VERMONT
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Preliminary Analysis of Vermont's Wetland Biological Monitoring: Floristic Quality Assessment Index

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Introduction

The purpose of the wetlands bioassessment project is to build a pertinent and practical wetland bioassessment and monitoring program in order to assess wetland biological integrity and the ecological condition of Vermont's wetlands. The program continues to build on the previous findings of the wetland bioassessment program (VT DEC, 2010) and an EPA-funded pilot wetland bioassessment project involving vernal pools and northern white cedar swamps (VT DEC, 2003).

Objectives of the project include:

1) Conduct assessments of wetlands across a condition gradient;
2) Record and gather chemical and physical data at each wetland site including water quality, hydrology, soils and landscape characteristics;
3) Sample and describe the vegetation in assessed wetlands to develop vegetation-related metrics of wetland integrity;
4) Complete rapid assessments and evaluate the ability of the methods to reflect the overall wetland condition, and
5) Begin to expand the use of metrics in assessing the overall ecological health of Vermont's wetlands.

It is a continued goal of the program that outcomes from the wetlands bioassessment program may be used in the future to: improve permitting and regulatory decisions; provide significant information for mitigation and restoration projects; and identify the effects of environmental and anthropogenic stressors on wetlands over time. All objectives are dependent on funding for the wetlands bioassessment and monitoring program.

The adoption of the Vermont Rapid Assessment Method (VRAM) in 2008 has improved on the Human Disturbance Rating (HDR) ability to distinguish wetland condition, offering a method that is generally more consistent in assessing the stressors impacting wetland condition. For instance, the VRAM metrics can be used to compare anthropogenic modifications to hydrology and water quality or vegetative communities, where the HDR did not.

To better characterize the vegetation communities and anthropogenic stressors surrounding the assessment sites, each wetland is scored across six metrics. The VRAM was adapted from the Ohio Rapid Assessment Method v 5.0 for Wetlands (Mack, 2001). The Vermont Wetlands Bioassessment Program incorporated this assessment method to improve upon the disturbance assessment criteria adopted from The Program's vernal pool and northern white cedar swamps project. The VRAM assesses condition, function, value and quality.

To date, the program has collected data from 131 sites over 8 seasons of sampling. In 2014, a database was created to store the data and support analysis. Within the database equations can now be programmed to automatically calculate indices such as a floristic quality assessment index (FQAI).

The FQAI was designed to assess the level of "naturalness" of an area based on the tolerance for the species found and their specificity to a particular habitat type. It rates the degree of human

disturbance to an area by accounting for the presence of cosmopolitan, native species, and nonnative taxa based on Coefficient of Conservatism (CoC) scores. The CoC scores are described in Table 1. A CoC is assigned by a regional expert or group of experts familiar with the flora of a geographic region based on what is known about the ecological tolerances of each taxa. There is, as a result, an inherent subjective element to the CoC score. However, when calculating a FQAI with the assigned CoC score to a particular species, the same score is applied objectively and consistently so that the relative comparison across sites is not affected by any bias in assigning the CoC.

Table 1 Description of Coefficient of Conservatism Scores

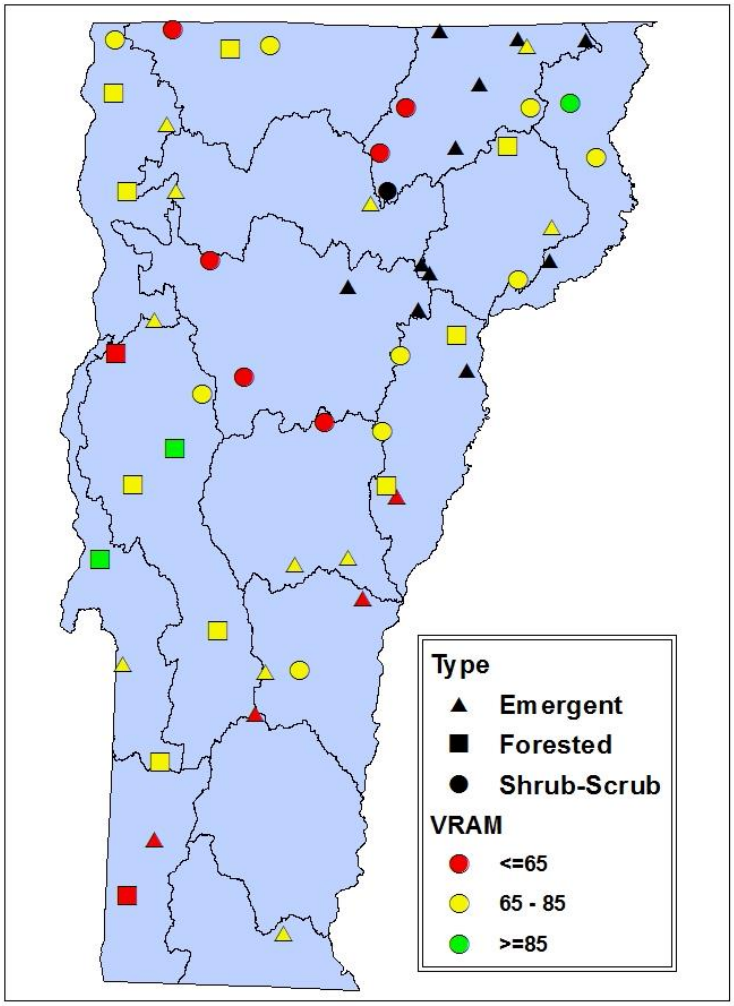
Score	Description
0	Non native plants with a wide range of ecological tolerances. Often these are opportunistic invaders of intact undisturbed habitats.
1	A native invasive plant
2	Widespread native taxa that are not typical of (or only marginally typical of) many communities.
3	Native plants with an intermediate range of ecological tolerances that typify a stable phase of some native community but persist under some anthropogenic and natural disturbance.
4	
5	
6	Native plants with a narrow range of ecological tolerances that typify a stable community.
7	
8	
9	Native plants with a narrow range of ecological tolerances that exhibit relatively high degrees of fidelity to a narrow range of habitat requirements and demonstrates sensitivity to anthropogenic influences.
10	

The focus of this report is a preliminary analysis of FQAI using data from 56 wetlands sampled over the 2007, 2010, 2011 and 2014 field seasons (Table 2). See Figure 1 for the distribution of sample locations throughout Vermont.

Table 2 Count of Wetlands Sampled By Type and Year

Year	Emergent	Forested	Shrub-Scrub	Total
2007	11		1	12
2010	10	7	7	24
2011	5	6	6	17
2014			3	3
				56

Figure 1 Wetland Bioassessment Sites Relevant to Report



Black symbols represent sites without VRAM data.

Methods

The following is a brief outline of the methods used. For a complete description refer to The Quality Assurance Project Plan for Biological Monitoring of Vermont's Wetlands: An Evaluation of the Chemical, Physical, and Biological Characteristics of Vermont Wetlands (VT DEC, 2007, 2008, 2009 & 2015).

Site Selection

Sites were selected in an effort to assess wetlands over condition gradient from reference (minimally disturbed) to highly disturbed based on landscape characteristics and historical data using GIS data and orthophotos. Sites were geographically analyzed to assess landscape characteristics such as watershed location, average buffer size and intensity of surrounding land use. Additional factors influencing site selection included prior experiences with the wetland or watershed, site location and accessibility, land owner permission and sampling feasibility.

Water Chemistry Sampling

Water samples were collected following the protocol outlined in the Vermont Wetlands Bioassessment Program Quality Assurance Project Plan (VTDEC: 1999, 2003, 2005, 2009). Within the assessment area, grab samples were taken in the vicinity of vegetation sampled.

Samples collected were analyzed at the Department of Environmental Conservation's Laboratory. Parameters analyzed are listed in Table 3. Field measurements collected using a Hydrolab™ Surveyor 4 and Minisonde 4 unit (Hach Environmental, Loveland, CO). If not specified, samples were analyzed in the laboratory.

Table 3 Water Quality Parameters

Water Quality Parameters
Alkalinity
Chloride, Dissolved
Color
Conductivity (field and lab)
Dissolved Oxygen (field)
Metals
Nitrogen, Nitrate/Nitrite
pH (field)
Phosphorus, Dissolved and Total
Sulfate, Total
Temperature (field)
Total Suspended Solids
Turbidity (lab)

Vegetation Sampling

Prior to 2014 vascular vegetation was sampled at each site using a transect-quadrat method detailed in the Quality Assurance Project Plan (VT DEC, 2007). At each location a transect was laid out from the edge of a water body (stream or pond) to the upland edge of the wetland. When sampling shoreline linear patch communities with a short width (40m or less), multiple transects were set perpendicular to the shoreline. Ten to twenty 1 m^2 quadrats were placed along the transect depending on the length of the wetland: every 5 ($\leq$50 m), 10 (60-150 m) or 15 meters ($\geq$150 m) to maximize the number of plants sampled. All plant species within a quadrat were identified to lowest possible taxonomic classification and the percent cover within the quadrat was estimated.

Vegetation sampling occurred once at each site between June and September. A second biologist verified the identity of wetland plants at 10% of the sampling sites in order to check the accuracy of field identification. The presence of any vegetation not present in the quadrat, but observed within 3 meters of the quadrat border and/or along the transect was also recorded. Starting in 2014, the bioassessment program adopted a new vegetation plot method based on the National Wetland Condition Assessment (NWCA) (EPA, 2011). The details are outlined in the updated QAPP (VT DEC, 2015). This method for vegetation sampling utilized five, 100 m^2 plot

layouts with nested, 10 m^2 and 1 m^2 quadrats in the southeast and northwest corner of each plot. Configuration of veg plot layout around the assessment area (AA) center was based on the overall wetland boundary size and shape as well as any obstacles within the AA in accordance with NWCA (EPA, 2011). Plants present within each plot were identified to the lowest taxonomic classification in the field. For each plot, data collection included: the smallest quadrat size in which each plant is found present, the percent coverage and height class. Plants that could not be identified were sampled for later identification.

Vermont Rapid Assessment Method (VRAM)

The VRAM combines scores from six metrics described in Table 4. The sum of scores from each metric combines for a score ranging between 4 and 100. A high score designates a site with little or no disruption. Scores decrease with increased levels of human disturbances and lack of vegetation community diversity.

Table 4 VRAM Metrics

Metric	Description	Score Range	Assessment Method
1	wetland area (size)	0-6	Vermont Agency of Natural Resources (ANR) GIS orthophotos and infrared aerial photos
2	upland buffers and surrounding land use	1-14	
3	hydrology within the wetland	4-30	ANR GIS maps, historical data and field observations
4	wetland habitat alteration	3-20	
5	special wetlands	0-10	Field data indicating the natural community type and state/federal threatened or endangered species GIS layers
6	plant communities, interspersion, and microtopography	(-)4-20	Field observation of plant species and community layout

Desktop and field assessments are combined to evaluate VRAM scores. Orthophotos, Vermont Significant Wetland Inventory (VSWI) layers, and aerial images are used for desktop assessments. The desktop assessment is confirmed in the field and VRAM scores were calculated after the on-site assessment.

Data Analysis

Water Chemistry Data

Laboratory water quality results were analyzed from 41 sites. For results below detection limits, the detection limit was interpreted as the final result for analysis.

Biological Data

The Floristic Quality Assessment Index is calculated as the average CoC of native species at a site, weighted by the square root of native species richness (Andreas and Lichvar 1995).

Modified equations to the original FQAI have been developed accounting for the percent cover of each taxa (FQAI $_{\text{Cover weighted}}$) and the proportion of native to non-native plants (FQAI$_{\text{Adjusted}}$). FQAI equations used are listed in
Table 5.

Table 5 FQAI and Related Equations

Equation 1 FQAI	$I = \frac{\sum C_i}{\sqrt{N}}$
Equation 2 FQAI $_{\text{Adjusted}}$	$I' = 100\left(\frac{\overline{C_n}}{10}\right)\left(\frac{\sqrt{N}}{\sqrt{S}}\right)$
Equation 3 Cover Weighted Mean CoC	$\overline{C_{t\gamma}} = \frac{\sum(C_i \times \Upsilon_i)}{\sum \Upsilon_i}$
Equation 4 FQAI $_{\text{Cover weighted}}$	$I_{t\gamma} = \overline{C_{t\gamma}}\sqrt{S}$
Equation 5 FAQWet	$\frac{\sum \mathrm{W}}{\sqrt{\mathrm{S}}} \times \frac{\mathrm{N}}{\mathrm{S}}$

*Eq. 3 is used to calculated Eq. 4

C- The Coefficient of Conservatism
S- Total Species Richness
Υ- Percent Cover
N- Native Species Richness
W- Wetness coefficients

Subscripts
t- Total
n- Native Species
i- For species i

Table 6 Calculations Applied to Specific Vegetation Families

Equation 6 Relative Percent Frequency	$\mu_r = 100(\frac{\mu_i}{\sum_{i=0}^{r} \mu_i})$
Equation 7 Relative Percent Coverage	$\gamma_r = 100({}^{\gamma_i}/_{\sum \gamma_i})$
Equation 8 Relative Importance Value (RIV)	$RIV = (\mu_r + \gamma_r)/2$

Υ- Percent Cover
μ- Frequency

r- For group *r*
i- For species *i*

Table 7 Calculations for Diversity and Evenness

Equation 9 Shannon's Diversity Index	$H' = -\sum(p_i)(log_e p_i)$

	$p_i = \gamma_i / \gamma_t$
Equation 10 Evenness (Shannon's)	$J' = H' / log_e(S)$
Equation 11 Simpson Diversity Index	$1 - D = 1 - \sum(p_i)^2$

γ- Percent Cover
S- Total Species Richness
i- For species i
t- Total

Results

Water Quality

Table 8 Water Quality

Wetland ID	Type	Alkalinity	Conductivity	Total Aluminum	Total Calcium	Total Chloride	Total Iron	Total Magnesium	Total Manganese	Total Nitrate/Nitrite	Total Nitrogen	Total Phosporus	Dissolved Phosphorus	Total Potassium	Total Sodium	Total Sulfate	Total Suspended Solids	Turbidity
		mg/l	umho/cm	ug/l	mg/l	mg/l	ug/l	mg/l	ug/l	mg/l	mg/l	ug/l	ug/l	mg/l	mg/l	mg/l	mg/l	NTU
BOBR01	E	26.7	57.2	87.0	8.83	0.27	283.6	0.91	44.57	0.08	0.21	14.2	10.5	0.67	1.09	2.68	5.63	1.35
PODU01	E	63.9	134.7	50.0	23.62	0.21	300.2	1.37	42.55	0.05	0.23	8.8	7.1	1.16	0.77	4.64	1.57	1.11
LANI01	E	8.0	24.0	107.0	2.57	0.26	435.2	0.69	82.40	0.05	2.17	10.4	10.4	0.96	0.80	2.48	1.03	0.85
ROBR01	E	48.5	99.5	50.0	13.96	0.20	124.9	4.15	13.63	0.05	0.33	14.2	10.9	0.50	0.76	2.20	1.00	0.55
KESW01	E	29.7	88.9	133.0	8.35	7.13	573.7	3.49	391.80	0.05	0.41	17.4	11.7	0.50	4.13	2.22	1.80	2.06
LOPO02	E	52.3	95.3	50.0	13.82	0.38	774.8	3.43	62.69	0.05	0.73	22.2	12.4	0.50	0.83	1.07	5.44	2.17
MITR01	E	-	224.1	92.0	13.82	59.86	-	2.50	-	0.05	0.50	24.6	17.1	0.96	24.25	2.38	5.63	3.49
LATR01	E	179.9	316.0	50.0	37.61	0.35	490.2	14.48	39.75	0.05	0.63	25.1	14.4	0.50	1.34	0.50	2.57	0.79
HUBR01	E	4.8	19.7	414.0	2.53	0.20	1672.0	0.43	73.96	0.05	0.58	28.6	14.4	0.50	1.06	0.58	3.62	2.49
BUMA01	E	-	184.7	50.0	30.91	1.22	-	4.86	-	0.05	0.24	36.2	7.8	0.83	2.01	8.52	1.40	1.17
BESW01	E	38.3	78.3	50.0	9.76	0.43	6723.0	2.71	1991.50	0.05	0.35	51.8	25.0	0.50	1.00	0.54	15.78	13.40
WHBR01	E	11.8	35.1	264.0	3.80	0.98	-	1.42	-	0.05	0.63	52.2	-	0.50	1.67	0.50	12.00	5.14
LOCR01	E	16.1	35.9	50.0	4.36	0.20	1147.0	0.99	196.70	0.05	0.61	58.2	40.4	0.50	0.82	1.12	2.65	1.54
OTRI01	E	57.2	211.6	50.0	18.07	28.61	3684.0	1.63	1117.00	0.05	0.84	133.0	44.9	1.24	22.45	1.97	23.68	10.90
BEBR01	F	54.3	112.8	50.0	20.00	2.00	73.2	1.01	40.51	0.05	0.21	14.4	6.6	0.50	0.70	-	3.43	1.17
DRBR01	F	3.2	18.4	76.0	2.01	0.20	123.2	0.27	23.73	0.05	0.41	15.3	11.7	0.50	0.50	2.98	1.00	0.20
COSW01	F	100.3	220.5	50.0	29.83	10.85	196.4	7.43	57.46	0.05	0.49	17.2	16.4	1.09	7.25	0.50	5.15	0.30
STTF01	F	115.7	225.0	50.0	42.85	0.48	50.0	1.40	30.63	0.05	0.20	17.3	6.5	1.13	0.76	2.50	2.89	0.27
EACR01	F	73.7	142.1	50.0	15.46	1.34	857.3	3.09	77.55	0.05	0.70	20.0	13.0	0.50	1.16	1.56	32.99	0.84
PACR01	F	218.9	453.1	83.0	64.83	16.02	-	20.36	-	0.05	0.28	24.6	15.1	0.88	9.92	2.66	11.43	2.19
LARI01	F	110.9	294.4	50.0	29.20	23.36	-	13.62	-	0.05	0.41	27.0	14.7	0.79	15.61	3.79	9.47	1.37
JEBR01	F	57.9	121.2	50.0	22.59	0.59	290.7	1.45	104.60	0.05	0.46	48.6	26.3	1.32	1.46	2.30	1.00	0.93
AISF01	F	59.4	125.0	83.0	16.79	0.33	-	6.39	-	0.05	0.31	51.5	13.4	0.54	1.07	3.48	7.02	1.58
EASL01	F	124.7	287.6	362.0	27.37	15.24	2526.0	12.89	514.80	0.05	0.80	150.0	39.6	2.16	13.94	1.98	33.40	18.70
MERI01	F	178.0	351.6	50.0	72.44	3.95	-	12.71	-	0.60	0.85	6.5	5.4	1.14	3.02	6.72	1.00	0.51
ROBU01	F	247.8	550.8	50.0	85.27	24.19	1004.0	12.51	118.30	1.36	2.12	112.0	63.3	3.79	12.91	14.99	16.87	2.27
LIBR01	S	23.0	67.2	50.0	6.70	4.26	50.0	0.79	15.01	0.05	0.18	8.4	6.3	0.76	3.25	2.69	1.00	0.61
COBR01	S	92.1	186.6	50.0	36.11	0.36	333.3	0.96	41.62	0.05	0.11	9.9	5.6	1.04	0.80	5.04	5.10	1.81
MIBR01	S	12.2	36.0	76.0	5.75	0.50	145.6	0.84	9.79	0.05	0.40	17.0	11.5	0.50	0.84	3.75	8.44	2.74
MARI01	S	11.8	34.0	169.0	5.14	0.26	485.3	0.93	20.97	0.05	0.12	19.2	8.0	0.50	0.78	4.23	5.92	13.10
YEBR01	S	4.7	22.5	369.0	3.47	0.20	732.1	0.65	39.72	0.05	0.57	26.6	30.2	0.50	0.88	0.50	1.14	1.41
DUPO01	S	61.5	197.7	145.0	24.04	18.69	1014.0	1.62	465.90	0.05	0.40	32.9	19.4	1.44	12.42	4.96	10.83	11.30
REPO01	S	31.6	64.2	75.0	8.47	0.44	3384.0	1.55	1144.00	0.05	0.51	44.6	22.2	0.50	1.28	1.20	10.69	7.16
BETF01	S	13.0	40.6	129.0	6.15	1.36	2180.0	0.91	163.20	0.05	0.70	82.3	34.0	0.50	1.10	0.67	5.09	4.39
RORI01	S	153.3	337.6	2382.0	51.90	17.11	-	13.25	-	0.05	3.33	811.0	387.0	9.44	13.40	1.95	150.77	916.00
BMBR01	S	1.3	15.5	142.0	1.38	0.20	214.1	0.42	56.14	0.07	0.15	5.0	5.0	0.50	0.50	3.66	1.42	0.44
SOBR01	S	25.4	55.4	97.0	8.65	0.23	206.7	0.83	61.00	0.07	0.26	21.6	17.3	0.50	1.38	2.59	2.06	0.97
BLRI01	S	107.0	257.5	89.8	39.23	9.71	696.2	4.82	153.70	0.11	0.39	30.7	9.2	1.30	6.30	5.68	4.60	5.73
WEMO01	S	13.9	38.3	62.0	4.57	0.20	62.1	0.83	10.05	0.13	0.22	10.4	9.4	0.78	1.83	3.03	1.00	0.25
SBWR01	S	146.6	301.7	50.0	49.07	5.01	146.0	6.09	35.58	0.14	0.26	9.8	6.9	0.50	4.48	-	1.34	0.58
BRBR01	S	67.0	202.2	50.0	21.19	13.80	452.6	5.23	105.30	0.60	0.93	27.1	15.9	0.87	8.50	6.86	1.00	3.63
	N	39	41	41	41	41	33	41	33	41	41	41	40	41	41	39	41	41
	Max	247.8	550.8	2382.0	85.27	59.86	6723.0	20.36	1991.50	1.36	3.33	811.0	387.0	9.44	24.25	14.99	150.77	916.00
	Min	1.3	15.5	**50.0**	1.38	**0.20**	**50.0**	0.27	9.79	**0.05**	0.11	**5.0**	**5.0**	**0.50**	**0.50**	**0.50**	**1.00**	**0.20**
	Mean	67.9	155.2	157.0	21.77	6.61	952.5	4.29	222.61	0.12	0.59	52.6	26.2	1.07	4.61	3.12	10.24	25.55
	StdDev	63.3	129.2	367.6	20.29	11.61	1388.6	5.03	421.84	0.23	0.61	125.7	59.8	1.47	6.15	2.74	23.85	142.61

The cells of values in the 75th and 25th percentile for each parameter column are grey and yellow, respectively. Red font indicates the 95th percentile. Values below detection limit are bold and underlined in the "Min" row. E=emergent (green), S-shrub-scrub (orange) and F=forested (white)

There was a significant difference in the test results for alkalinity and conductivity between forested and both shrub-scrub and emergent. There was no difference between shrub-scrub and emergent. There was no significant difference in water results comparing VRAM disturbed, reference and moderate sites.

Vermont Rapid Assessment Method (VRAM)

VRAM data exists for sites surveyed after 2007. VRAM scores ranged from 50 to 91 (n=44) out of a possible 100 points (Table 9). Lower scores indicate a greater degree of disturbance. Sites with scores between 85 and 100 are considered to be of reference condition, this corresponds with sites in the 95th percentile. Disturbed condition is classified as scores between 0 and 65 (25th percentile). Of the sites analyzed 12 were disturbed, 29 moderate and 3 were reference condition.

Table 9 VRAM Results

Wetland ID	Type	Area (size) V1	Upland Buffers /Surrounding Land Use V2	Hydrology V3	Habitat Alteration and Development V4	Special Wetlands V5	Plant Communities, Interspersion, Microtopography V6	VRAM
DRBR01	F	4	**14**	24	19	**10**	**20**	91
YEBR01	S	5	**14**	27	19	**10**	15	90
EACR01	F	4	**14**	**30**	**20**	0	18	86
LOCR01	E	4	**14**	26	19	0	**20**	83
HUBR01	E	4	**14**	29	**20**	0	15	82
LOPO02	E	5	**14**	24	19	0	**20**	82
LARI01	F	4	**14**	24	19	0	**20**	81
BMBR01	S	3	**14**	29	19	0	15	80
JEBR01	F	5	**14**	17	19	5	**20**	80
LATR01	E	**6**	12	26	18	**10**	7	79
BOBR01	E	**6**	**14**	23	19	0	17	79
REPO01	S	4	11	18	16	**10**	**20**	79
MERI01	F	3	9	27	19	5	15	78
DUPO01	S	5	12	22	19	0	**20**	78
WHBR01	E	5	**14**	27	19	0	12	77
BEBR01	F	4	**14**	23	17	5	14	77
LACA01	F	4	11	19	14	**10**	19	77
BUMA01	E	4	11	23	19	0	**20**	77
SOBR01	S	3	**14**	26	19	0	13	75
LANI01	E	4	11	29	16	0	15	75
BETF01	S	4	13	**30**	14	0	13	74
STTF01	F	3	13	26	19	0	13	74
ROBU01	F	4	9	22	14	5	**20**	74
COBR01	S	3	**14**	25	19	0	12	73
BLRI01	S	4	9	27	16	0	17	73
WEMO01	S	3	12	22	16	0	**20**	73
ROBR01	E	4	**14**	24	16	0	14	72
AISF01	F	2	**14**	21	15	0	19	71
MUCR01	S	**6**	12	20	16	0	16	70
COSW01	F	**6**	13	15	11	5	**20**	70
BESW01	E	5	12	21	15	0	13	66
TRWR01	E	2	12	20	15	0	17	66
SBWR01	S	3	11	24	13	0	12	63
EASL01	F	3	7	21	12	5	15	63
PACR01	F	3	**14**	16	12	0	18	63
PODU01	E	3	**14**	16	12	0	18	63
LIBR01	S	4	8	21	12	0	18	63
BRBR01	S	4	3	24	14	0	14	59
RORI01	S	**6**	5	17	9	5	16	58
KESW01	E	5	7	14	12	0	**20**	58
MIBR01	S	3	4	22	11	0	17	57
MITR01	E	3	9	24	12	0	8	56
OTRI01	E	2	4	20	8	0	18	52
MARI01	S	2	7	21	12	0	8	50

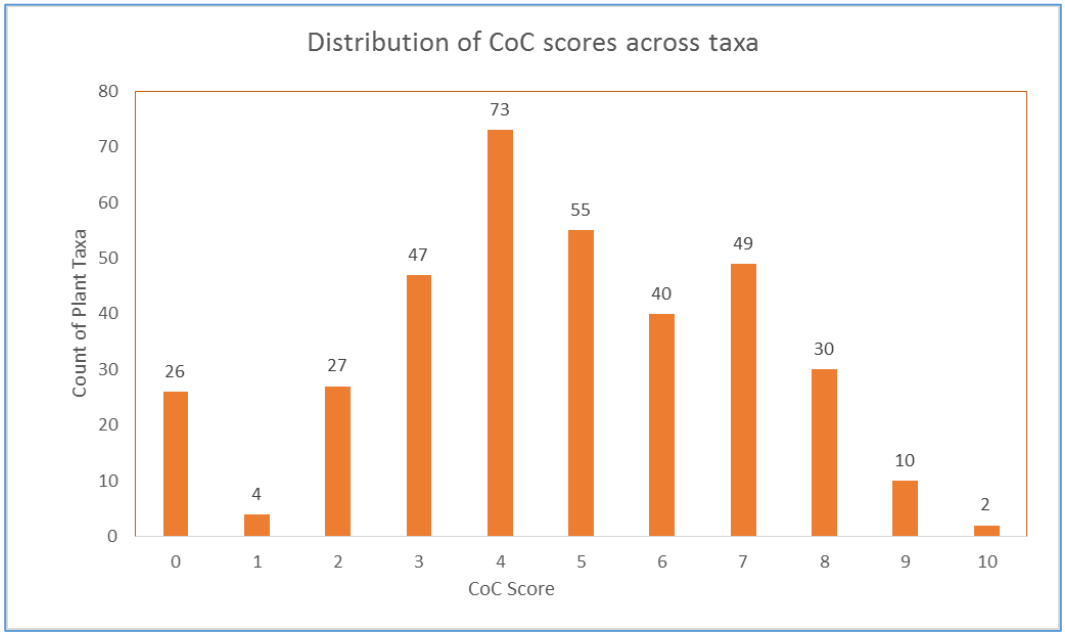
Bold breaks between the columns are the 25th, 50th and 75th percentile for the total VRAM scores. A score with red font indicates reference condition (95th percentile). Total scores in the 75th and 25th percentile at grey and yellow respectively. Metric scores with maximum values are bold and underlined. Wetland type is coded E=emergent (green), S=Shrub-scrub (orange) and F=Forested (white).

Vegetation

Vegetation can provide insight into the overall health of a wetland and indicate how a site is reacting to stressors. The probability exists that a greater number of stressors will decrease the number of intolerant native species in a site. A disturbed site tends towards more generalized or tolerant, and exotic species which can adapt to a fluctuating or ecologically compromised environment. Similarly, diversity and richness of intolerant, native species can equate to higher biological integrity of the wetland.

From these 56 sites, there are 477 records of vegetation taxa. There are 363 with assigned CoC values, 79 that were not identified to species and 35 that are identified to species but not assigned CoC scores. The distribution of CoC values is illustrated in Figure 2

Figure 2 Distribution of Coefficient of Conservatism Scores for taxa present at monitoring sites



The two species with CoC of 10 are bog birch (Betula pumila) found at YEBR01 (% cov 2.5) and purple pitcherplant (Sarracenia purpurea) present at LACA01 but not in the AA.

Floristic Quality Assessment Index (FQAI)

Calculated FQAI scores for each site are listed in Table 10.

Table 10 FQAI Scores

Wetland ID	Type	FQAI Eq. 1	FQAI Adjusted Eq. 2	Mean CoC Cover Weighted Eq. 3	FQAI Cover weighted Eq. 4	FAQ Wet Eq. 5	VRAM
JOPO01	E	28.1	48.8	6.1	35.2	21.4	x
PEPO01	E	27.9	51.7	3.9	24.2	21.4	x
CUPO01	E	26.3	53.8	1.9	11.2	18.2	x
PEPO02	E	25.4	53.0	4.9	28.1	16.4	x
HOPO01	E	24.0	50.0	6.6	35.7	17.6	x
CRLA01	E	23.8	46.8	5.3	30.1	16.8	x
LYPO01	E	23.0	55.9	4.7	21.0	18.6	x
MIPO01	E	21.6	52.4	4.4	19.7	19.2	x
GRAV01	E	21.0	49.4	6.4	32.1	14.8	x
LAME01	E	14.4	54.3	2.9	8.2	12.4	x
TINA01	E	13.0	34.5	3.5	13.0	12.2	x
BOBR01	E	31.3	41.1	3.8	30.1	23.9	
LOCR01	E	30.5	37.5	4.0	32.6	17.1	
LOPO02	E	30.5	45.9	5.5	36.7	27.7	
ROBR01	E	29.3	50.3	5.6	35.3	24.0	
LATR01	E	28.1	41.3	4.1	27.7	19.2	
BESW01	E	27.2	46.1	4.7	30.2	21.9	
WHBR01	E	26.5	46.9	3.6	23.0	13.6	
LANI01	E	26.3	40.9	3.9	24.7	18.9	
BUMA01	E	26.2	42.6	4.1	27.5	23.2	
HUBR01	E	25.3	40.0	2.9	18.5	19.0	
TRWR01	E	21.4	43.9	3.9	22.6	13.5	
KESW01	E	30.9	38.6	3.8	31.7	19.7	D
PODU01	E	27.0	31.4	2.6	20.8	14.7	D
MITR01	E	21.5	39.1	5.1	28.2	15.3	D
OTRI01	E	19.8	37.4	5.8	30.8	14.2	D

Wetland ID	Type	FQAI Eq. 1	FQAI Adjusted Eq. 2	Mean CoC Cover Weighted Eq. 3	FQAI Cover weighted Eq. 4	FAQ Wet Eq. 5	VRAM Rank
EACR01	F	31.7	45.8	2.7	19.6	20.1	R
DRBR01	F	31.5	45.4	4.9	36.3	9.6	R
LACA01	F	36.5	41.1	4.8	44.4	19.2	
BEBR01	F	34.9	45.5	2.5	20.2	17.4	
COSW01	F	30.4	40.4	3.7	26.0	13.3	
JEBR01	F	28.8	41.2	5.3	35.4	14.7	
AISF01	F	26.9	46.3	3.3	21.3	12.2	
MERI01	F	26.9	65.3	3.0	12.6	13.2	
STTF01	F	26.0	43.3	3.7	22.5	12.1	
LARI01	F	23.8	46.9	1.4	8.0	-0.8	
ROBU01	F	17.9	39.0	2.7	13.0	13.1	
PACR01	F	23.3	41.2	4.4	24.9	13.6	D
EASL01	F	20.0	32.4	2.0	11.6	5.9	D
YEBR01	S	32.5	52.1	2.8	19.3	18.3	R
LAEL01	S	25.0	50.0	4.3	27.4	14.4	x
REPO01	S	31.9	46.6	4.5	33.4	22.9	
DUPO01	S	30.8	43.1	3.8	27.8	9.4	
SOBR01	S	30.4	46.9	4.1	27.1	22.2	
MUCR01	S	28.9	40.1	4.2	31.4	14.3	
BETF01	S	27.2	40.6	3.9	26.8	24.2	
WEMO01	S	26.5	40.1	2.2	16.1	15.6	
BMBR01	S	26.4	37.8	3.2	24.0	12.0	
BLRI01	S	25.1	41.8	2.8	17.8	23.0	
COBR01	S	21.7	42.2	5.2	25.6	10.3	
RORI01	S	32.2	39.1	4.0	31.9	21.5	D
SBWR01	S	29.2	42.1	3.9	28.2	21.8	D
BRBR01	S	27.0	40.1	3.2	21.3	8.3	D
LIBR01	S	24.0	50.7	2.7	14.1	14.0	D
MIBR01	S	21.7	33.1	3.7	26.1	15.0	D
MARI01	S	18.3	26.2	1.6	9.3	4.0	D

The 25th percentile and 75th percentile cells are filled in yellow and grey, respectively. FQAI scores in the 95th percentile are red. Sites with VRAM scores in the reference (R) or disturbed ranges (D) and those without VRAM scores are marked with (x). Moderate VRAM scores are left blank.

Conclusions

Studies on FQAI suggest the index is best comparing similar wetland types. The reason being that some habitat types lack specialists (e.g., spruce flats, red maple swamps) and so low FQAI scores may be misinterpreted as higher disturbance or a decrease in wetland integrity that is not

true. How broad or narrow a classification to use is uncertain. Currently the program maintains very broad classifications (shrub-scrub, emergent, and forested). This study found no significant difference in the FQAI scores between wetland types. This should be retested when all past data has been put into the database and perhaps a more narrow classification will be desirable for future application of the data.

Two changes have been made to the bioassessment methods since the National Wetland Condition Assessment: site selection and plant sampling design. In 2014 vegetation sampling changed from a transect method to the nested plot method used in the NWCA (EPA, 2011). In the original method, the identification and percent cover of plants occurred in a 10 to 20 m^2 area laid out along the wetland from waterbody upland. The new method identifies and estimates percent cover for 500 m^2 in an assessment area that may vary depending on the shape or boundaries of the wetland. However as a standard, the circular plot layout spans 80 m diameter.

For this report, only the 2014 sites (n=3) reflected the new vegetation sampling method. With such a small sample size, it cannot be determined whether significant differences exist in the means of any of the parameters addressed in this study. Sites sampled in 2015 used the same methodology as 2014 and the larger sample will be compared with the old method once collection and analyses are complete. Both the transect and the NWCA plot method may capture a similar representation of plant communities despite the difference in area surveyed such that human disturbances are detectable when applying the data to metrics (i.e. FQAI). This is something that should be assessed when a larger sample size of vegetation data with the new method is available.

In 2015, post the sampling in this study, the program adopted a probabilistic site selection method (Olsen, 2014) which allows statistical confidence to estimates of characteristics for the entire target population to be computed accounting for any stratification or unequal probability selection in the design.

Although an FQAI rating system is valuable, it should not be the only measurement of condition for a site. Biological, chemical and landscape assessments should be combined to attain an overall representation of site condition. The eight seasons of biomonitoring have provided the Vermont DEC Wetlands Bioassessment Program with a foundation upon which to develop a valuable state biomonitoring program and begin to develop metrics which can be used to determine wetland condition throughout the State of Vermont. The parameters sampled will allow multiple facets of wetland health (chemistry, vegetation and physical characteristics) to be combined in an effort to have a comprehensive view of wetland quality.

It is the long-term goal of the wetlands bioassessment program to utilize what we learn from the bioassessment data to aide in permitting and regulatory decisions. Understanding wetland quality will allow appropriate mitigation and restoration efforts and ensure that wetlands of high ecological quality are protected and those of poor quality are improved. The efforts of the Vermont Wetlands Bioassessment Program have started the VT DEC working in an appropriate direction toward achieving these goals.

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