselves are not impaired as a result of human impacts.

Biological communities integrate the effects of various stressors at local and watershed scales. This makes biological condition an ideal method for assessing overall water quality, but human activities can lead to several factors interacting to produce the observed response. For instance, agricultural activity may result in warming due to loss of riparian canopy, enrichment due to nutrient loading, and sedimentation due to land erosion. When looking across all sites, it is apparent that watershed land use is indeed playing an important role in determining macroinvertebrate biological condition. Sites were grouped into three condition categories; failure to meet minimum criteria (*Fail*), moderate departure from natural condition (*Good*), and at or near reference condition (*VHQ*). For macroinvertebrates, the percent of agriculture, development, and natural land cover (wetlands plus forest) were significantly different between the *Good* and *VHQ* categories (Figure 4; Mann-Whitney U test $p<0.05$). Macroinvertebrate communities that failed to meet aquatic biota criteria were not included in this analysis due to small sample size (n=2), though as discussed above, development and agriculture play very clear roles at these sites.

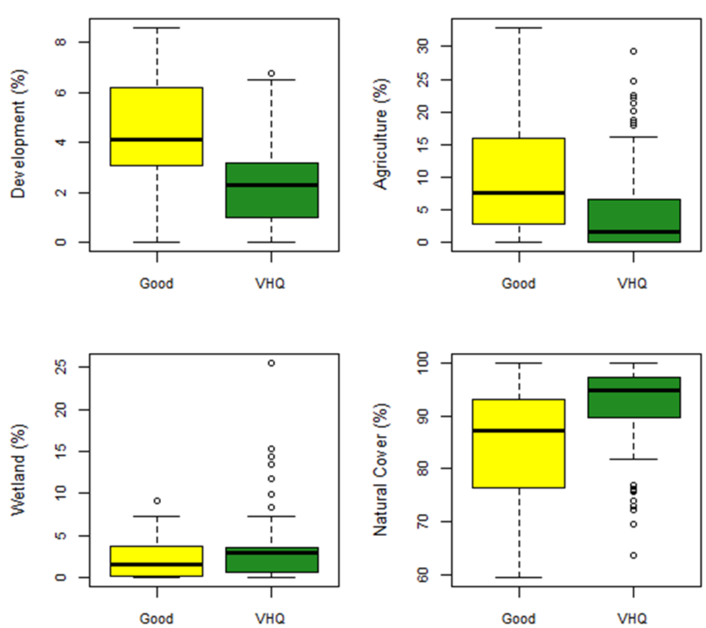


Figure 4: Difference in land use between sites where macroinvertebrate communities were assessed as Good or VHQ. VHQ refers to "very high quality" communities assessed as Very Good or Excellent.

The pattern is not as clear when looking at fish assessments (Figure 5). A comparison of the three assessment categories shows no significant difference due to land use, though both percent wetland and development were bordering on significance (One-way ANOVA on ranks, p=0.07). The results are suggestive of a pattern where VHQ sites may have less development and failing sites may have more wetland in the watershed. While wetlands serve important ecosystem functions and do not diminish water quality, this is a good demonstration of the effect water temperature changes can have on fish communities in Vermont. For example, increasing temperatures related to climate change could ultimately limit populations of intolerant and cold-water fish species. These results also indicate that the development of a separate index for natural warm-water stream fish communities may be a useful tool for supplementing the mixed-water and cold-water IBI's.

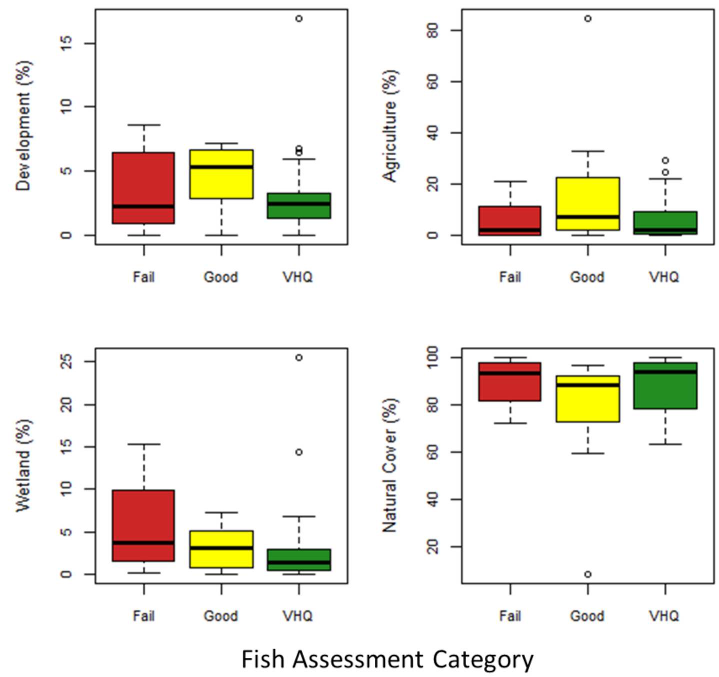


Figure 5: Difference in land use between sites where fish communities were assessed as Fail, Good or VHQ. VHQ refers to "very high quality" communities assessed as Very Good or Excellent, while Fail refers to communities assessed as Poor or Fair.

COMPARISONS TO PREVIOUS SURVEYS

With only three surveys completed, and due to the modified design that Vermont uses for the probabilistic survey, statistical temporal trends have not yet been detected. This problem is at least partially due to the survey sample size in relation to the number of assessment categories. For example, a subtle change in biology can cause a community to drop from *Very Good* to *Good*, yet the addition of just one *Good* biological community could result in a substantial change in the estimated number of stream miles in that category. However, we can make a few generalized observations from the data. While there may be fewer stream miles with failing macroinvertebrate communities in the 2013-2017 survey, there were an almost identical number of stream miles identified as "very high quality" (VHQ) when compared to 2008-2012 (Figure 6). Fish surveys seem to show a somewhat consistent percentage of stream miles that fail to meet criteria across surveys (Figure

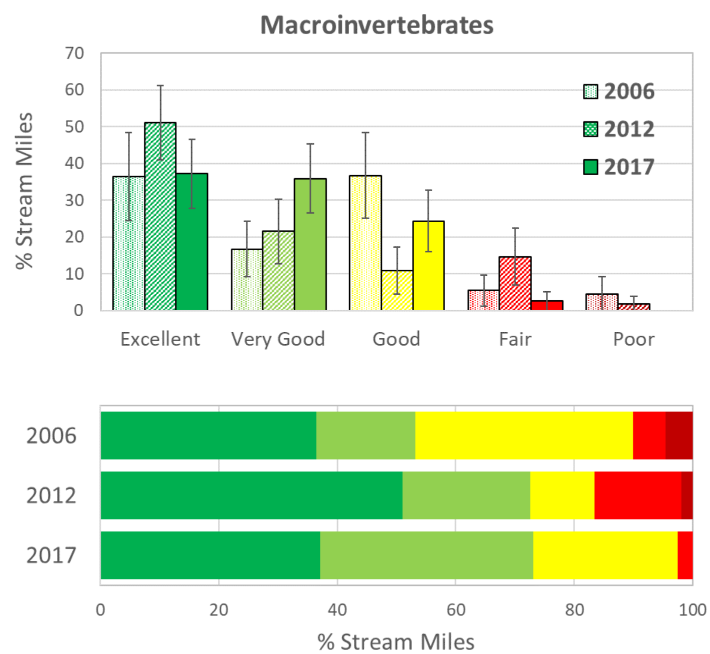


Figure 6: Macroinvertebrate assessment results from three probabilistic surveys. The date refers to the year each survey was completed. In the top plot, progressively darker shading (left to right) is indicative of more recent surveys.

7). There were also more stream miles identified as VHQ in the 2013-2017 survey when compared to previous results.

The three surveys to-date follow a five-year rotational basin design within each survey. This means that some sites *between* surveys are sampled closer in time than those *within* surveys. Three surveys may not provide enough data to look at trends even if all sites were sampled within the same year every five years, and this modified design further complicates the analysis. To solve this problem, Vermont's probabilistic survey has recently been redesigned. Beginning in 2018, fifteen completely randomized sites are sampled annually statewide. After three years, we can begin to use a moving window of 45 sites to produce annual estimates of biological status, and to look at trends on a yearly basis. It may still take a great deal of time to detect statistical patterns, but this new design should find them more quickly.

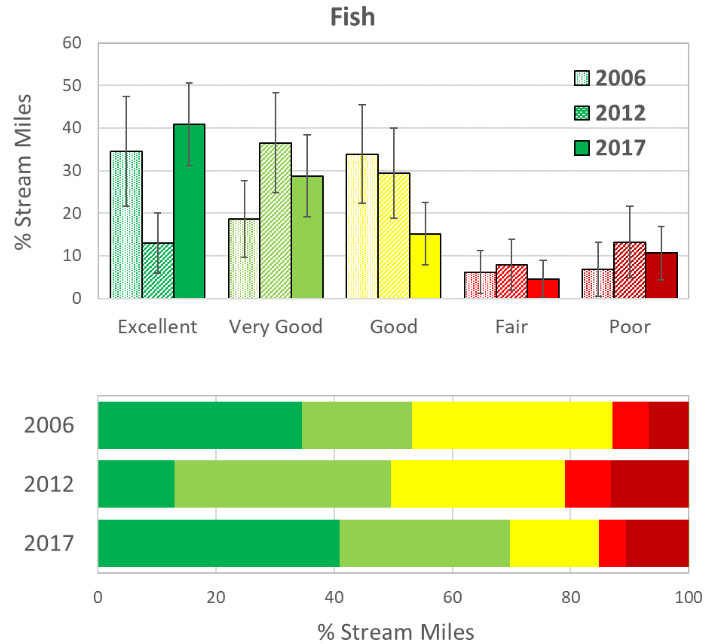


Figure 7: Fish assessment results from three probabilistic surveys. The date refers to the year each survey was completed. In the top plot, progressively darker shading (left to right) is indicative of more recent surveys.

COMPARISON TO REGIONAL AND NATIONAL RESULTS

The National Rivers and Stream Assessment (NRSA) provides both national and eco-region results on biological condition as well as habitat and chemical stressors. As discussed previously, direct comparisons between Vermont's statewide probabilistic survey and results of the NRSA are complicated by several factors.

- The population of target streams in the Vermont survey is different than the NRSA. Notably, the statewide survey excludes non-wadeable streams, and fish populations are not assessed in Vermont low gradient streams.
- Vermont's biomonitoring program uses a different index period (September 1st – October 15th) than NRSA (June 1st – September 30th), uses different collection methods for biological data, and assesses community condition using different biological criteria.
- Vermont does not collect most of the same chemical and habitat data as the NRSA, therefore most stressor related variables are not comparable.

- The analysis of NRSA data included estimates of stream miles “not assessed”, where statewide analysis only included assessed streams; therefore all comparisons had to be simplified to “percent of sites assessed” instead of using stream mile estimates.

Despite these caveats, there were three important chemical stressors that did allow for relatively direct comparisons between state, regional and national results; concentrations of total phosphorus and nitrogen, and salinity (measured using the water’s conductivity). The NRSA has established thresholds for “least”, “moderately” and “most” disturbed condition for each parameter, allowing for separation of Vermont’s data into each category.

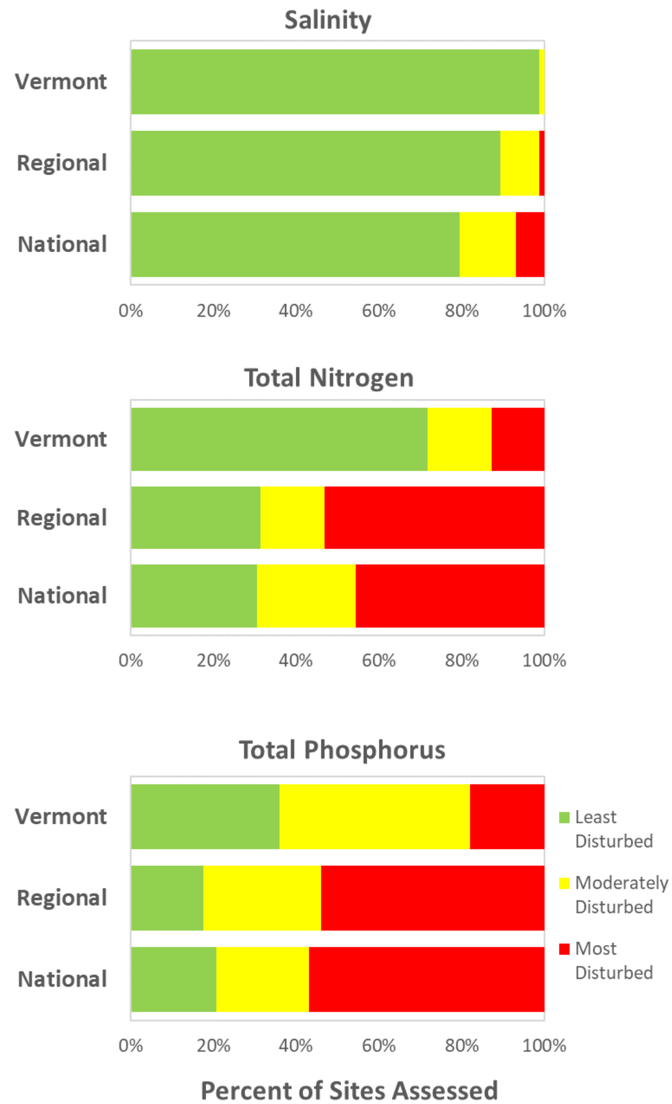


Figure 8: A comparison of water chemistry parameters in Vermont to regional and national data. Regional results refer to the Northern Appalachians ecoregion, including New England and New York, and parts of Pennsylvania and Ohio.

Only one site surveyed in Vermont had a conductivity value high enough to fall into the moderately disturbed category for salinity (>500 µS/cm), and no sites were in the most disturbed category having greater than 1000 µS/cm (Figure 8). National and regional data show a slightly higher number of sites in these categories, but a majority of sites still fall within the least disturbed category. While elevated salinity in Vermont was not found to be widespread in the probabilistic survey, we know from targeted monitoring that salinity (in the form of chloride concentration) can be extremely harmful to stream communities. Detrimental effects can also be quite noticeable at concentrations lower than those needed to produce a conductivity of >500 µS/cm.

Nitrogen showed similar results at the regional and national scales. While it appears that Vermont may have more sites in least disturbed condition, nearly 30% of sites were in the moderately or most disturbed categories (>0.33 and >0.44 mg/l, respectively). In contrast, only 21% of sites surveyed in Vermont had phosphorus concentrations in least disturbed condition (<8.2 µg/l), and 18% were in the most disturbed condition (>15.7 µg/l).

Phosphorus loading from Vermont rivers and streams, and subsequent detrimental effects to water quality in Vermont lakes, is a topic of great concern. While Vermont concentrations may be better than regional or national averages, the fact that it is a notable stressor in this context is not surprising.

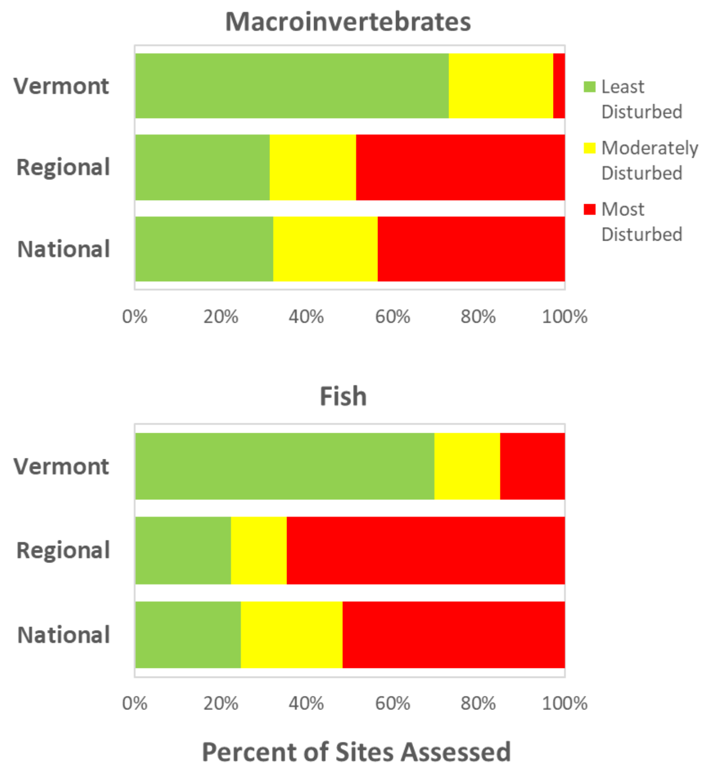


Figure 9: Comparison of biological results from the Vermont statewide survey with national and regional results.

Both the state and national surveys use a well-established tiered system for assessing biological condition, which allows for simplified comparisons of results. NRSA also provides results by eco-region, allowing for a regional comparison to the Northern Appalachians area. The NRSA's categories of "least", "moderately" and "most" disturbed biological condition line up well narratively with the categories analyzed in the statewide survey. "Least disturbed" sites are comparable to Vermont's "very high quality" (VHQ) category of *Very Good* and *Excellent* assessments, representing minimal to minor departure from the natural condition. "Moderately disturbed" sites equate to Vermont's *Good* condition, described as a moderate departure from reference. "Most disturbed" sites compare to *Fair* and *Poor* assessments, those communities that fail to meet minimum criteria for a biological health.

While no statistical significance can be attached to these comparisons, it appears that the statewide condition of macroinvertebrate and fish communities may be better than both regional and national averages (Figure 9). This may be intuitive given the relative lack of high intensity development throughout Vermont in comparison to other areas of the country. While the statewide survey shows that overall biological condition in Vermont is quite high, monitoring in areas of Vermont with intensive agriculture and urban development (specifically those areas under-employing offsetting management practices) has also shown that effects on stream health can be quite dramatic. This highlights the importance of continued vigilance to protect, maintain, enhance and restore the State's surface waters.

FINAL CONCLUSIONS FROM THE 2013-2017 PROBABILISTIC STREAM SURVEY

- A vast majority of stream miles in Vermont maintain biological communities that are "very high quality" waters; demonstrating reference condition, or minimal changes thereto.
- Fish and macroinvertebrate communities can be affected by different stressors. Invertebrates may be more susceptible to stressors resulting from watershed land use change, including

nutrient loading from agriculture, and toxic substances like chloride. Fish communities in this survey seem to be more altered by channel erosion and thermal influences.

- The probabilistic survey design used by Vermont since 2002 seems to have limited utility for detecting change in biological condition over time. In response to this, Vermont has changed its design to sample 15 randomized sites on a yearly basis, which will allow annual reporting of results after 2020.
- Vermont has more sites in "least disturbed" condition for salinity, nitrogen and phosphorus than national or regional averages. However, total phosphorus appears to the be more predominant stressor of these three. Given our knowledge of the potential effects of chloride and nutrients on biological communities, protections against increases in these parameters is imperative.
- Vermont has substantially fewer biological communities in "most disturbed" condition, and more communities in "least disturbed" condition compared to regional and national results. This may be due to less overall land development in Vermont, further highlighting the importance of maintaining the integrity of our unique water resources.

Deer Hollow Brook (Granville, VT)

ACKNOWLEDGEMENTS

Sincerest thanks to staff at the USEPA; particularly Tony Olsen, who provided tremendous help on sample design, technical support and statistical analyses, and Richard Mitchell, who made the 2013-2014 NRSA results available for statewide comparison. Thanks also to all biomonitoring and other WSMD staff, past and present, who were essential in carrying out field work, processing macroinvertebrate samples, compiling data, and reviewing this document. Special thanks to Vermont biologists Steve Fiske (retired), Rich Langdon (retired), Aaron Moore, and Jim Deshler, who performed all the biological assessments (and subsequent ecological analyses). Aaron Moore drafted this report, Sean Regalado provided the map used, and all photos were courtesy of Jim Deshler.

APPENDIX: Site information and assessment ratings for the 78 streams evaluated as part of this report. “Map ID” corresponds to the numbers from the map on page 2. Invertebrate stream types and fish IBI types are described in the Vermont Water Quality Standards. “BPJ” indicates a fish community evaluated by “best professional judgment”, generally referring to streams having Brook Trout as the sole population. More information on each site can be found in the Vermont Integrated Watershed Information System.

Map ID	Stream	River Mile	Town	Vermont Water Body ID	Drainage Area (km2)	Elevation (ft)	Sampling Date	Invertebrate Stream Type	Invertebrate Assessment	Fish IBI Type	Fish Assessment
1	Airport Brook	1.2	Clarendon	VT03-06	11.2	640	2016-09-27	WWMG	Good	MW	Poor
2	Arcadia Brook	0.3	Newark	VT15-07	6.6	1299	2015-09-16	SHG	Very Good	BPJ	Excellent
3	Bailey Brook	1.5	Reading	VT13-08	13.9	1077	2017-10-11	SHG	Good	MW	Very Good
4	Barnard Brook Trib #6	0.4	Pomfret	VT10-10	4.6	962	2014-09-11	SHG	Very Good	CW	Excellent
5	Black Branch Nulhegan River	2.3	Bloomfield	VT16-11	56.2	1135	2017-09-13	MHG	Excellent	MW	Fair
6	Black River Trib #9	0.2	Springfield	VT10-12	1.5	853	2014-09-10	SHG	Excellent	CW	Excellent
7	Bond Brook	1.7	Searsburg	VT12-04	1.9	2309	2016-09-26	SHG	Very Good	BPJ	Excellent
8	Burton Brook	1.8	Weston	VT11-18	0.62	1750	2017-09-19	SHG	Excellent	BPJ	Excellent
9	Button Brook	0.3	Tunbridge	VT09-04	4.04	720	2014-09-02	SHG	Good	BPJ	Very Good
10	Cota Brook	2.5	Lincoln	VT03-11	1.1	1660	2016-10-06	SHG	Good	BPJ	Excellent
11	Cutler Mill Brook	1.0	Guildhall	VT16-14	53.6	846	2017-09-12	HLG	Very Good		
12	Deer Hollow Brook	0.9	Granville	VT09-07	2.9	1675	2015-09-02	SHG	Very Good	BPJ	Excellent
13	Dutton Brook	0.7	Leicester	VT03-04	10.7	1450	2016-10-04	SHG	Excellent	BPJ	Fair
14	East Branch North River	10.3	Halifax	VT12-07	102	787	2016-09-15	MHG	Good	MW	Very Good
15	Eddy Brook	1.9	Winhall	VT11-16	5.5	1397	2016-09-20	SHG	Excellent	MW	Very Good
16	Fairfield River	0.2	Fairfield	VT06-05	51.3	351	2013-09-24	WWMG	Good	MW	Very Good
17	Foundry Brook	0.8	Tunbridge	VT09-04	1.35	1000	2014-09-02	SHG	Very Good	BPJ	Good
18	Glen Falls Brook	0.8	Fairlee	VT16-20	2.6	956	2017-09-25	SHG	Excellent		
19	Gold Brook	3.0	Stowe	VT08-11	7.6	1097	2015-09-23	SHG	Excellent	CW	Excellent
20	Great Brook	6.9	Chester	VT10-12	7.7	766	2014-09-11	HLG	Excellent	MW	Excellent
21	Hannah Clark Brook	1.7	Montgomery	VT06-07	7.5	1592	2016-09-12	SHG	Good	BPJ	Very Good
22	Happy Hollow Brook	0.4	Royalton	VT09-03	3.03	560	2014-09-05	SHG	Good	CW	Excellent
23	Hardwood Brook	1.6	Worcester	VT08-13	8.5	1104	2013-09-03	SHG	Very Good		
24	Harlow Brook	2.1	Hartland	VT10-02	2.6	880	2014-09-11	SHG	Good	BPJ	Excellent
25	Holden Hill Brook	1.4	Weston	VT11-18	2	1610	2017-09-19	SHG	Very Good	BPJ	Excellent
26	Hubbardton River	12.9	Benson	VT02-02	23.5	325	2015-10-08	HLG	Good		

Map ID	**Stream**	**River Mile**	**Town**	**Vermont Water Body ID**	**Drainage Area (km2)**	**Elevation (ft)**	**Sampling Date**	**Invertebrate Stream Type**	**Invertebrate Assessment**	**Fish IBI Type**	**Fish Assessment**
27	Huntington River	7.9	Huntington	VT08-10	120.7	566	2015-09-28	MHG	Very Good	MW	Good
28	Jewett Brook	4.1	Swanton	VT05-07	7.6	145	2016-10-11	SLG	Fair	MW	Good
29	Jug Brook	3.0	Woodbury	VT08-09	4.2	1280	2013-09-17	SHG	Very Good	BPJ	Very Good
30	Lamoille River	53.6	Morristown	VT07-04	697	545	2013-09-18	WWMG	Very Good	BPJ	Fair
31	Lewis Creek	8.5	Charlotte	VT03-08	180.3	250	2016-10-03	WWMG	Excellent	MW	Good
32	Little Brook	1.8	Pittsford	VT03-13	8.9	517	2016-09-26	SHG	Excellent	CW	Very Good
33	Little River	7.1	Stowe	VT08-11	170.7	652	2013-09-06	MHG	Good	MW	Poor
34	Madden Brook	0.3	Plymouth	VT10-06	5.5	1377	2014-10-01	SHG	Good	CW	Poor
35	McArthur Brook	0.5	Hartland	VT13-07	5.6	474	2017-09-21	SHG	Very Good	BPJ	Excellent
36	Meadow Brook	8.1	Corinth	VT14-06	0.8	1714	2017-09-07	SHG	Excellent		
37	Middlebury River	3.6	Middlebury	VT03-12	136	350	2016-10-05	MHG	Excellent	MW	Good
38	Mineral Spring Brook	5.0	Lowell	VT06-08	4	1424	2015-09-15	SHG	Very Good	CW	Excellent
39	Mud Creek	9.8	Newport Town	VT06-08	23.6	696	2013-09-25	MHG	Good	MW	Good
40	Mud Pond Brook	0.6	Peacham	VT14-09	5.7	1320	2017-09-06	SHG	Excellent	CW	Excellent
41	Nelson Brook	2.3	Orange	VT08-15	6.3	1652	2015-09-23	SHG	Very Good	BPJ	Excellent
42	New Haven River	13.7	Bristol	VT03-11	124	815	2016-10-06	MHG	Excellent	MW	Very Good
43	North Branch Winooski River	11.0	Worcester	VT08-13	72.5	734	2015-09-21	SLG	Excellent		
44	North Brook	2.6	Danville	VT15-04	0.2	1283	2015-09-02	SHG	Good		
45	Nulhegan River	4.5	Bloomfield	VT16-11	243.8	1092	2013-09-10	HLG	Very Good		
46	Nulhegan River	21.2	Brighton	VT16-11	1.32	1750	2017-09-13	SHG	Excellent	BPJ	Good
47	Piper Hill Brook	1.5	Weston	VT11-18	4.7	1341	2017-09-19	SLG	Good		
48	Podunk Brook	0.9	Hartford	VT09-03	4.2	704	2014-09-08	SHG	Very Good	BPJ	Excellent
49	Roaring Brook	0.9	Killington	VT10-06	13.8	1592	2016-09-13	SHG	Fair	CW	Very Good
50	Roaring Brook	4.4	Bradford	VT16-19	2.2	1165	2017-09-07	SHG	Excellent	CW	Excellent
51	Roaring Brook	5.3	Glover	VT17-08	4.6	1460	2014-09-17	SHG	Very Good	BPJ	Excellent
52	Rock River	10.8	Dover	VT11-09	5.3	1596	2017-09-28	SHG	Excellent	CW	Excellent
53	Sacketts Brook	4.8	Putney	VT13-12	7.6	694	2017-09-27	SHG	Very Good	CW	Excellent
54	Sargent Brook	0.2	Strafford	VT14-02	3.2	910	2017-09-21	SHG	Excellent	BPJ	Very Good
55	Sargent Brook	1.6	Shrewsbury	VT03-16	7	1806	2016-09-13	SHG	Very Good	CW	Excellent
56	Second Branch White River	18.5	Randolph	VT09-05	78.5	634	2014-09-02	MHG	Very Good	MW	Very Good
57	Sleepers River	1.3	St. Johnsbury	VT15-04	119.4	574	2015-09-02	MHG	Good	MW	Very Good
58	Snipe Island Brook	1.4	Richmond	VT08-04	11.7	474	2015-09-22	SHG	Excellent	CW	Poor

Map ID	Stream	River Mile	Town	Vermont Water Body ID	Drainage Area (km2)	Elevation (ft)	Sampling Date	Invertebrate Stream Type	Invertebrate Assessment	Fish IBI Type	Fish Assessment
59	South Branch Wells River	2.5	Groton	VT14-08	33.2	1240	2013-08-29	MHG	Good	CW	Excellent
60	South Branch Williams River Trib #7	0.4	Chester	VT11-03	1.1	1376	2017-09-19	SHG	Excellent	CW	Poor
61	Stark Brook	1.5	St. Johnsbury	VT15-05	5.9	797	2015-09-16	SHG	Good	BPJ	Excellent
62	Stevens River	4.0	Barnet	VT14-09	104.6	740	2012-09-10	MHG	Very Good	MW	Very Good
63	Stoddard Brook	0.5	Bethel	VT09-07	2.23	617	2014-09-05	SHG	Excellent	BPJ	Very Good
64	Tamarack Brook	1.6	Montgomery	VT06-07	4	1108	2013-09-19	SHG	Excellent	CW	Very Good
65	Tarbell Hill Brook	0.8	Cavendish	VT10-13	1.7		2014-09-10	SHG	Very Good		
66	Trout Brook	0.3	Milton	VT05-08	12	110	2013-10-07	SLG	Excellent	MW	Very Good
67	Trout Brook	1.6	Brownington	VT17-07	4.5	1026	2014-09-16	SHG	Very Good	CW	Poor
68	Truland Brook	1.8	Lowell	VT06-08	2.2	1430	2013-09-26	SHG	Very Good	BPJ	Excellent
69	Waite Brook	0.8	Wardsboro	VT11-14	10	1405	2017-09-28	SHG	Excellent	CW	Excellent
70	Walloomsac River	14.9	Bennington	VT01-03	223	602	2013-10-02	MHG	Good	MW	Good
71	Washburn Brook	1.0	Guildhall	VT16-14	9	955	2017-09-12	SHG	Very Good	MW	Very Good
72	Water Andric	7.8	Danville	VT15-03	0.4	1466	2015-09-03	SHG	Excellent	BPJ	Good
73	Webster Brook	4.6	Morgan	VT17-05	3.3	1615	2014-09-15	SHG	Very Good	BPJ	Excellent
74	West Branch Deerfield River	5.9	Readsboro	VT12-02	38.8	1765	2016-09-21	MHG	Excellent	CW	Poor
75	West River	22.6	Jamaica	VT11-10	593	539	2017-09-28	MHG	Excellent		
76	Wild Branch	11.2	Craftsbury	VT07-19	25.6	1079	2016-09-12	MHG	Excellent	MW	Very Good
77	Wilkins Brook	0.1	Fairfax	VT07-09	13.5	472	2016-10-11	HLG	Very Good	MW	Good
78	Willoughby Trib #17	1.7	Westmore	VT17-06	0.7	1972	2014-09-17	SHG	Very Good		