June 2024

BASIN 16
Assessment Report
Upper Connecticut

Contents

Basin overview

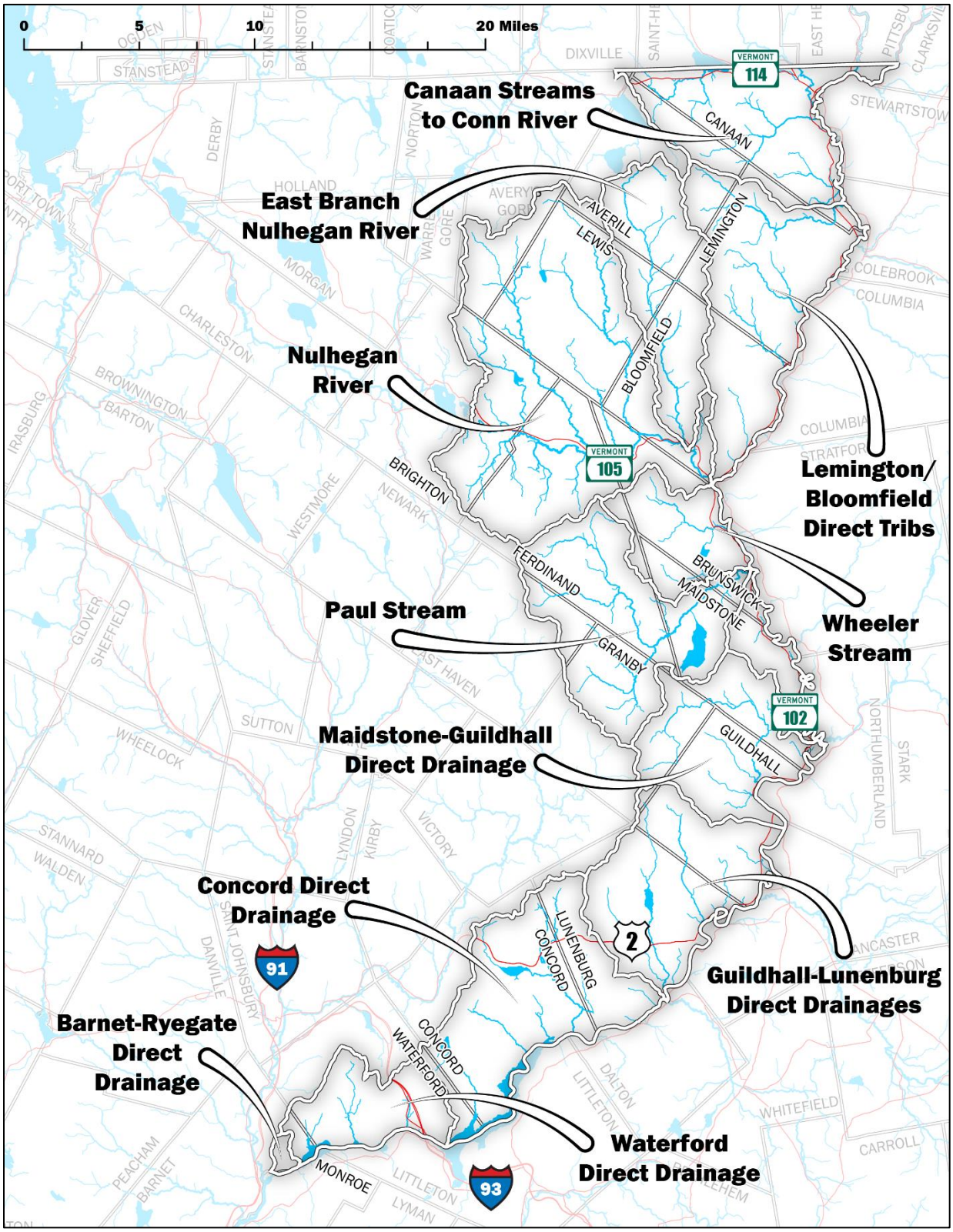

Figure 1 The 482 square mile Upper Connecticut basin encompasses the Essex County contributions to the Connecticut river and the Town of Waterford in Caledonia County direct drainages to the Connecticut River.

Table 1 Distribution of Strahler stream orders by miles across Basin 16. This data is from the High-Resolution National Hydrography Dataset Plus (NHDPlus).

1	2	3	4	5	8
84	115	123	60	36	79

Table 2 Distribution of lake surface area (acres) across Basin 16. Data from the High-Resolution National Hydrography Dataset Plus (NHDPlus).

Lake area (acres)			
<10	*>10<100*	*>100<500*	*>500*
9	18	5	2

Table 3 Distribution of wetland area (acres) across Basin 16. Data from the Vermont State Wetland Inventory (VSWI). Contiguous wetlands were combined to account for wetlands complexes containing multiple classes.

<5	*>5<50*	*>50<500*	*>500*
1067	392	60	6

Table 4 Summation of town level human population over time that intersects with Basin 16.

Basin-wide human population by year				
1980	*1990*	*2000*	*2010*	*2020*
5024	5327	5369	5421	5129

Table 5 . Major waters of Basin 16.

Largest River, not Connecticut River	Nulhegan River (22.5 miles)
Largest Lake, not a Connecticut River Reservoir	Maidstone Lake (756 acres)
Deepest Lake or Reservoir	Maidstone Lake (121 feet)
Largest Wetland Complex	Ferdinand Wetland Complex (2490 acres; 44.7708, -71.7526)

Land cover

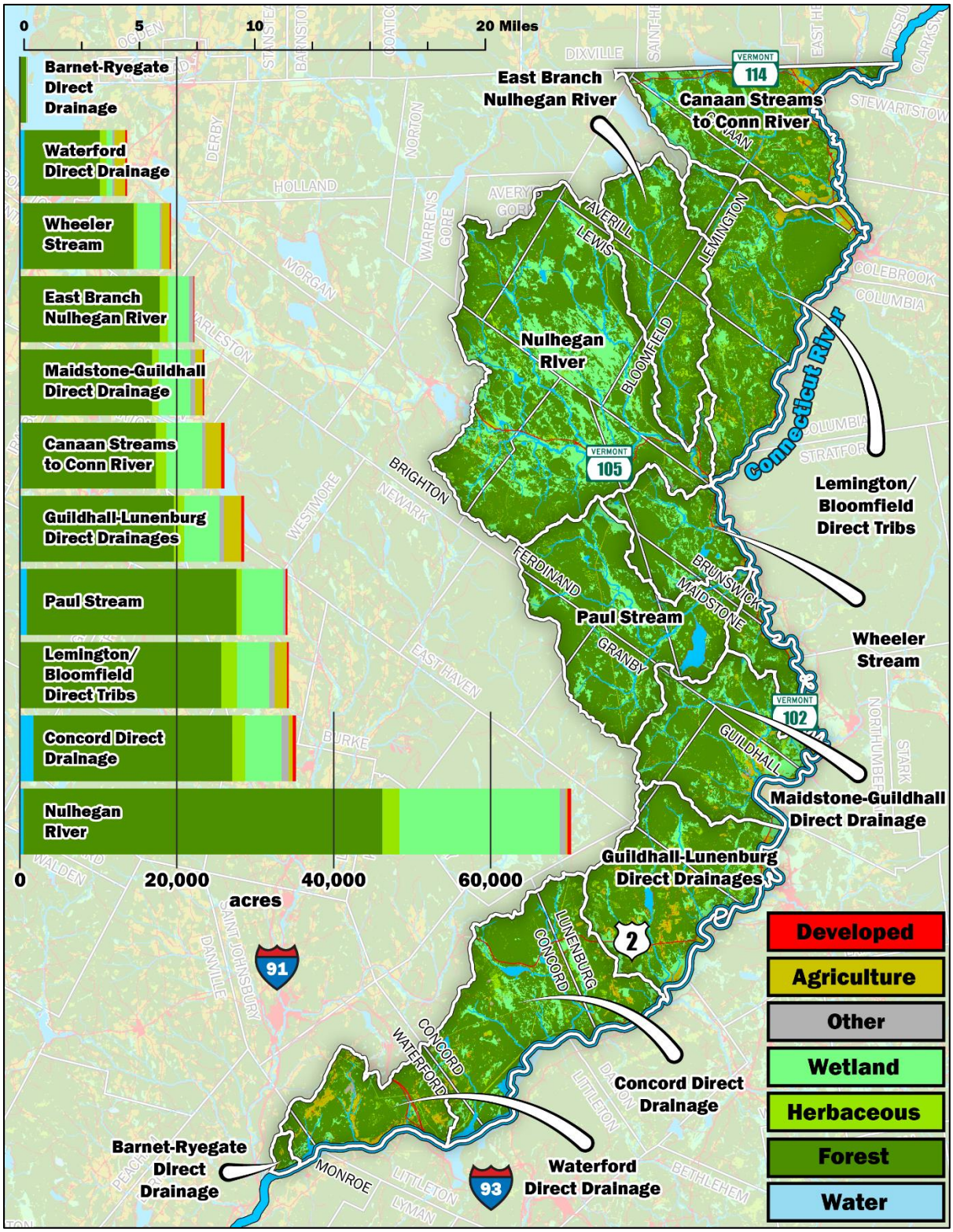

Figure 2. Landcover based on the 1-meter Statewide land cover dataset produced by the University of Vermont spatial analysis laboratory and the Lake Champlain Basin program. The bar graph is a summary based on the Vermont WBID subwaterheds of the tactical basin.

Table 6 The percentage of major land cover types across the Vermont WBID subwatersheds of Basin 16. 0.5-meter Vermont land cover dataset produced by the University of Vermont spatial analysis laboratory and the Lake Champlain Basin program. Common land cover types were combined, for example deciduous and coniferous are categorized as forest. The other category includes shrubs and barren land. Wetlands are found throughout other cover types.

Name	Acres	Developed	Agriculture	Other	Wetlands	Herbaceous	Forest	Water
Barnet-Ryegate Direct Drainage	930.4	0.81	4.43	1.61	7.31	3.72	81.03	1.08
Canaan Streams to Conn River	26074.9	1.57	7.77	1.54	17.51	5.12	65.48	1.01
Concord Direct Drainage	35208.2	1.25	1.45	2.52	13.25	4.65	71.94	4.94
East Branch Nulhegan River	22223.3	0.52	0.00	2.47	11.95	4.75	80.04	0.25
Guildhall-Lunenburg Direct Drainages	28583.9	1.26	7.74	2.01	15.64	4.65	67.85	0.86
Lemington/Bloomfield Direct Tribs	34269.1	0.70	4.59	2.04	11.92	5.78	74.73	0.24
Maidstone-Guildhall Direct Drainage	23492.6	0.73	4.28	2.45	17.22	3.53	71.44	0.35
Nulhegan River	70253.1	0.66	0.27	1.16	29.06	3.09	65.14	0.63
Paul Stream	34098.0	0.62	0.07	0.89	15.44	1.98	78.40	2.61
Waterford Direct Drainage	13667.4	1.63	10.16	1.85	5.52	6.24	70.49	4.12
Wheeler Stream	19242.5	0.74	5.30	1.38	14.86	2.25	73.60	1.88

Lakes and Ponds

Conditions and trends

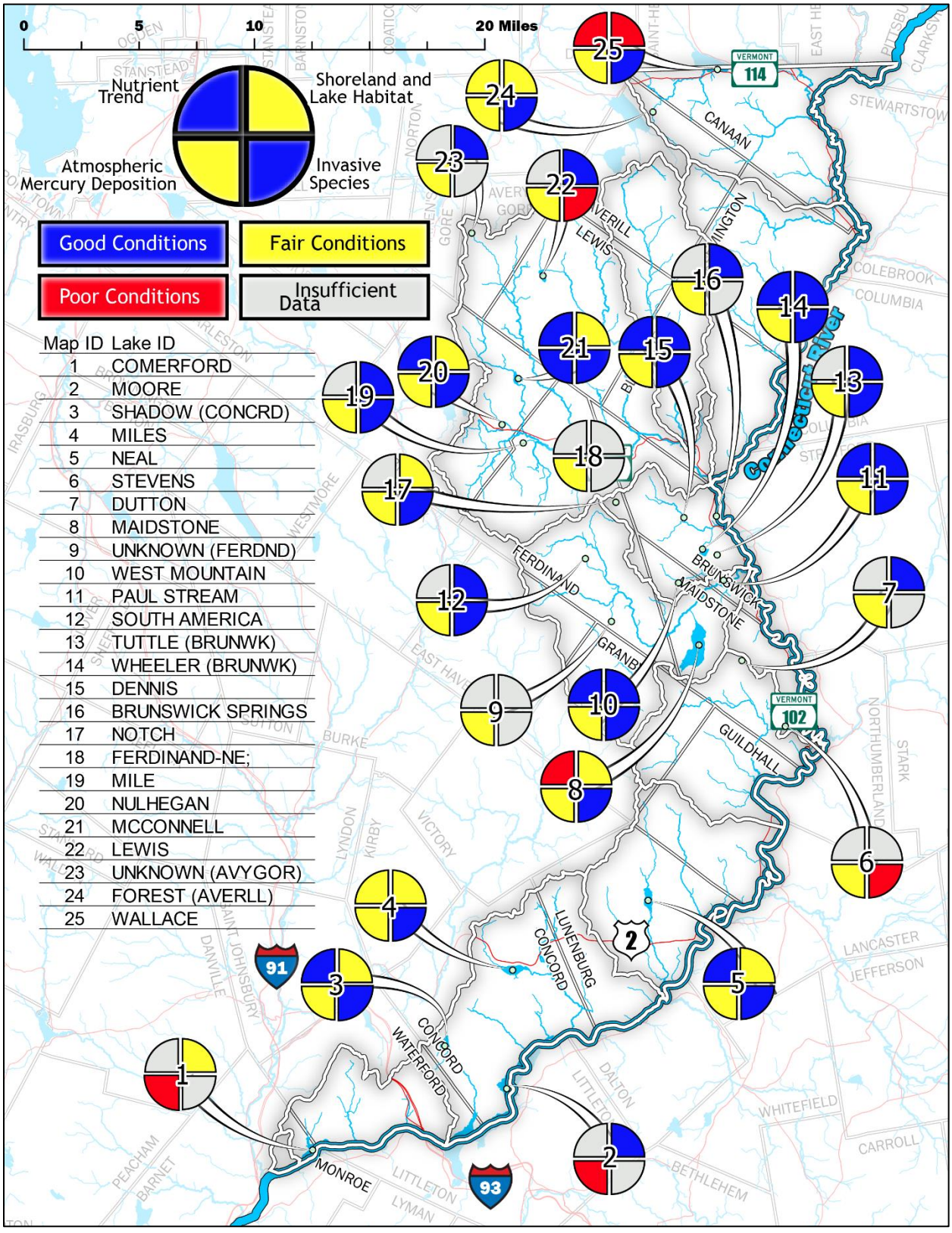

Figure 3. Lake scorecards for Basin 11(13). Only lakes greater than 10 acres are included. Lake IDs and additional information is provided in the table below.

The Lakes and Ponds Management and Protection Program (VLMPP) reports lake condition with the Vermont Inland Lake Score Card. Lake condition includes these key aspects: nutrients status and trends, aquatic invasive species, shoreland and lake habitat, and mercury pollution. For a more detailed overview, see the *score card webpage*. For more technical information, see *how lakes are scored*, and for lake specific information, navigate to the Score Card tab in this *Lake Score Card* links using the Lake IDs reported below.

VLMPP provides score cards for twenty five lakes in Basin 16. The colors are a ranked representation of condition: blue is better than yellow, yellow is better than red, and grey is insufficient data. The Map ID numbers correspond with the following table. Use the ID to navigate the *report viewer* to find more information.

The score for a lake's nutrient trend is derived primarily from data obtained through two lake monitoring programs within the Lakes and Ponds Program - the Spring Phosphorus Program and the Lay Monitoring Program; both data sets are used for analysis when available. The final nutrient trend score, which determines the color of the nutrient quadrant on the Score Card, combines the individual scores from the spring TP (total phosphorus), summer TP, summer Chlorophyll-a and summer Secchi depth. See *how lakes are scored* for more information.

Shoreland habitat is assessed using the Lakeshore Disturbance Index (LDI). A value of 0.2 or less is considered in good condition; an LDI value between 0.2 and 0.75 is considered in fair condition and an LDI value of greater than 0.75 is considered in poor condition. The Lake Wise Program offers technical assistance to shoreland property owners who want to protect or restore their shoreland habitat. Take advantage of free technical assistance through the Lake Wise Program and have your shoreland property assessed for controlling runoff and preventing erosion. The Lake Wise Program offers solutions - Best Management Practices - for managing shoreland property and making it lake-friendly for all.

The Aquatic Invasive Species (AIS) score is based on the presence of one or more invasive animal or plant species. A good score indicates there are no known invasive species present while a poor score indicates that there is at least one invasive species present, regardless of its abundance or 'nuisance' level (a fair score is not used for this criteria).

The Mercury Fish Tissue Contamination Score reflects the most recent data that VLMPP has regarding the presence of mercury (Hg) in the food web of Vermont lakes. A good score indicates low probability of Hg accumulation in fish tissue; a fair score indicates that Hg accumulation in fish tissue is likely; a poor score indicates that Hg in fish tissue exceeds EPA guidelines.

Table 7 Vermont Inland Lake Score Card table: lake-specific information with area in acres and depth in feet. Only lakes greater than 10 acres are included. AIS: Aquatic invasive species score. Mercury: mercury fish tissue contamination. Shoreland: shoreland disturbance (USEPA National Lake Assessment). Nutrient Trend: an index of trends in annual means of spring TP, summer TP, Secchi, and chlorophyl-a.

Map ID	Lake ID	Area (ac)	Max Depth (ft)	Nutrient Trend	Shoreland	AIS	Mercury
1	COMERFORD	330.7	110	Insufficient data	Fair	Insufficient data	Poor
2	MOORE	1321.4	95	Insufficient data	Good	Insufficient data	Poor
3	SHADOW (CONCRD)	131.6	55	Good	Fair	Good	Fair
4	MILES	221.1	55	Fair	Fair	Good	Fair
5	NEAL	188.1	35	Good	Fair	Good	Fair
6	STEVENS	24.0	9	Insufficient data	Insufficient data	Poor	Fair
7	DUTTON	13.1	4	Insufficient data	Good	Insufficient data	Fair
8	MAIDSTONE	755.8	121	Poor	Fair	Good	Fair
9	UNKNOWN (FERDND)	11.5		Insufficient data	Insufficient data	Insufficient data	Fair
10	WEST MOUNTAIN	60.2	12	Good	Good	Good	Fair
11	PAUL STREAM	20.8	10	Good	Good	Good	Fair
12	SOUTH AMERICA	30.8	4	Insufficient data	Good	Good	Fair
13	TUTTLE (BRUNWK)	16.6	5	Insufficient data	Good	Good	Fair
14	WHEELER (BRUNWK)	73.4	35	Good	Good	Good	Fair
15	DENNIS	41.4	3	Good	Good	Good	Fair
16	BRUNSWICK SPRINGS	19.0	11	Insufficient data	Good	Insufficient data	Fair
17	NOTCH	21.2	26	Insufficient data	Fair	Good	Fair
18	FERDINAND-NE;	13.4		Insufficient data	Insufficient data	Insufficient data	Fair
19	MILE	22.2	12	Insufficient data	Good	Good	Fair
20	NULHEGAN	39.8	14	Good	Fair	Good	Fair
21	MCCONNELL	86.5	18	Good	Good	Good	Fair
22	LEWIS	69.5	8	Insufficient data	Good	Poor	Fair
23	UNKNOWN (AVYGOR)	17.3	4	Insufficient data	Good	Insufficient data	Fair
24	FOREST (AVERLL)	61.5	13	Fair	Fair	Good	Fair
25	WALLACE	112.0	62	Poor	Poor	Good	Fair

Lake Reclassification

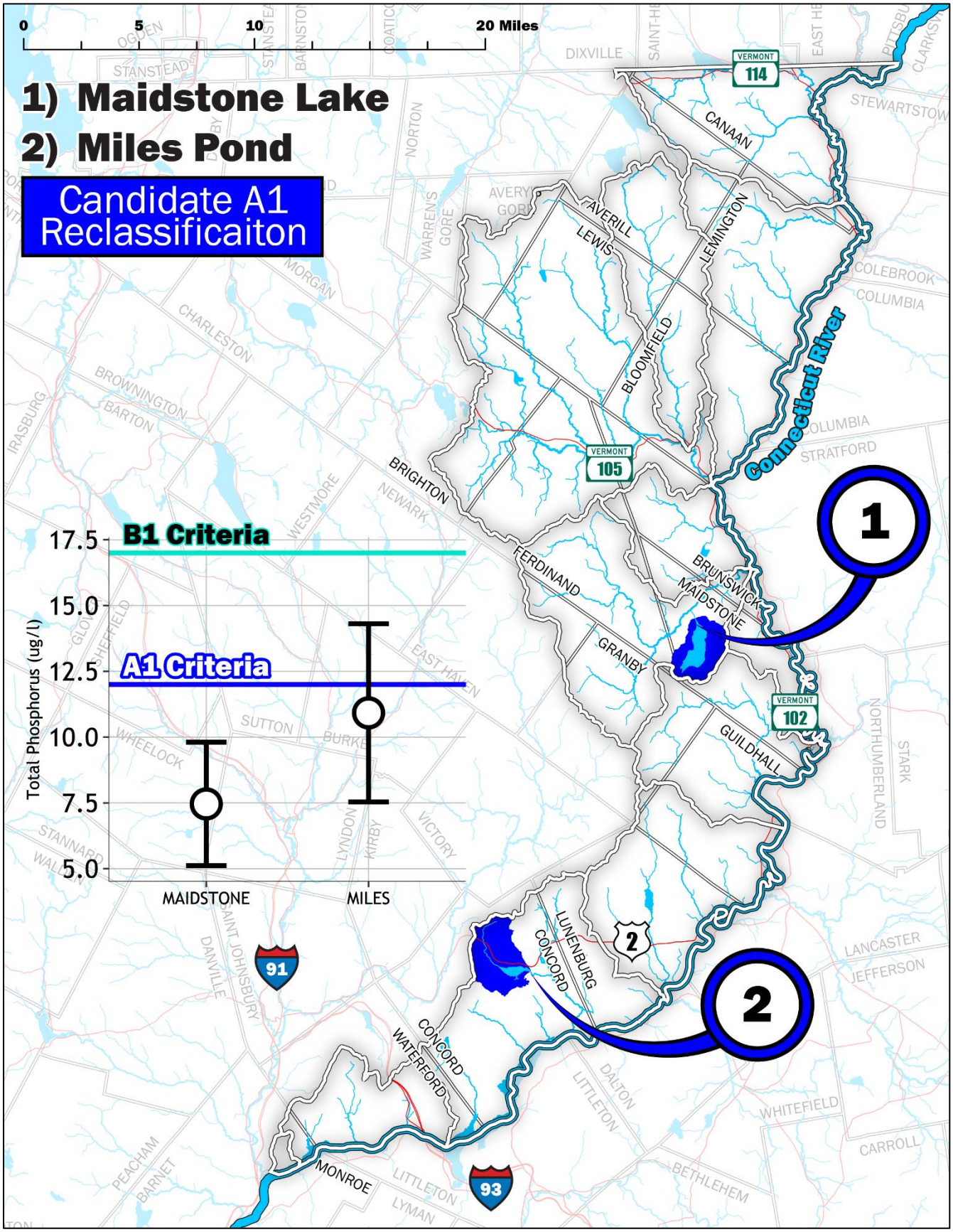

Figure 4 Lake reclassification candidates and their corresponding watersheds.

To protect the waters of the State of Vermont, the Watershed Management Division (WSMD) can initiate rulemaking to reclassify surface waters to maintain a higher standard. The public may also petition the Division to request the initiation of rulemaking. The major implication of reclassification is the application of new *Water Quality Standards*[1].

Most lakes in the state have a classification of B(2) for aesthetics uses, requiring that the lake maintains a total phosphorus criteria of below 18 ug/l. Reclassification to B(1) for aesthetics uses would lower the criteria to 17 ug/l, and a reclassification to A(1) for aesthetics uses would lower the criteria to 12 ug/l. To access data for the lakes below, navigate the *report viewer* using the Lake ID.

- A(1): Maidstone Lake (all of these sites have lay monitors collecting water samples for total phosphorus and chlorophyll-a in addition to Secchi depth).
- A(1): Miles Pond (all of these sites have lay monitors collecting water samples for total phosphorus and chlorophyll-a in addition to Secchi depth).

Impaired Lakes

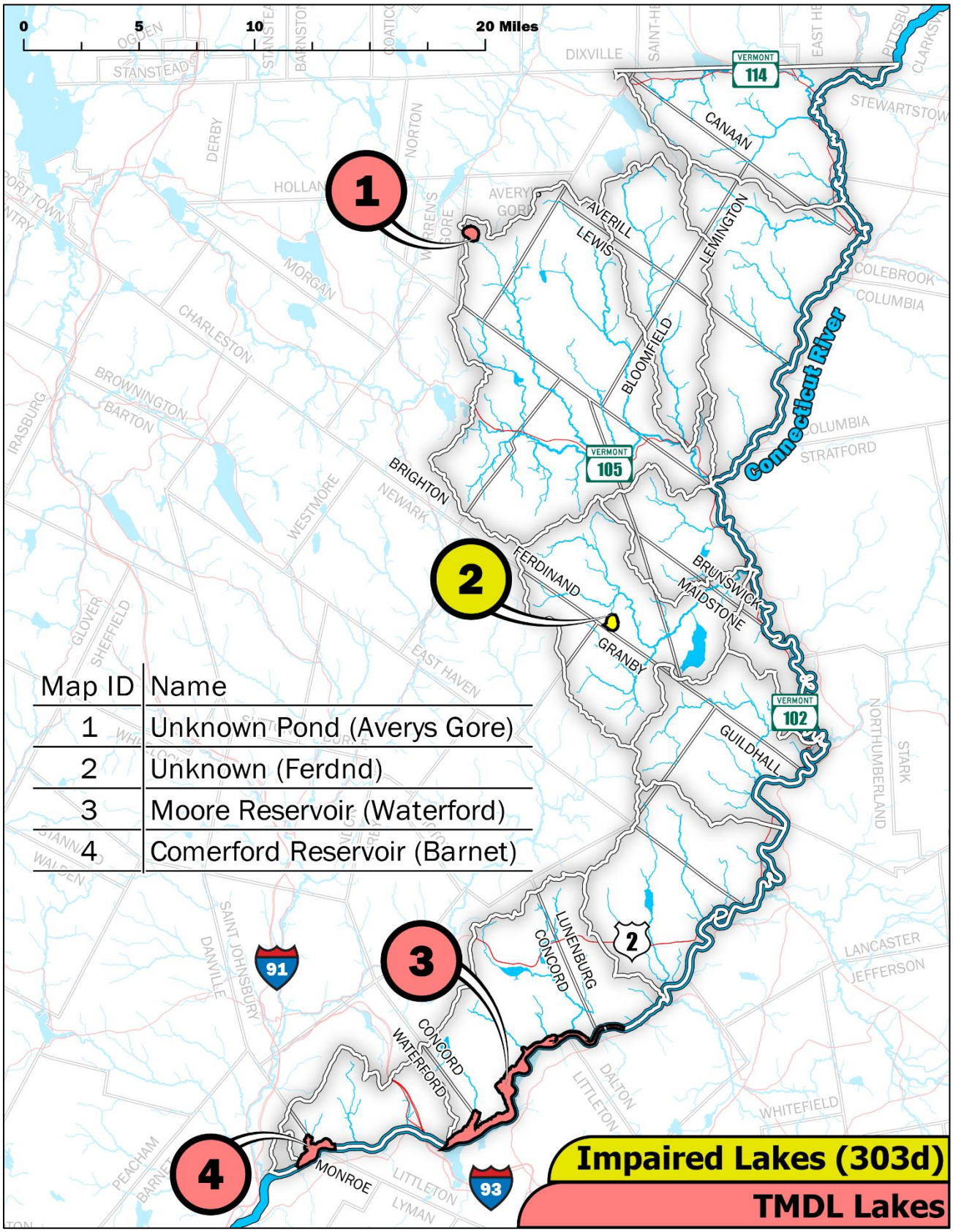

Figure 5 Map of impaired lakes across Basin 16 through 2024. Salmon color represent lakes that are on Part D of the Priority Waters List and have an approved Total Maximum Daily Load (TMDL).

Restoring waters is one of the priorities of the *Watershed Management Division's Strategic Management Plan*. WSMD begins the process of restoring Vermont surface waters by listing waters not in compliance with the water quality standards on a biennial basis. Waters are added and removed based on whether they meet *water quality standards* through a process defined in the Vermont *Surface Water Assessment and Listing Methodology*[1]. Adding waters to these lists prioritizes them for fund allocation, remediation, and monitoring. Fifteen sections of Lake Champlain are impaired and listed in Table 8, .

Table 8 List of impaired lakes across Basin 16. Map IDs correspond to the map above. Part A= impaired and needs a TMDL, Part B=impaired with alternative restoration plan in place, and Part D=impaired with an EPA approved TMDL.

MAP ID	NAME	PROBLEM	POLLUTANT	PART
1	Unknown Pond (Averys Gore)	Atmospheric deposition: extremely sensitive to acidification; episodic acidification	pH	D
2	Unknown (Ferdnd)	Atmospheric deposition: extremely sensitive to acidification; episodic acidification	pH, LOW	A
3	Moore Reservoir (Waterford)	Elevated levels of mercury in all fish	MERCURY IN FISH TISSUE	D
4	Comerford Reservoir (Barnet)	Elevated levels of mercury in all fish	MERCURY IN FISH TISSUE	D

Phosphorus Trends in Lakes

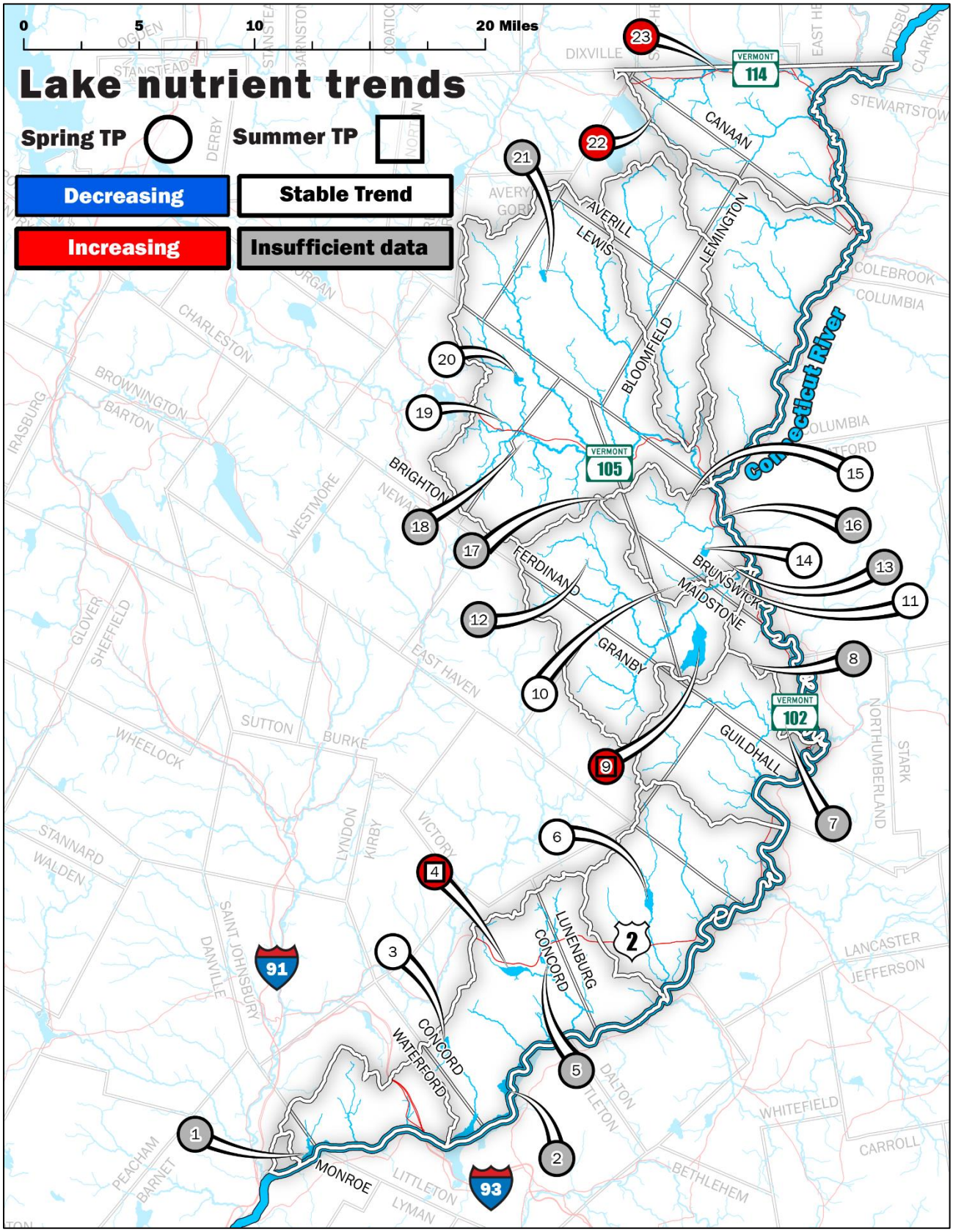

Figure 6 Total phosphorus trends for lakes in Basin 16. Note that trends can be for either spring or summer data or for both.

The WSMD conducts long-term monitoring of surface waters to identify increasing, stable, and decreasing trends of the most relevant water quality parameters in the Vermont Water Quality Standards. Modeling water quality trends before a surface water becomes impaired or altered can lead to more effective and efficient actions to reduce stressors to these waters. For more information on how trends in lakes are identified, see the nutrient trend section of the *Lake Score Card Document*.

While the Lake Score Card identifies trends for multiple parameters of lake health, Lakes with sufficient data to identify a trend in total phosphorus concentrations are shown on the above map. Trends are categorized into three groups: Increasing (models with p-values <0.05 and positive coefficients), stable (models with p-values > 0.05) and decreasing (models with p-values <0.05 and negative coefficients). Use the Lake ID in Table 10 to find more information in the *report viewer*.

Table 9 List of lakes with enough data to model trends in summer or spring total phosphorus. Map IDs correspond with the map above. (+) increasing TP trends, (=) stable TP trends, and (-) negative TP trends. Insufficient data are lakes with data but require more to model a trend.

Map ID	Lake ID	Summer	Spring
1	COMERFORD	No data	Insufficient data
2	MOORE	No data	Insufficient data
3	SHADOW (CONCRD)	No data	=
4	MILES	=	+
5	CONCORD;	No data	Insufficient data
6	NEAL	No data	=
7	STEVENS	No data	Insufficient data
8	DUTTON	No data	Insufficient data
9	MAIDSTONE	+	+
10	WEST MOUNTAIN	No data	=
11	PAUL STREAM	No data	=
12	SOUTH AMERICA	No data	Insufficient data
13	TUTTLE (BRUNWK)	No data	Insufficient data
14	WHEELER (BRUNWK)	No data	=
15	DENNIS	No data	=
16	BRUNSWICK SPRINGS	No data	Insufficient data
17	NOTCH	No data	Insufficient data
18	MILE	No data	Insufficient data
19	NULHEGAN	No data	=
20	MCCONNELL	No data	=
21	LEWIS	No data	Insufficient data
22	FOREST (AVERLL)	No data	+
23	WALLACE	No data	+

Rivers

Conditions and trends

Physical condition

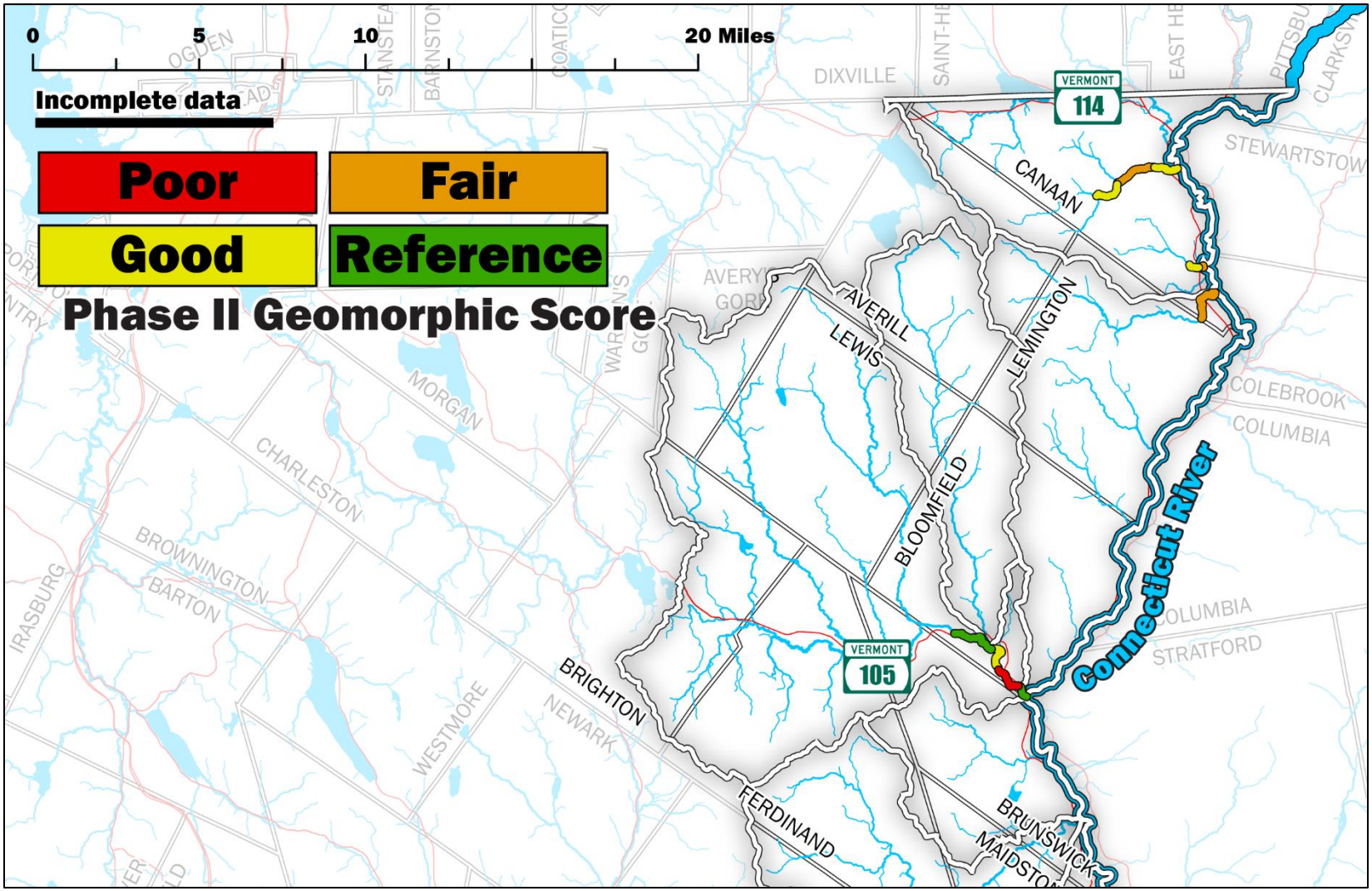

Figure 7 Map of rivers in Basin 16 (north section), with Phase II geomorphic condition scores through 2023. Poor rivers have extreme departure from reference condition, fair rivers have major departure, and good rivers have minor departure. Reference rivers have no departure.

Within the WSMD Rivers Program, two sections conduct assessments of Vermont's rivers and streams. The Biomonitoring Section collects data and assesses the biological and chemical condition of rivers, and the Stream Geomorphic Assessment Section collects data and assesses the physical condition of rivers.

Fluvial geomorphology is a subdiscipline of geomorphology that investigates how flowing water shapes and modifies Earth's surface through erosional and depositional processes. The Rivers Program conducts a three-phase approach to assess the physical condition of rivers in the State of Vermont. Phase 1 is a watershed assessment. Phase 2 is a rapid field stream assessment, and Phase 3 is a survey assessment. Figures 7- 9 give the overall Phase 2 geomorphic condition score of rivers in Basin 16. Figures displayed here are based on Phase 2 data.

The Stream Geomorphic Assessment (SGA) can be used to problem solve and set priorities for river corridor conservation and restoration strategies at a watershed scale because it allows you to ascertain how one reach may be affecting the condition of another. In Phase 2 SGA direct observations are used to evaluate stream geomorphic condition and different channel adjustment processes in each reach. In the Phase 2 SGA, the geomorphic stream condition is largely a function of the type and degree to which the stream has departed from its reference condition and the type and magnitude of channel adjustments that are happening in response to the channel and floodplain modifications that have been documented at assessed reaches in the watershed.

For more information on these type of assessments see the River's Assessment *webpage*. To learn more about the rivers and streams with Phase 1 and Phase 2 assessments in Basin 16, final reports for each project can be found at: *https://anrweb.vt.gov/DEC/SGA/finalReports.aspx*.

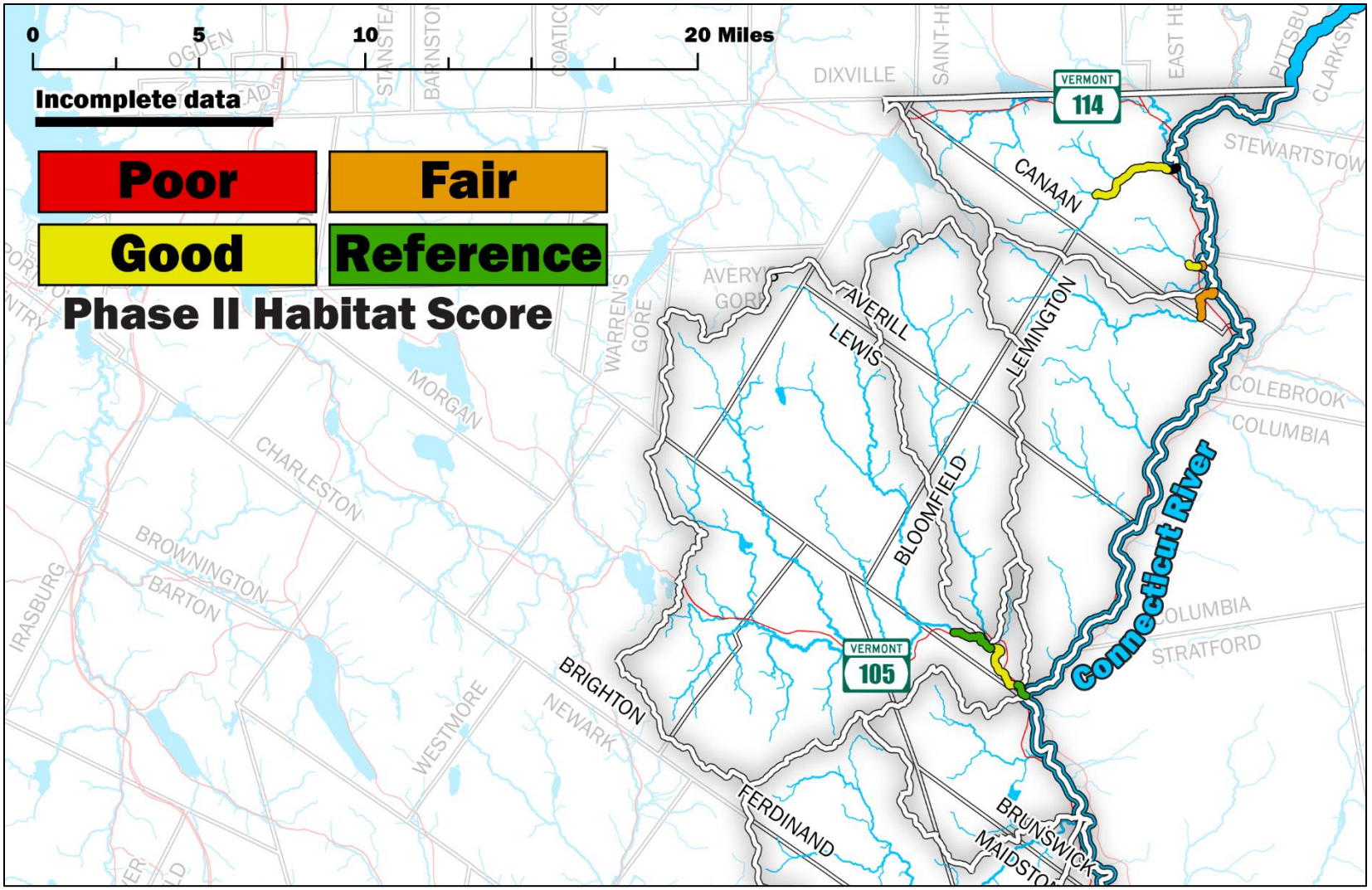

Figure 8 Map of rivers in Basin 16 (north section), with Phase II geomorphic condition scores through 2023. Poor rivers have extreme departure from reference condition, fair rivers have major departure, and good rivers have minor departure. Reference rivers have no departure.

The Rapid Habitat Assessment evaluates the physical components of a channel bed, banks, and riparian vegetation and how they may affect aquatic life. The Habitat condition ratings can be used to identify high quality habitat and to red-flag areas of degraded physical habitat. It is also useful to examine habitat condition ratings at a watershed scale and compare these ratings with Phase 1 and Phase 2 impact rating data to determine potential reasons for habitat degradation, and to understand habitat quality and availability throughout the watershed. Looking closely at the physical processes and the resulting physical conditions that determine aquatic habitat, and thus the biota that inhabit it, and by comparing healthy systems to unhealthy systems, a better understanding of how fluvial processes impact aquatic habitat and biota can be determined. For information on habitat assessments, see the rapid habit assessment section in the SGA handbook: https://dec.vermont.gov/sites/dec/files/wsm/rivers/docs/rv_SGA_Phase2_Protocol.pdf#page=69.

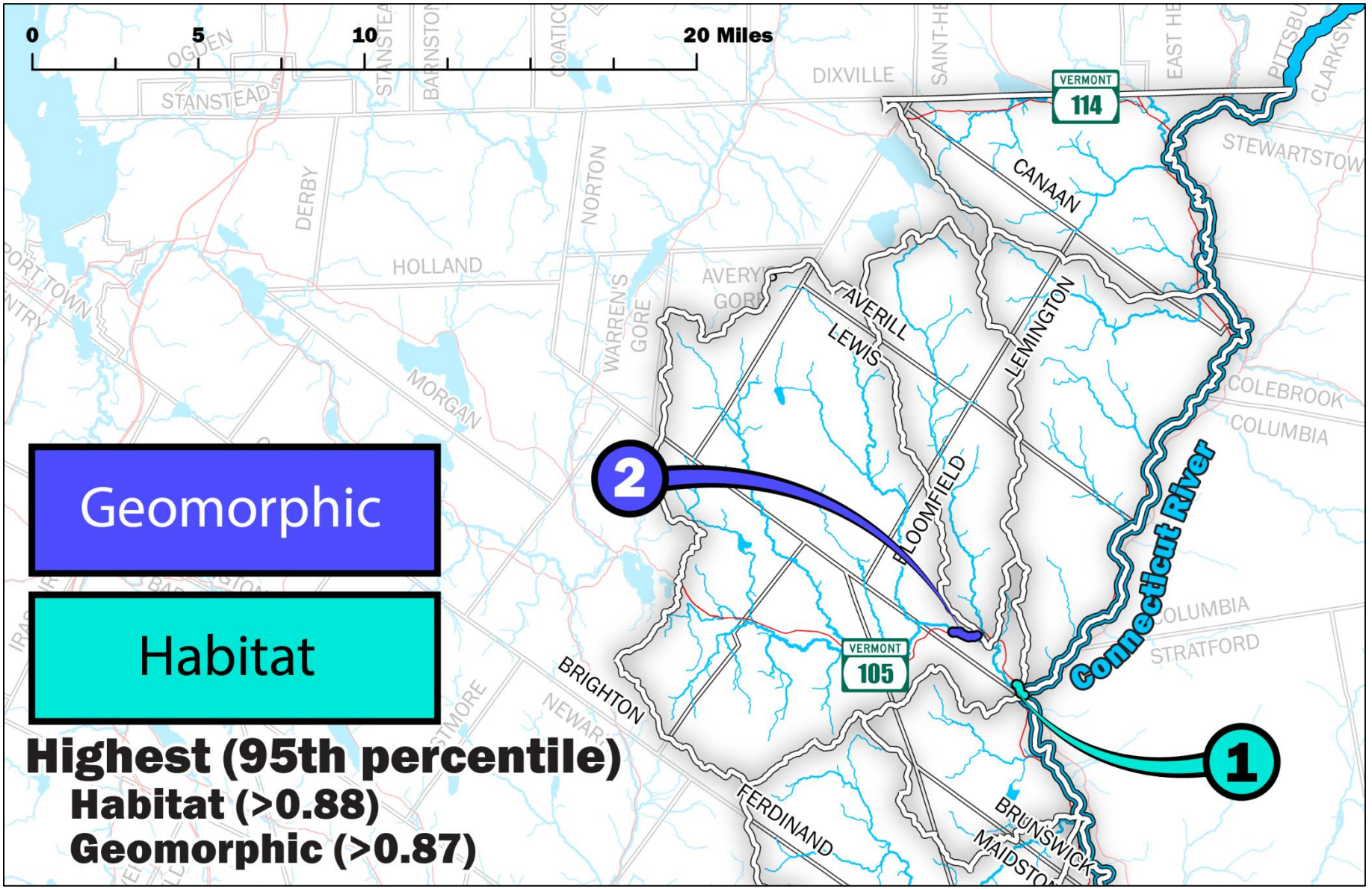

Figure 9. Map of the 95th percentile (highest) habitat and geomorphic condition scores (Basin 16 north section). Map IDs correspond to the table below. Using this percentile approach identifies the reaches with the best geomorphic and habitat condition relative to conditions across the basin. Each is scored separately but overlap does occur.

Table 10 The highest 5th percentile habitat and geomorphic condition scores. Map IDs correspond to the map above and the Assessment link hyperlinks to more information on the reach.

Map ID	SGAT_ID	Name	Geomorphic	Habitat	Assessment	Longitude	Latitude
1	165_M01-	Nulhegan River			Link	-71.636	44.754
2	165_M05-	Nulhegan River			Link	-71.669	44.778

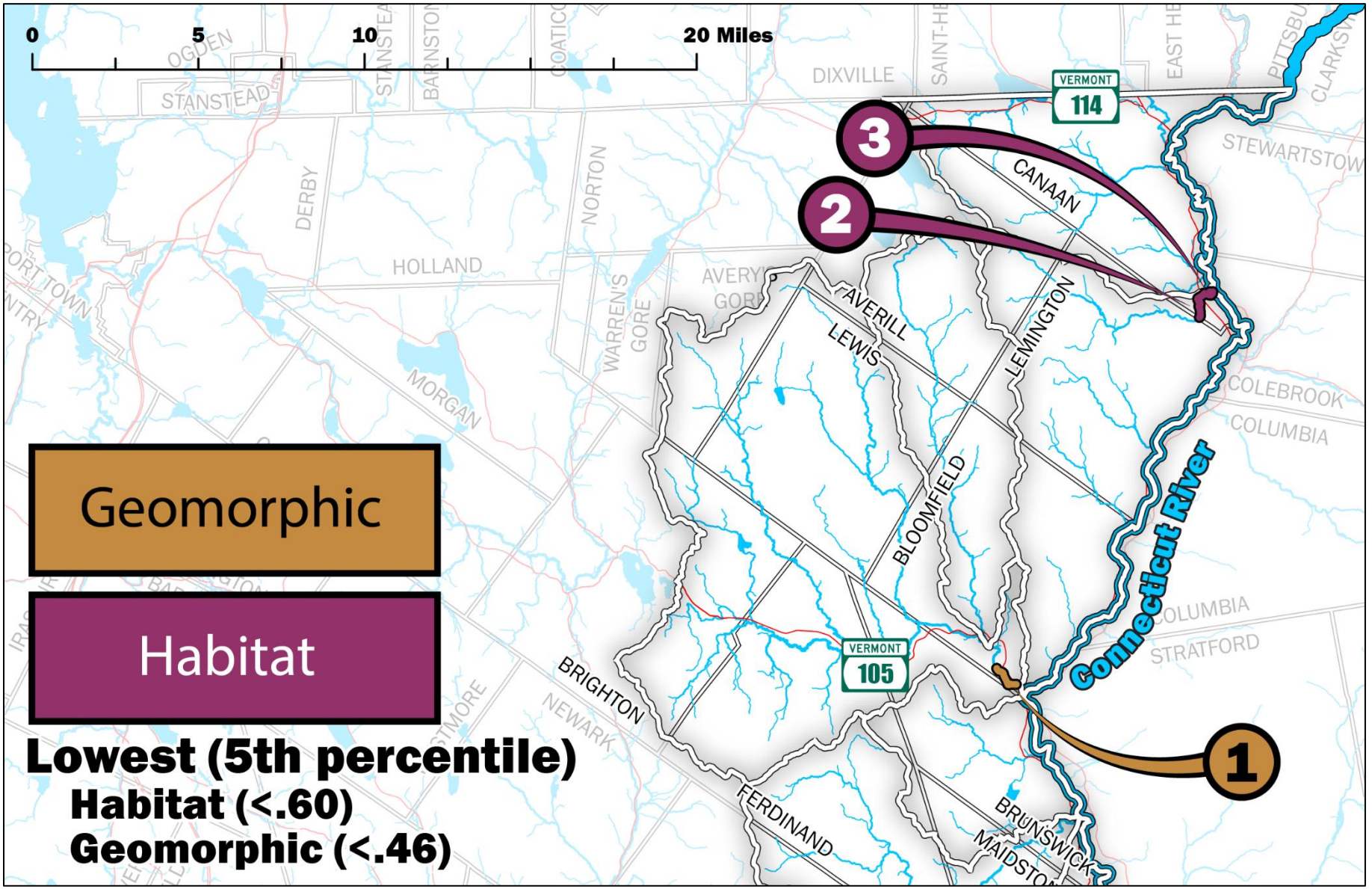

Figure 10 Map of the lowest 5th percentile habitat and geomorphic condition scores (Basin 16 north section). Map IDs correspond to the table below.

Table 11. The lowest 5th percentile habitat and geomorphic condition scores. Map IDs correspond to the map above and the Assessment link hyperlinks to more information on the reach.

Map ID	SGAT_ID	Name	Geomorphic	Habitat	Assessment	Longitude	Latitude
1	165_M02-	Nulhegan River			Link	-71.644	44.759
2	69_M01B	Willard Stream			Link	-71.523	44.920
3	69_M01A	Willard Stream			Link	-71.517	44.925

Biological condition

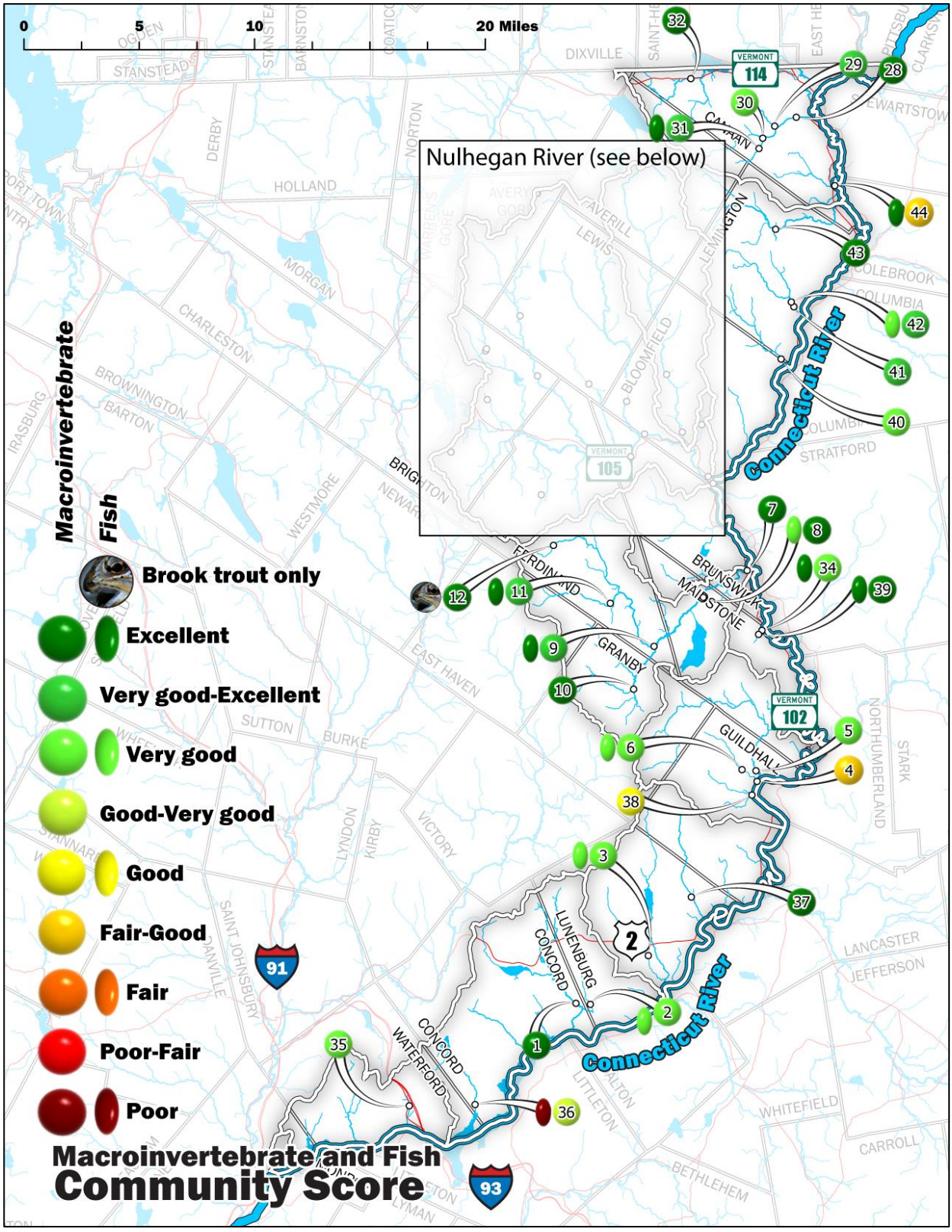

Figure 11. Map of the most recent Macroinvertebrate and Fish Community assessments over last 24 years for sites in Basin 16. Poor scores represent the greatest deviation from reference conditions and Excellent scores represent non-significant deviation from reference conditions. We do not have criteria for assessing Brook Trout Only streams (where brook trout are the only observed taxa). Map IDs correspond with the table below.

The Biomonitoring Section conducts biological assessments of wadeable rivers and streams. For more information on these assessments see the WSMD Biomonitoring Section *webpage*[1]. The assessments include sampling of macroinvertebrate and fish communities to determine Aquatic Biota use support, as well as the collection of water quality and habitat data to better understand the condition of the biological communities. Aquatic biota health in streams is one of the primary areas of study by the WSMD with data used to determine a river's ability to fully support aquatic biota. Brook Trout (BKT) only streams are defined as streams that contain only Brook Trout, which cannot be assessed using the VDEC Fish Index of Biological Integrity (IBI), which requires two or more native species to score.

Table 12 Macroinvertebrate (bug) and fish community assessment matrix for the streams of Basin 16, south section (last 11 years). Blank = no data,

Unable to assess	Poor (P)	Poor-fair (PF)	Fair (F)	Fair-good (Fg)	Good (G)	Good-Very good (GVg)	Very good (Vg)	Very good-excellent (VgE)	Excellent (E)

Name	Map ID		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Miles Stream, 1.5	1	Bug										E	
Scales Brook, 0.9	2	Bug					Vg						
Scales Brook, 0.9	2	Fish					Vg						
Mink Brook, 2.7	3	Bug										Vg	
Mink Brook, 2.7	3	Fish										Vg	
Cutler Mill Brook, 0.1	4	Bug										FG	
Cutler Mill Brook, 0.1	4	Fish										U	
Cutler Mill Brook, 1.0	5	Bug					Vg						
Washburn Brook, 1.0	6	Bug					Vg						
Washburn Brook, 1.0	6	Fish					Vg						
Paul Stream, 0.1	7	Bug					E						
Paul Stream, 3.4	8	Bug										E	
Paul Stream, 3.4	8	Fish										Vg	
Granby Stream, 0.1	9	Bug					E					VgE	
Granby Stream, 0.1	9	Fish					E						
Granby Stream, 2.9	10	Bug										E	
Madison Brook, 0.8	11	Bug	VgE										
Madison Brook, 0.8	11	Fish	E				E						

Name	Map ID		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
North Branch Paul Stream, 2.7	12	Bug	E										
North Branch Paul Stream, 2.7	12	Fish					BKT						
Keyer Brook, 1.0	28	Bug					E						
Jacobs Chopping Brook, 0.1	29	Bug					VgE						
Clay Brook, 0.2	30	Bug					Vg						
Clay Brook, 0.7	31	Bug										VgE	
Clay Brook, 0.7	31	Fish										E	
Leach Brook, 10.2	32	Bug										E	
Taylor Brook, 0.1	34	Bug					Vg						
Taylor Brook, 0.1	34	Fish					E						
Mad Brook, 0.7	35	Bug										Vg	
Halls Brook, 0.3	36	Bug										GVg	
Halls Brook, 0.3	36	Fish										P	
Catbow Brook, 1.6	37	Bug										E	
Emery Brook, 0.2	38	Bug										G	
Rich Brook, 0.1	39	Bug					E						
Rich Brook, 0.1	39	Fish					E						
Clough Brook, 0.5	40	Bug										Vg	
Clough Brook, 0.5	40	Fish										U	
Blodgett Brook, 0.5	41	Bug										VgE	
Blodgett Brook, 0.7	42	Bug					VgE						
Blodgett Brook, 0.7	42	Fish					Vg						
Willard Stream, 4.6	43	Bug					E						
Capon Brook, 0.1	44	Bug					Vg					FG	
Capon Brook, 0.1	44	Fish										E	

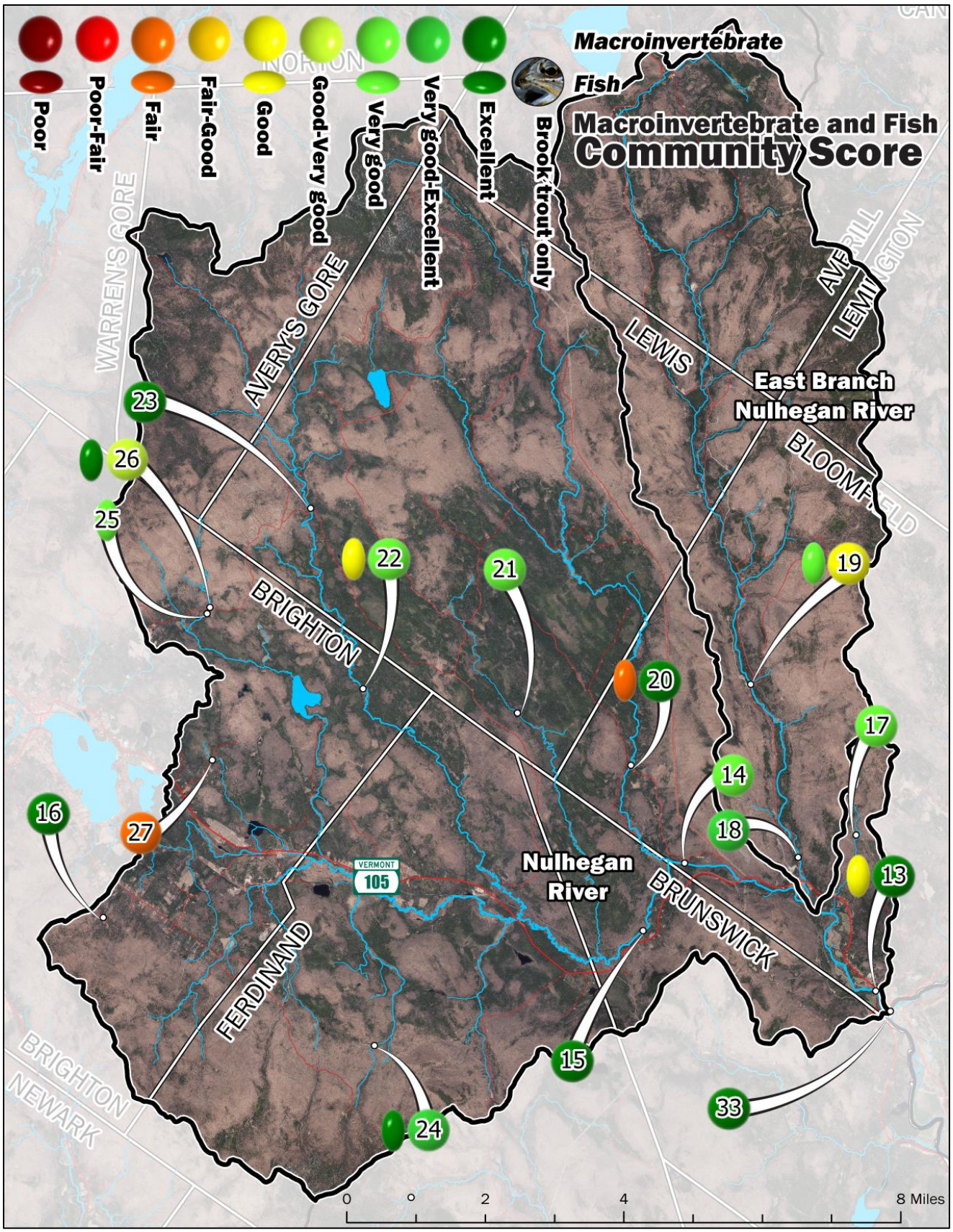

Figure 12 Map of the Macroinvertebrate and Fish Community assessments for Basin 16 Nulhegan River. Poor scores represent the greatest deviation from reference conditions and Excellent scores represent non-significant deviation from reference conditions. Map IDs correspond with the table below.

Table 13 Macroinvertebrate (bug) and fish community matrix for the watersheds of Basin 16, middle section. Blank = no data, bkt = streams with a robust brook trout community

Unable to assess	Poor (P)	Poor-fair (PF)	Fair (F)	Fair-good (Fg)	Good (G)	Good-Very good (GVg)	Very good (Vg)	Very good-excellent (VgE)	Excellent (E)

Name	Map ID		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Nulhegan River, 0.3	13	Bug	E	E	E	E	E	VgE	E	E	E	E	E
Nulhegan River, 0.3	13	Fish	Vg	Vg				Vg			G		
Nulhegan River, 4.5	14	Bug	Vg										
Nulhegan River, 4.5	14	Fish	U										
Nulhegan River, 6.0	15	Bug										E	
Nulhegan River, 21.2	16	Bug					E						
Nulhegan River, 21.2	16	Fish					U						
Hibbard Brook, 1.3	17	Bug					Vg						
East Branch Nulhegan River, 0.9	18	Bug										VgE	
East Branch Nulhegan River, 4.2	19	Bug					G						
East Branch Nulhegan River, 4.2	19	Fish					Vg						
Black Branch Nulhegan River, 2.3	20	Bug					E						
Black Branch Nulhegan River, 2.3	20	Fish					F						
Yellow Branch Nulhegan River, 4.5	21	Bug					Vg						
Yellow Branch Nulhegan River, 4.5	21	Fish					U						
North Branch Nulhegan River, 6.0	22	Bug						Vg					
North Branch Nulhegan River, 6.0	22	Fish						G					
North Branch Nulhegan River, 10.5	23	Bug										E	
Murphy Brook, 3.1	24	Bug	Vg					VgE					
Murphy Brook, 3.1	24	Fish						E					
Clay Hill Brook, 6.1	25	Fish										Vg	
Clay Hill Brook, 6.2	26	Bug					VgE					GVg	
Clay Hill Brook, 6.2	26	Fish					E						
Nulhegan Pond Trib, 1.5	27	Bug											F
Nulhegan Pond Trib, 1.5	27	Fish											U
Connecticut River, 350.	33	Bug					VgE					E	

Chemical water quality monitoring occurs across the state in rivers and streams in a variety of ways: targeted, probability-based, and special studies. Examples of targeted monitoring include the LaRosa Partnership Program (LPP) and water quality samples collected by the Ambient Biomonitoring Network (ABN). All chemical data can be accessed through the Vermont Integrated Watershed Information System (VIWIS) and generally there is too much data that requires special contextual information to effectively display in graphics and tables in the format of this report. LPP monitoring stations are normally sampled eight times during the spring and summer season, and may be monitored from one to several years, depending on the monitoring purpose. LPP data can provide enough information to screen waters for more assessment (i.e., impaired or full support). Chemical monitoring associated with the ABN is used to help interpret the biological data, which is relied upon more heavily for assessment and regulatory purposes.

Special chemical studies are usually only conducted in response to compelling data and information obtained from fixed-station and probability-based projects. The number and nature of special studies is commonly dictated by the nature of issues that need further monitoring or that arise as interest or funding permits. These types of studies include detailed sampling to assess use support or standards violations, stressor identification, diagnostic-feasibility studies, effectiveness evaluations of pollution control measures, and watershed-based surveys and evaluations. These evaluations are usually resource intensive and are reserved for issues of particular interest. Additionally, data from these investigations are usually organized and presented in a summary report format and would not be used separately for assessments.

River reclassification candidates (Aquatic biota)

To protect aquatic biota in rivers in the State of Vermont, the Watershed Management Division can initiate reclassification for Aquatic Biota use in rivers that meet a very high-quality standard. The major implication of reclassification is the application of new *Water Quality Standards*. Most rivers in the State of Vermont are classified B(2) for Aquatic Biota use and must maintain biological assessments of Good or better for both macroinvertebrate and fish communities. Rivers reclassified to B(1) must maintain biological assessments of Very Good or better, and Rivers reclassified to A(1) must maintain biological assessments of Excellent. The rivers shown here have maintained biological condition expected of either A(1) or B(1) waters and therefore are candidates for reclassification. For more information, visit the *stream reclassification webpage*.

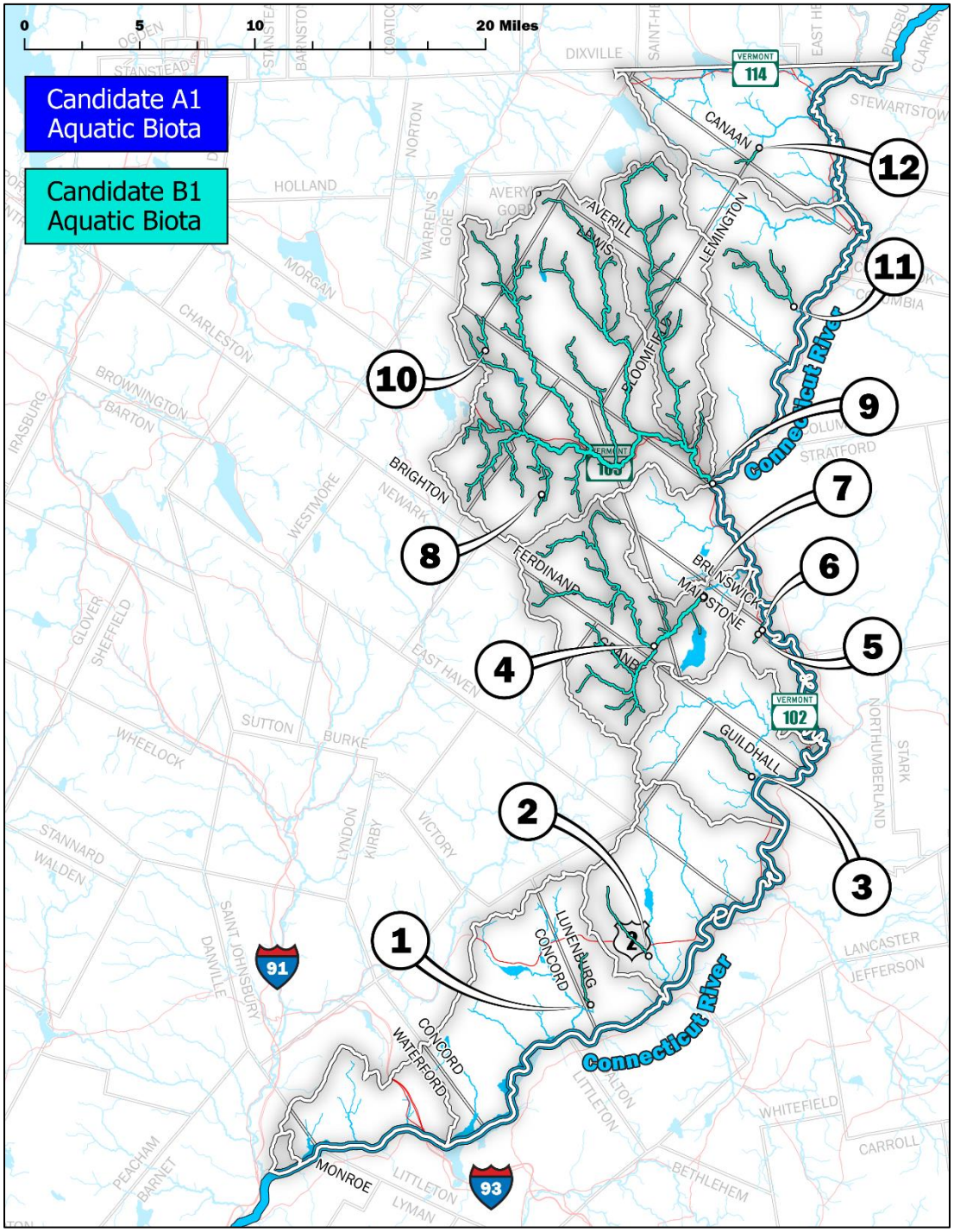

Figure 13 Aquatic biota reclassification candidates across Basin 16.

Table 14 Macroinvertebrate (bug) and fish community matrix for Basin 16 reclassification candidates based on biological data from the last ten years, middle section. Blank = no data, bkt = streams with a robust brook trout community

Unable to sample or assess	Poor (P)	Poor-fair (PF)	Fair (F)	Fair-good (Fg)	Good (G)	Good-Very good (GVg)	Very good (Vg)	Very good-excellent (VgE)	Excellent (E)

Name	Map ID		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Scales Brook, 0.9	1	Bug					Vg						
Scales Brook, 0.9	1	Fish					Vg						
Mink Brook, 2.7	2	Bug										Vg	
Mink Brook, 2.7	2	Fish										Vg	
Washburn Brook, 1.0	3	Bug					Vg						
Washburn Brook, 1.0	3	Fish					Vg						
Granby Stream, 0.1	4	Bug					E					VgE	
Granby Stream, 0.1	4	Fish					E						
Rich Brook, 0.1	5	Bug					E						
Rich Brook, 0.1	5	Fish					E						
Taylor Brook, 0.1	6	Bug					Vg						
Taylor Brook, 0.1	6	Fish					E						
Paul Stream, 0.1	7	Bug					E						
Paul Stream, 3.4	7	Bug										E	
Paul Stream, 3.4	7	Fish										Vg	
Murphy Brook, 3.1	8	Bug	Vg					VgE					
Murphy Brook, 3.1	8	Fish						E					
Nulhegan River, 0.3	9	Bug	E	E	E	E	E	VgE	E	E	E	E	E
Nulhegan River, 0.3	9	Fish	Vg	Vg				Vg			G		
Clay Hill Brook, 6.2	10	Bug					VgE					GVg	
Clay Hill Brook, 6.1	10	Fish										Vg	
Clay Hill Brook, 6.2	10	Fish					E						
Blodgett Brook, 0.5	11	Bug										VgE	
Blodgett Brook, 0.7	11	Bug					VgE						
Blodgett Brook, 0.7	11	Fish					Vg						
Clay Brook, 0.2	12	Bug					Vg						
Clay Brook, 0.7	12	Bug										VgE	
Clay Brook, 0.7	12	Fish										E	

Impaired rivers

There are no impaired rivers in Basin 16

Altered Rivers

Altered waters are waters where a lack of flow, water level or flow fluctuations, modified hydrology, physical channel alterations, documented channel degradation, or stream type change is occurring and arises from some human activity, or where the occurrence of aquatic invasive species has had negative impacts on designated uses. This assessment category includes those waters where there is documentation of water quality standards violations for flow and aquatic habitat, but EPA does not consider the problem(s) caused by a pollutant.

There are no altered rivers in basin 16

Trending rivers

To maintain waters in their current state, WSMD conducts long term monitoring on surface waters and identifies increasing, stable, and decreasing trends of the most relevant water quality parameters in the Vermont Water Quality Standards. Modeling trends can act as an early warning system for declining water quality, and it may be cost effective to reduce stressors to these waters before they become impaired or altered. Likewise, increasing trends can show areas of effective remediation. For each biological monitoring site, two linear regression models are used with year of sampling as the independent variable. The response variables include the community assessment ratings for macroinvertebrates and/or fish (Poor to Excellent; coded as 1 to 9). Sites with more than three data points were included. Data from sites is pooled by coincident NHD+ reach code (multiple sites on the same reach) unless the sites are bracketing. Trends are categorized into three groups: Improving (models with p-values <0.1 and positive coefficients), stable (models with p-values > 0.1) and declining (models with p-values <0.1 and negative coefficients.

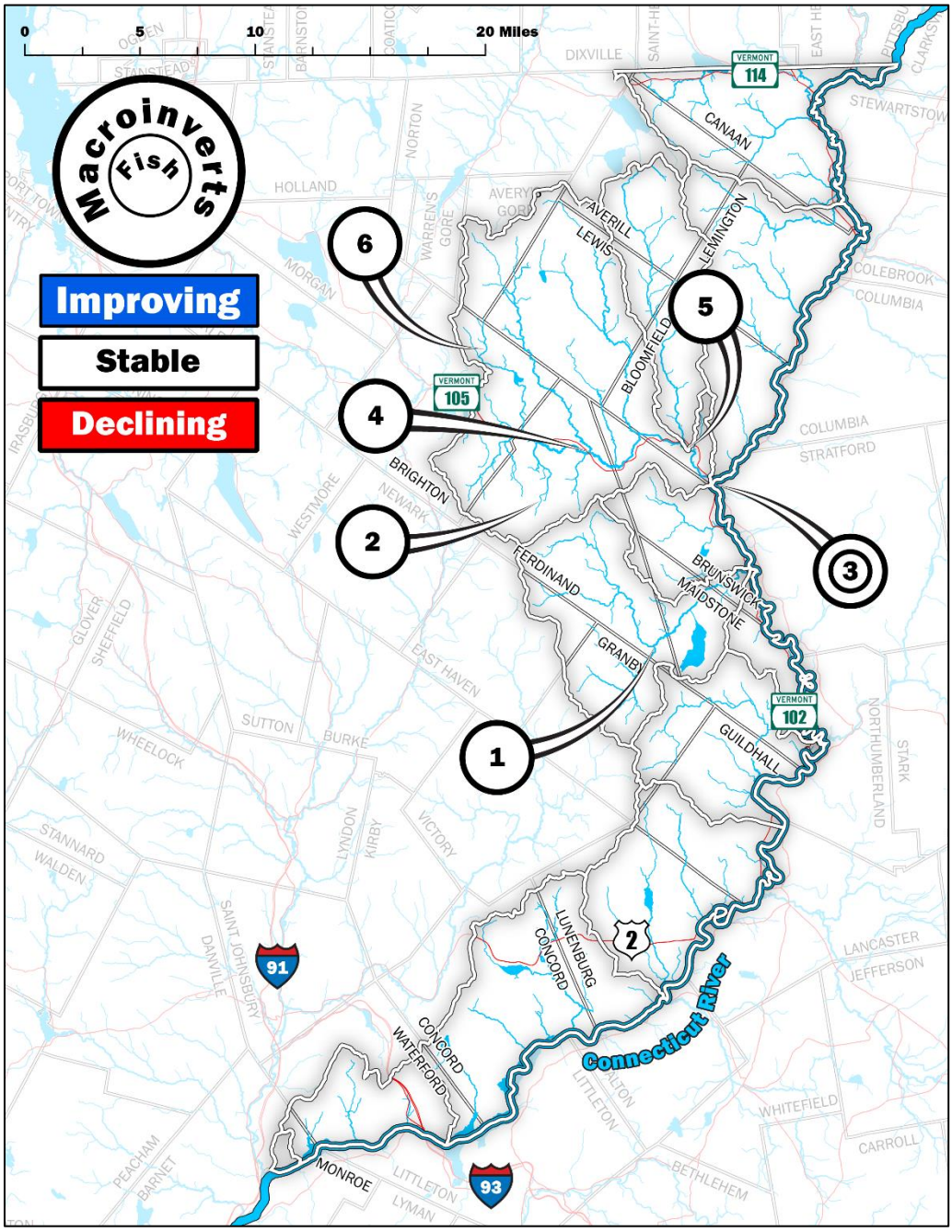

Figure 14 Map of rivers with enough biological data to model a water quality trend.

Table 15 Trends in biological condition of macroinvertebrate (bug) and fish communities in Basin 16. + Improving, - declining, = stable/no trend. B = Bug community, F = Fish community. Community: B = macroinvertebrate, F = fish.

Unable to sample or assess	Poor (P)	Poor-fair (PF)	Fair (F)	Fair-good (Fg)	Good (G)	Good-Very good (GVg)	Very good (Vg)	Very good-excellent (VgE)	Excellent (E)

Stream, river mile	Map ID		Trend	Set			1992	1997	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Clay Hill Brook, 6.2	6	=	Bug	0	0	Vg	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
East Branch Nulhegan River, 0.7	5	=	Bug	Vg	E	Vg	0	0	0	E	0	Vg	0	0		0	0	0	0		0	0	0	0	0	0
East Branch Nulhegan River, 0.9	5	=	Bug	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
East Branch Nulhegan River, 2.9	5	=	Bug	0	0	0	E	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
East Branch Nulhegan River, 4.2	5	=	Bug	0	0	0	0	0	0	0	0	0	0	0		0	0	0	G		0	0	0	0	0	0
Granby Stream, 0.1	1	=	Bug	0	0	E	0	0	0	0	0	0	0	0		0	0	0	E		0	0	0	0	0	0
Murphy Brook, 3.1	2	=	Bug	0	0	0	0	0	0	0	0	E	Vg	0		0	0	0	0		0	0	0	0	0	0
North Branch Nulhegan River, 10.5	4	=	Bug	0	0	G	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	E	0
North Branch Nulhegan River, 4.4	4	=	Bug	0	0	0	0	0	E	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
North Branch Nulhegan River, 6.0	4	=	Bug	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0		Vg	0	0	0	0	0
Nulhegan River, 0.2	3	=	Bug	E	0	E	0	E	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
Nulhegan River, 0.3	3	=	Bug	0	0	0	0	0	E	E	E	E	E	E		E	E	E	E		VGe	E	E	E	E	E
Nulhegan River, 0.3	3	=	Fish	0	0	0	0	0	Vg	0	0	Vg	Vg	Vg		0	0	0	0		Vg	0	0	G	0	0

Rivers in need of assessment

Aquatic biota health in streams is one of the primary areas of assessment by the WSMD. In the sections above, areas with sufficient data were used to determine a river's ability to fully support aquatic biota. This section highlights the 56 streams within this basin that lack data needed to determine the support status of aquatic biota. Streams larger than 2 square kilometers and have no biological data between 2000 and 2024 were removed. Because all these streams cannot be monitored at the same time, land use/cover data are provided in the figure below to aid site prioritization. Many of these streams are unnamed, therefore, names were added based on their source location (hill names) or adjacent road names and are identified by an asterisk.

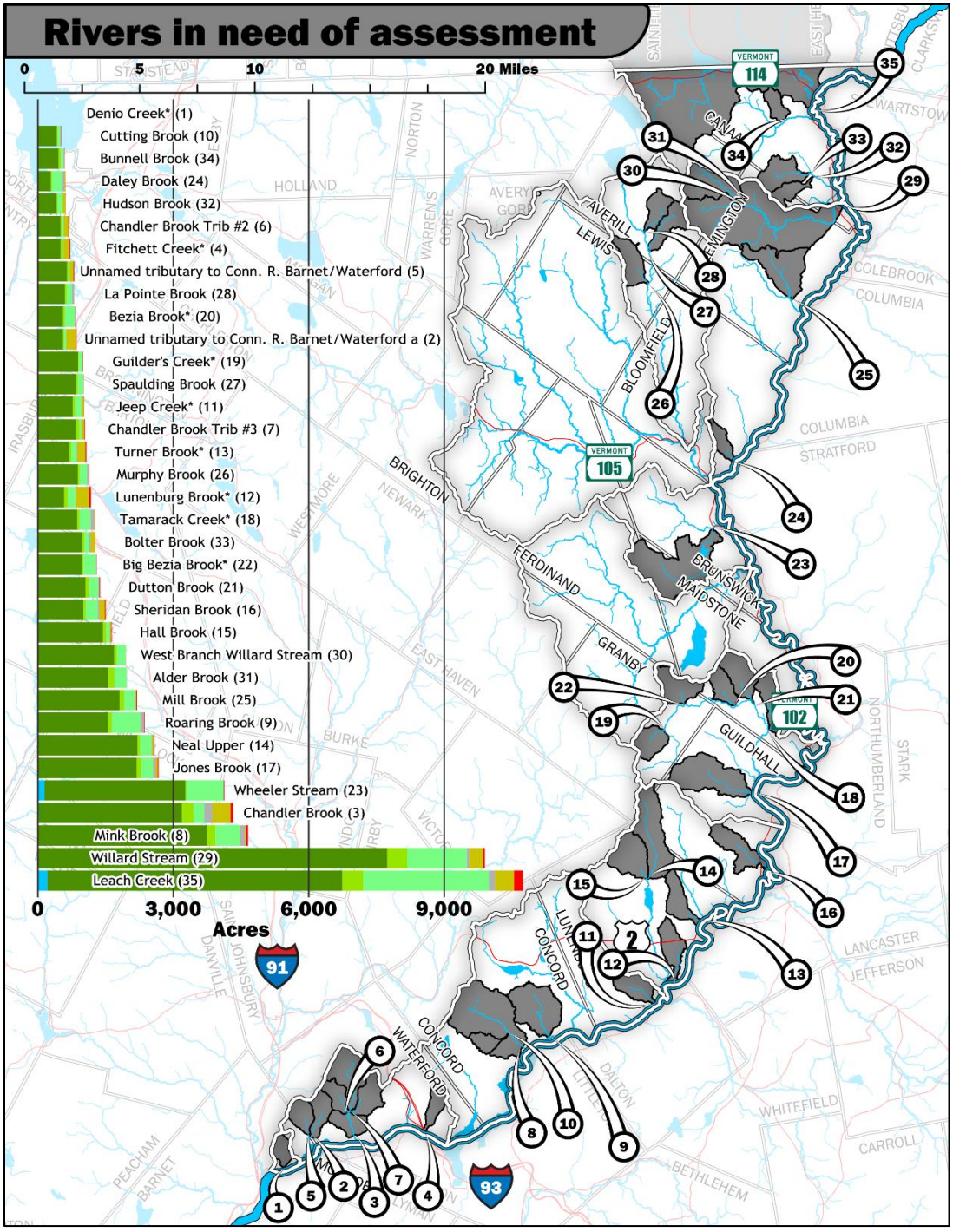

Figure 15 Waters in need of assessment for aquatic biota us in basins 16.

Table 16. Rivers with unassessed aquatic biota use, values are in percent land cover. The Map IDs correspond to the map above. Latitude and longitudes designate the pour point of the watershed. Asterisks are officially unnamed streams.

Name, Map ID	Latitude	Longitude	Acres	Developed	Agriculture	Other	Wetlands	Herbaceous	Forest	Water
Alder Brook (31)	44.9264	-71.6028	1966.3	0	0	0.3	13.6	6.5	79.5	0
Bezia Brook (20)*	44.6114	-71.6148	828.3	0.5	0.1	0.4	26.7	4.7	67.5	0
Big Bezia Brook (22)*	44.6127	-71.6591	1303.2	0.4	0	0.9	21.3	2.7	74.7	0
Bolter Brook (33)	44.945	-71.5424	1275.2	0.6	7.1	3.1	8.2	3.8	77.2	0
Bunnell Brook (34)	44.9795	-71.5643	589.6	0.7	0	3.1	10	8	78.2	0
Chandler Brook (3)	44.3439	-71.9534	4325.8	1.3	9.4	4.1	5.5	6.1	73.1	0.5
Chandler Brook Trib #2 (6)	44.3584	-71.9578	686.4	1	15.5	0.8	4.6	5.5	72.5	0
Chandler Brook Trib #3 (7)	44.3586	-71.9563	1039.7	0.9	6.4	0.5	4.3	7.1	80.5	0.3
Cutting Brook (10)	44.4069	-71.8163	510.4	1.2	0.3	1.8	12	3	81.8	0
Daley Brook (24)	44.7646	-71.6126	606	0.4	3	7.2	37.6	4.6	47.1	0.1
Denio Creek (1)*	44.3234	-72.0148	563.1	0.8	2.8	0.5	2.1	3	90.8	0
Dutton Brook (21)	44.6122	-71.5985	1379	0.9	0.2	1.8	15	5.7	75.4	1
Fitchett Creek (4)*	44.344	-71.8897	715.1	2.6	17.1	1.1	0.5	8.6	70.1	0.1
Guilder's Creek (19)*	44.5964	-71.6776	1002.3	0.7	0	0.3	8.4	1.8	88.8	0
Hall Brook (15)	44.5033	-71.6944	1634.7	0.7	1.7	0.3	4.8	4.5	87.9	0
Hudson Brook (32)	44.9432	-71.5402	615.2	0.2	9.8	0.8	19.5	2.5	67.3	0
Jeep Creek (11)*	44.4246	-71.6879	1022.8	0.2	4.7	0.7	14.4	4.8	75	0.1
Jones Brook (17)	44.5557	-71.6009	2674.3	0.6	1.7	2.1	10	3.6	81.7	0.2

Name, Map ID	*Latitude*	*Longitude*	*Acres*	*Developed*	*Agriculture*	*Other*	*Wetlands*	*Herbaceous*	*Forest*	*Water*
La Pointe Brook (28)	44.9095	-71.6913	804.4	0.5	NA	5.3	15.3	4.2	74.7	0
Lunenburg Brook (12)*	44.4364	-71.6722	1169	3.1	25	1	14.2	7.2	49.5	0.1
Mill Brook (25)	44.8675	-71.5628	2195.1	0.7	0.4	0.7	11.3	4.6	82.2	0.1
Mink Brook (8)	44.3988	-71.8049	4654.5	0.9	0.6	2.4	11.6	4.1	80.3	0.1
Murphy Brook (26)	44.8773	-71.6878	1139.1	1	NA	3.1	14.9	3.4	77.5	0
Neal Upper (14)	44.503	-71.694	2575.1	0.4	1.4	0.2	10.1	2.2	85.6	0.1
Roaring Brook (9)	44.4052	-71.7812	2365.1	0.6	0	3.3	27	3.6	65.1	0.5
Sheridan Brook (16)	44.5075	-71.5875	1501.6	1.1	8.2	2.1	18.1	3.4	66.9	0.1
Spaulding Brook (27)	44.897	-71.6859	1013.5	0.4	NA	0.2	12.1	4.4	83	0
Tamarack Creek (18)*	44.596	-71.5859	1273	0.3	1.2	6.9	19.1	4	68	0.4
Turner Brook (13)*	44.4764	-71.6475	1073.1	1.9	16.6	1.4	10.9	4.5	64.6	0.1
Unnamed tributary to Conn. R. Barnet/Waterford (5)	44.3442	-71.9929	800.2	1.2	11.8	0	2.3	4.1	80.6	0
Unnamed tributary to Conn. R. Barnet/Waterford a (2)	44.3428	-71.9907	848.3	0.9	25.4	0.3	5.5	2.1	65.9	0
West Branch Willard Stream (30)	44.9259	-71.6031	1948.5	0.1	0	0	10.1	3	86.8	0
Wheeler Stream (23)	44.7225	-71.6333	4127.5	0.3	NA	0.1	20	0.5	75.6	3.6
Willard Stream (29)	44.9258	-71.5146	9899.7	0.3	3.2	0.6	13.3	4.5	78.1	0.1
Alder Brook (31)	44.9264	-71.6028	1966.3	0	0	0.3	13.6	6.5	79.5	0

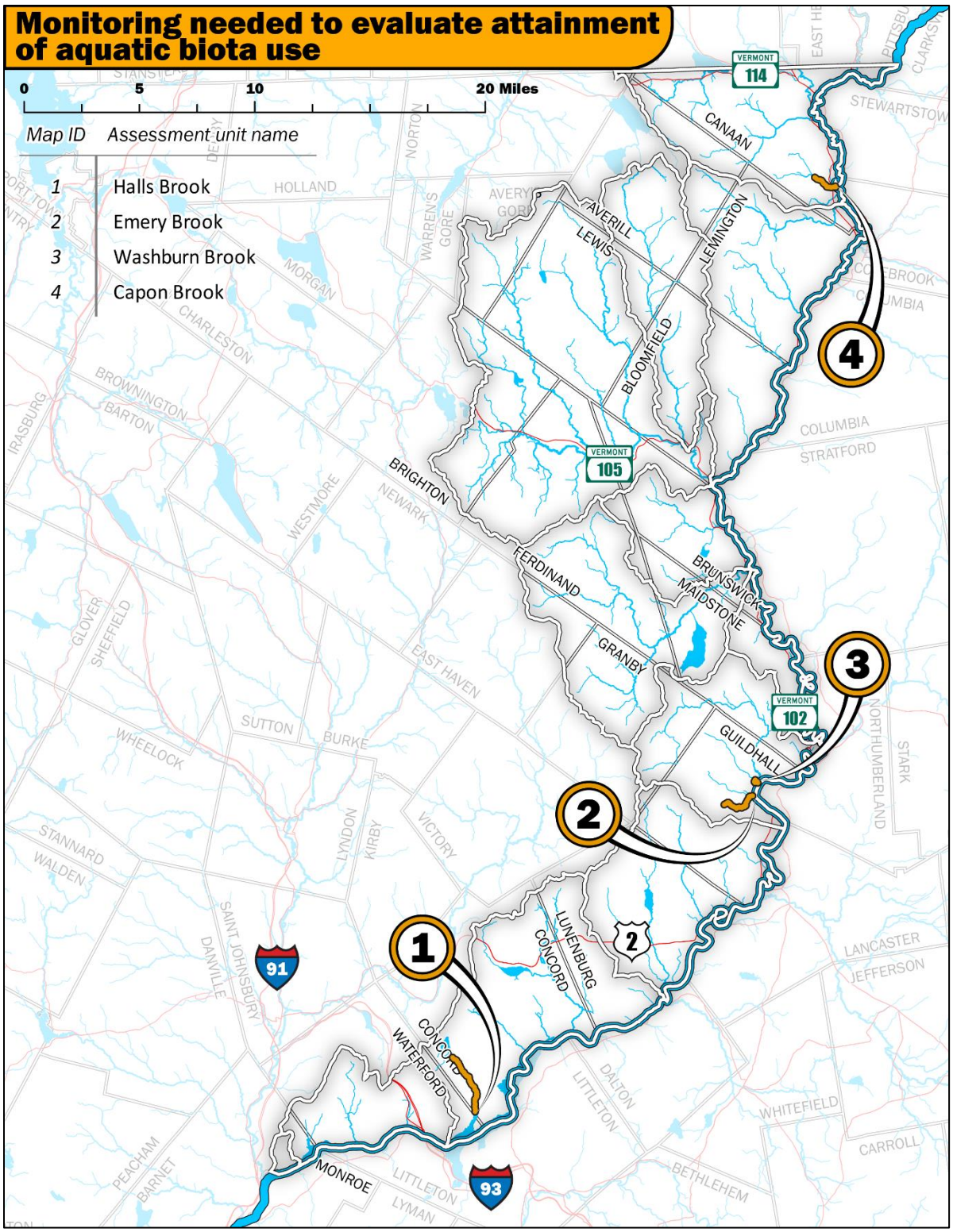

Figure 16 Map of rivers that require more monitoring to evaluate attainment of Aquatic Biota use. Unlike the streams mentioned above with no biological monitoring data, the streams here have limited biomonitoring data that indicates at or below B(2) biological condition, however, there is either not enough data to fully evaluate the attainment of Aquatic Biota use or monitoring results show volatile condition year to year.

Table 17 Table of rivers that require more monitoring to evaluate attainment of aquatic biota use. Map IDs correspond to the map above.

Map ID	Assessment unit name	Pollutant	Problem
1	Halls Brook	CAUSE UNKNOWN	Poor fish community, potential wetland and impoundment impacts. Stressor ID required.
2	Emery Brook	CAUSE UNKNOWN	Macroinvertebrate community meeting standards but several borderline indices, potential impacts from open canopies and logging.
3	Washburn Brook	CAUSE UNKNOWN	Low macroinvertebrate densities and borderline richness, potential natural stressors from seasonally elevated flows.
4	Capon Brook	CAUSE UNKNOWN	Macroinvertebrate community borderline, potential impacts from nearness to the Connecticut River and elevated fines and gravel substrate. Site should be relocated upstream.

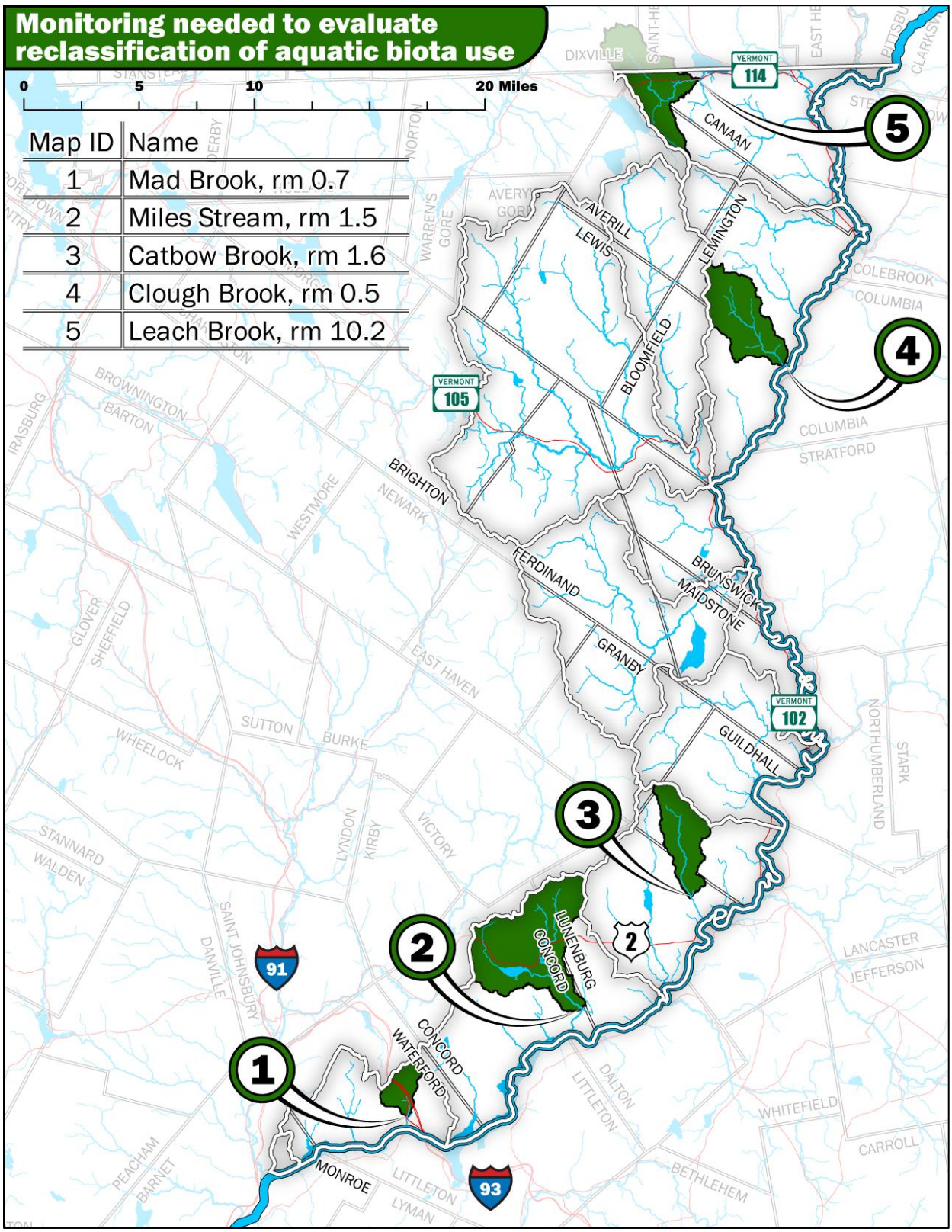

Figure 17 Map of rivers that require more monitoring to assess condition relative to A(1) or B(1) criteria for Aquatic Biota use. The streams have biological monitoring data between 2012-2022 which suggests Very Good or Excellent. Additional data may be necessary to assess if it meets A(1) or B(1) criteria for Aquatic Biota use.

Table 18 Table of rivers that require more monitoring to evaluate reclassification candidacy. Map IDs correspond with the map above and the years associated with each community field represent additional data requirements for reclassification candidacy verification. When there are No criteria for the fish community, reclassification relies upon the macroinvertebrate community. **land cover is >95% and only requires one macro and one fish observation.*

Map ID	Name	Macroinvertebrate	Fish
1	Mad Brook, rm 0.7	2027	*No criteria**
2	Miles Stream, rm 1.5**		2027
3	Catbow Brook, rm 1.6**		2027
4	Clough Brook, rm 0.5**		2027
5	Leach Brook, rm 10.2**		2027

Wetlands

The purpose of the Wetland Bioassessment and Monitoring Program ("Program") is to build a pertinent and practical program to assess the biological integrity and ecological condition of Vermont's wetlands. The Program has adopted the EPA's wetland monitoring methodology and is organized into three levels. Level 1 assessments are performed through desktop review and rely on coarse landscape-scale inventory information. Level 2 surveys are a "rapid assessment" at the specific wetland scale and use simple and quick protocols to collect data. Level 2 protocols are calibrated and validated by more intensive assessments known as Level 3, which are rigorous biological assessments that derive multi-metric indices. The Program conducts vegetation surveys to calculate biological metrics with a strong focus on the Coefficient of Conservatism score, which is a numeric scale from 0-10 assigned to each plant species which measures its tolerance and sensitivity to disturbance (Link to latest Bioassessment Report).

Table 23. Number and type of level 3 wetland assessments conducted across Basin 16. Heritage (Natural Heritage Inventory).

Boundless Plot	Heritage	Species List	VRAM Only	Wetlands Heritage	Wetlands Transect
2	4	6	6	8	3

Vermont Rapid Assessment Method (VRAM)

The Level 2 assessment is conducted using the Vermont Rapid Assessment Method (VRAM), which is composed of 6 qualitative metrics used to collect data on the wetland's function, value, and condition. These metrics include wetland area, buffers, hydrology, habitat, special wetland status, and plant communities. It generates a quality score on a scale of 0-100, where the higher the score equates to better wetland quality. From the VRAM information, condition indexes can be calculated that offer additional information to help evaluate human stressor impacts on the wetland and surrounding landscape or evaluate wetland restoration success.

Total VRAM scores (function and condition) are less comparable between wetlands due to the unique characteristics of a given wetland, such as the presence of a rare or threatened plant species or its size. Smaller wetlands generally receive less points than larger wetlands. Therefore, a lower total VRAM score may still demonstrate that a particular wetland is in reference or excellent condition with significant functions present. Function scores between wetlands are also not directly comparable as these scores do not relate specifically to wetland condition nor reflect whether one wetland is exemplary for one or more functions. Condition scores do provide relative comparison of wetland health between wetlands. This basin has some of the best condition and function wetlands in the state. However, it should be noted that sampling locations are not randomized and conclusions on area-wide wetland health, based on condition scores or total VRAM scores within the basin, cannot be determined at this time.

Additionally, the Program is currently unable to report on basin-wide wetland conditions and trends, impairments, or altered wetlands. The following information provides an overview of the various monitoring, assessment, and mapping objectives the Program is focused on.

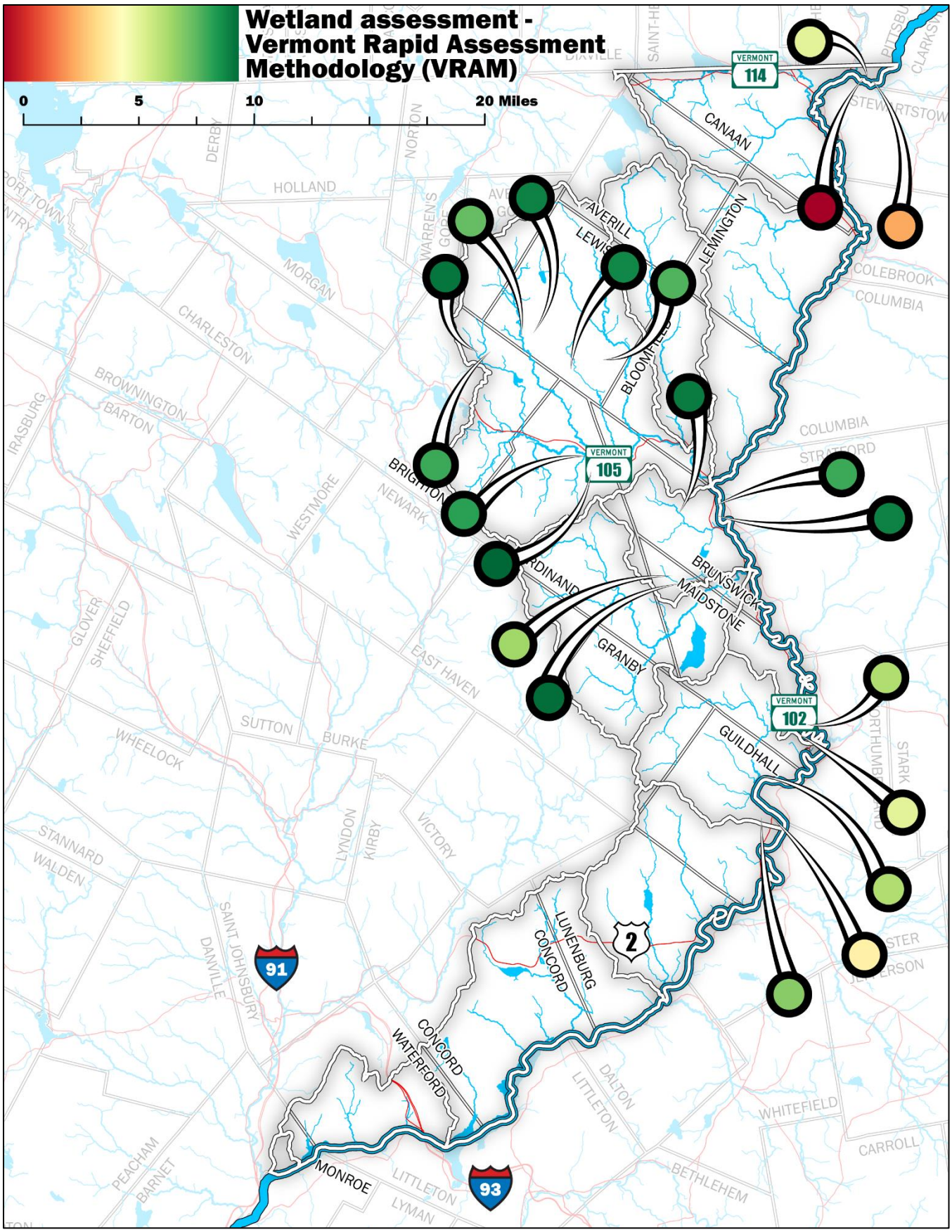

Figure 18. VRAM scores Basin 16 (North). The red to green symbology illustrates the relative wetland condition amongst VRAMs.

Table 19 Number of VRAMs conducted in Basin 16, summarized by HUC12 sub-basins. Sub basin size in acres included for reference.

Name	*Sub basin acres*	*VRAM Count*
Barnet-Ryegate Direct Drainage	28.2	0
Canaan Streams to Conn River	1208.1	3
Concord Direct Drainage	1481.5	0
East Branch Nulhegan River	885.8	0
Guildhall-Lunenburg Direct Drainages	1520.6	0
Lemington/Bloomfield Direct Tribs	819.9	0
Maidstone-Guildhall Direct Drainage	2118.6	3
Nulhegan River	10087.1	9
Paul Stream	3597.9	0
Waterford Direct Drainage	438.3	0
Wheeler Stream	1848	7

Wetland restoration monitoring

In 2017, the Program initiated a pilot project of monitoring restoration sites and associated reference sites. The project focused on sites with (1) recent restoration work; and (2) pre-restoration sites, with the intent to return to the sites as restoration progresses. Monitoring includes Level III assessments, Level II assessments using the VRAM, and tracking wetland restoration success using a metric called the Restoration Indicators of Success (RIS). This metric generates a numeric score calculated by summing the VRAM scores of metrics specifically relevant to and affected by restoration success, such as habitat development and alteration, presence of high-value habitat features, and intactness of hydrologic regime. To learn more about the RIS, and preliminary findings of the restoration monitoring project, click here: (link to RIS and Restoration Report).

There are no restoration monitoring sites in this basin.

Class I wetlands

Class I wetlands are exceptional or irreplaceable in their contribution to Vermont's natural heritage. They provide unmatched environmental functions and values and therefore merit the highest level of protection. Wetlands meeting Class I criteria and sub-criteria can be petitioned for reclassification from Class II to Class I by the public. These criteria evaluate the wetland's size, location, surrounding landscape, condition, and contribution to the functions and values identified by the State of Vermont.

There is one Class I Wetland in the basin, Dennis and Mud Pond Wetlands in Brunswick, VT.

Class I candidate wetlands are those where enough data has been collected to support a petition for reclassification. An important note is there are likely to be multiple additional wetlands in the basin that meet Class I criteria and have not been proposed or have had a complete Class I assessment conducted. For more information on this process see this webpage: https://dec.vermont.gov/watershed/wetlands/class1wetlands

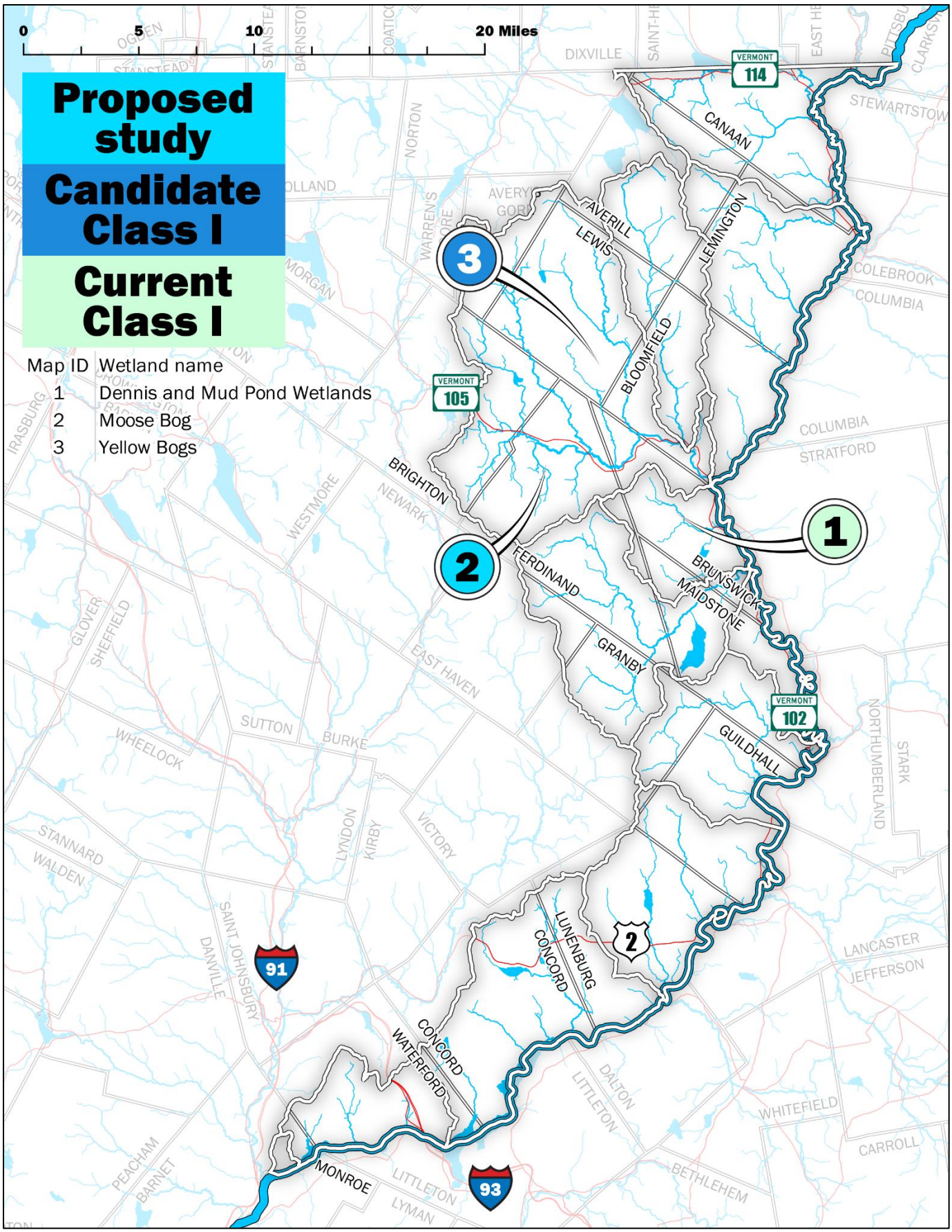

Figure 19 Class I wetland candidates.

Table 20 Class I wetland candidates.

Map ID	*Latitude*	*Longitude*	*Wetland name*	*Category*	*Towns*
1	44.7288	-71.6583	Dennis and Mud Pond Wetlands	Class I	Brunswick
2	44.7623	-71.7371	Moose Bog	Proposed for study	Ferdinand
3	44.8207	-71.7306	Yellow Bogs	Candidate	Lewis

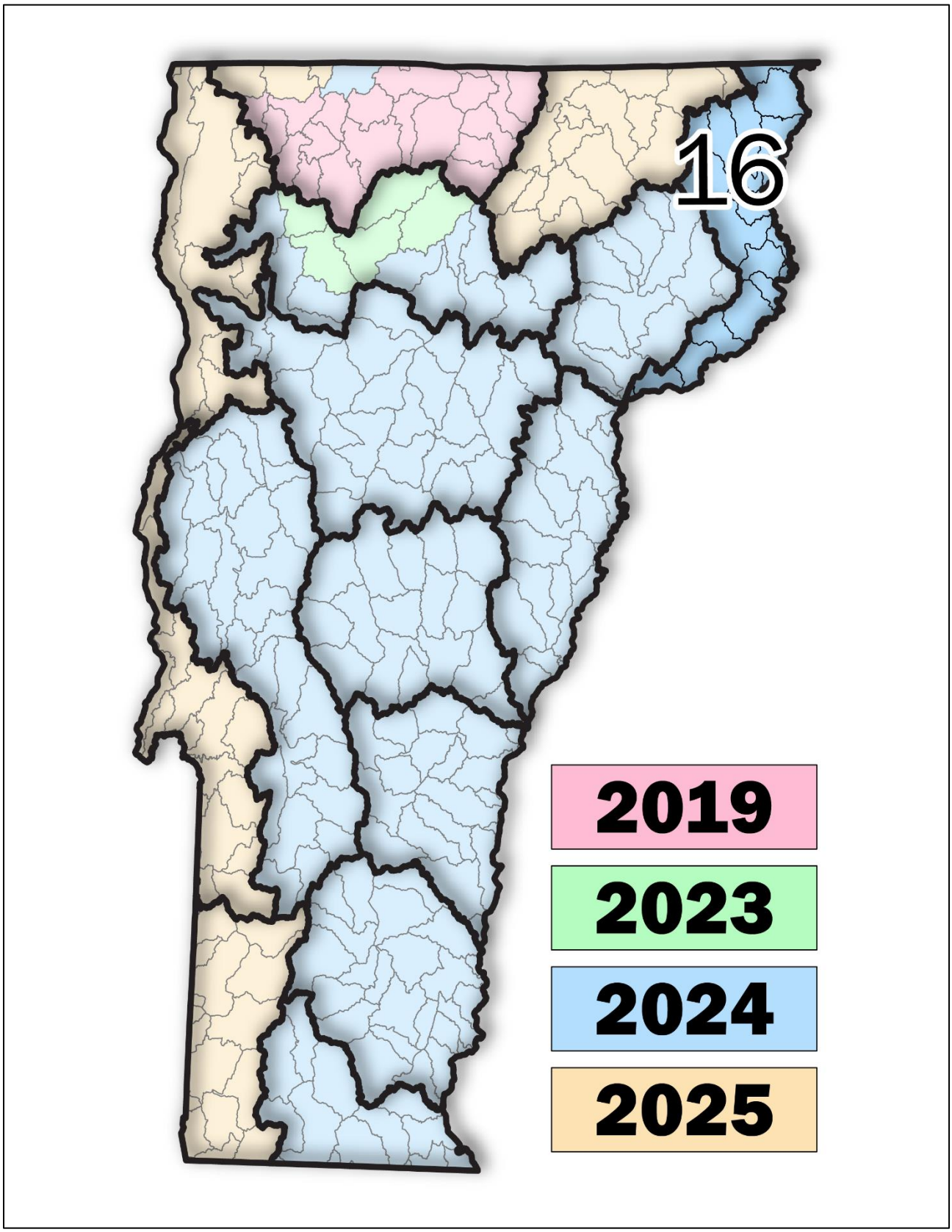

Figure 20. Wetland mapping schedule for Vermont Tactical Basins. Mapping is scheduled for 2024 in Basin 16.

The Vermont Wetlands program is currently in the process of working with contractors and federal agencies to update wetland mapping across the state. This will provide essential data as much of the current mapping is out of date and significantly under maps some types of wetlands such as seepage forests and softwood swamps. New mapping will gradually be made available in the Vermont Significant Wetlands Inventory layer over the next few years, with some basins updated sooner than others. This process has already started with updated mapping currently being added to VSWI for the Missisquoi basin.