Ecoregional Floristic Quality Assessment Tools for the Northeast and Mid-Atlantic Regions: Linking EPA Region 2 (New Jersey and New York) with EPA Regions 1 and 3

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PROJECT ABSTRACT

Introduction: Floristic Quality Assessment (FQA) is a robust, botanically based method for assessing the quality of ecological communities and natural areas. Integral to the method is that each native plant species in a state or region is assigned a Coefficient of Conservatism, or C value, based on its response to stressors. Although FQAs are often completed at the state level, jurisdictional units are not optimal for addressing changes in species behavior across their range. For this reason, the Environmental Protection Agency (EPA) has funded various projects to support development of ecoregional C values. Ecoregional C ("eC") values were developed for Region 3 (Mid-Atlantic States) in 2012 and in Region 1 (New England) in 2019. But integration of eC values was not complete for ecoregions in Region 2 (New Jersey and New York).

Methods: We developed eC values as follows: 1) developed a regional plant species list for all 10 ecoregions found in the three EPA regions. Most of this work was already complete in 8 of the ecoregions found in EPA R1 and R3, so we focused on the Allegheny Plateau glaciated region in central-western NY (USEPA 60-61) and the Atlantic Coastal Plain (USEPA 84). We used USDA PLANTS as the botanical standard; 2) assigned eC values in these two regions for each species, starting with an automated integration of state C values from NJ and NY, then used a team approach to produce an initial *e*C values for the two ecoregions; 3) We then compared and adjusted eC values, as needed, across all 10 ecoregions.

Results and Discussion: We compiled 5559 taxa across all 10 ecoregions in EPA R1 – R3, including 4794 species, 73 hybrids, 192 subspecies and 540 varieties. By ecoregion, the number of native taxa varied from 1279 taxa in the Acadian Plains and Hills (82) to 2285 in the Northeastern Highlands (58). Across all ecoregions, 19% of the taxa had eC values of 0 (i.e., exotics), 7% of 1-2, 25% of 3-5, 36% of 6-8, and 13% of 9-10. There was minimal variation in the percentage of natives with a narrow range of ecological tolerances (i.e., C values of 9-10), with the majority (7 ecoregions) having 16-21%, though two (Acadian Plains and Hills, Northeastern Highlands) had 11-13%, and Atlantic Coastal Plain (84) had 4%.

When assessing maximal ecoregional differences for a taxa across all the ecoregions where it was reported and evaluated, we excluded differences caused by a taxon being exotic in one ecoregion and native in the other, as these can be difficult judgement calls. Of the 4940 taxa evaluated, none had eC values with a maximal difference of 9, 137 (2.8%) species varied by 5-8 (2.8%), 630 (12.8%) varied by 3 or 4, and 4173 (84.5) % varied by 0, 1, or 2. These differences represent important ecological shifts in species behavior, and valuable for improving FQA metrics.

The upgraded eC values are posted on the Universal FQA Calculator. Both the website and the database now contain the full set of ecoregional spreadsheets across the 3 regions developed for this project. Together these improvements provide a scientifically defensible and publicly accessible ecoregionally-based FQA method across the northeastern USA. The eFQA tool will be integrated into recommended monitoring protocols for wetland mitigation site evaluations in the NJDEP Mitigation Technical Manual.

INTRODUCTION

Floristic Quality Assessment (FQA) is a robust, botanically based method for assessing the quality of species composition of ecological community occurrences and natural areas (Swink and Wilhelm 1979, Taft et al. 1997, Herman et al. 1997). Integral to the method is that each plant species in a state or region is assigned a Coefficient of Conservatism, or C value, based on its tolerance to degradation and dependence on pristine natural habitats and processes (Swink & Wilhelm 1994). The C values range from 0 to 10; the most highly conservative species (C values >7) are typically found under historic, natural, and restricted ecological conditions and are sensitive to anthropogenic disturbances, whereas the least conservative species (C values <3) are adapted to or tolerant of a wide range of anthropogenic disturbances. Integrating the C values of all species at a site into one or more FQA metrics can provide a valuable indicator of the condition at a site and for this reason, the FQA method has become an important tool for assessing ecosystem condition, especially for wetlands (Swink and Wilhelm 1979, Miller and Wardrop 2006, DeBerry et al. 2015).

Developing C values has often been based on state boundaries, where a comprehensive flora is often readily available (for a current list of available state FQAs, see DeBarry et al. 2015, Table 1; Freyman et al. 2016, Table 1). Because there is strong interest in a regional approach to wetland assessments, there has also been widespread interest in developing ecoregionally based C values ("eC"), in addition to state C values (e.g., Chamberlain et al. 2012). Ecoregional FQA's (eFQA) have been completed for the Northeast Region 1, including northern New York (Faber-Langendoen 2019), Mid-Atlantic Region 3 (Chamberlain and Ingram 2012), and Southeast Region 4 (Gianopolous 2014) utilizing USEPA Wetland Program Development Grant funding. However, the ecoregions in Region 2 were never fully completed. Developing eC values for New Jersey and southern New York would fill the gap in coverage and create a seamless tool for floristic assessments that spans eastern EPA Regions 1, 2, 3 and 4.

Developing eC values is facilitated by knowledge of C values at the state level. For Region 2, we were fortunate that state C values are now available for both New Jersey (Walz et al. 2018) and New York (Ring, 2016). That information provides the opportunity to integrate state information in Region 2 with the Mid- and Northeast (Faber-Langendoen 2019) eC values. Contiguous eFQA data is a critical component of vegetation multi-metric indices used in state wetland condition assessments and the National Wetland Condition Assessment (USEPA, 2016) across state boundaries and within ecological regions of USEPA Region 2 (see Fig. 1 and Fig. 2).

In this study, we sought to improve the use of ecoregionally-based FQA in EPA R2, especially for wetland programs, by addressing the following objectives:

Objective 1: Ecoregional Regional Species: Develop a regional plant list for New Jersey and New York that also links to the species lists for EPA R1 and R3, based on USDA plant taxonomy as the standard, and determine the ecoregional distribution of each species in the ecoregions that cover EPA Region 2. The major focus was the Allegheny Plateau glaciated region in central-western NY (USEPA 60-61) and the Atlantic Coastal Plain (USEPA 84), because those ecoregions were largely omitted from the R1 and R3 projects.

Objective 2. Ecoregional C values. Assign ecoregional (*e*)C values for all species in New Jersey and New York using the knowledge already compiled at the state level (Ring 2016, Walz et al. 2018).

Objective 3. Make Data available through Regional Database and on the. Web. We a) post all eC values on the current Universal FQA Calculator and b) incorporate all C values into NatureServe's EcoObs database so that these FQA data can be integrated into vegetation data used for wetland condition assessments in the regions.

METHODOLOGY

STUDY AREA

Our study area encompassed the entire set of 10 ecoregions across EPA regions 1 (New England states) 2 (New York, New Jersey) and 3 (Mid-Atlantic states) (Fig. 1, Table 1). The projects in the Northeast and Mid-Atlantic left several ecoregions incomplete in New Jersey and New York (Fig. 2). Our goal was to fill in the gaps in ecoregion scores so that a seamless set of eC values were available across the Northeast and Mid-Atlantic.

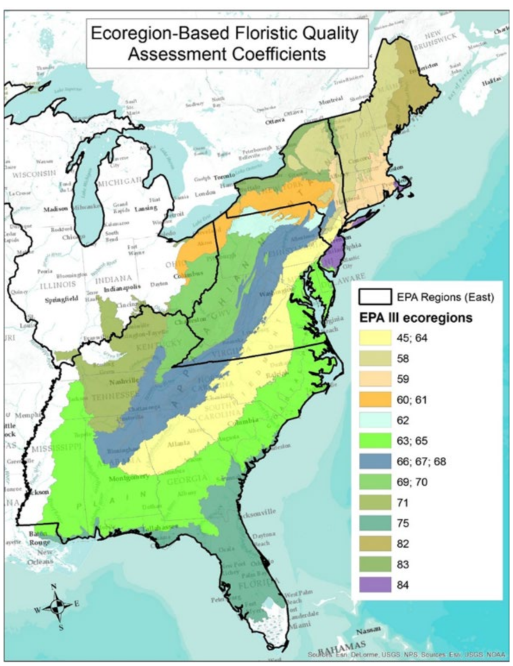

Figure 1. Map of ecoregion units used to develop ecoregion-based C-("eC") values across EPA R1 -R4 (Faber-Langendoen et al, 2019). Previous projects assigned eC values to species in ecoregions for EPA R1 (New England), R3 (Mid-Atlantic) and R4 (Southeast). Several Ecoregions in Region 2 (New York and New Jersey) were not completed (see Figure 4). Note that for Mid-Atlantic and Southeast, the ecoregion units

are comprised of one or more Omernik (EPA) Level III ecoregions (Omernik, 1987; Omernik and Griffith, 2014).

Table 1. List of the 10 ecoregions included in our study.

Ecoregion_Name	Ecoregion Code(s)
Acadian Plains & Hills	82
Northeastern Highlands	58
Northeastern Coastal Zone	59
Eastern Great Lakes Lowlands	83
Allegheny Plateau, Glaciated	60,61
Allegheny Plateau, Unglaciated	62,69,70
Ridge & Valley	66,67,68
Piedmont	45,64
Atlantic Coastal Pine Barrens	84
Coastal Plain	63,65

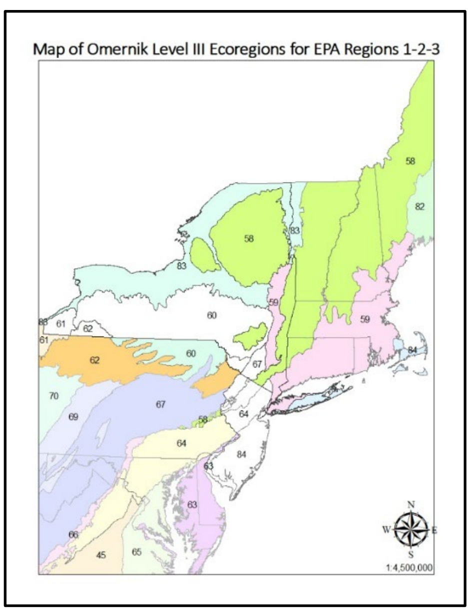

Figure 2. Map showing missing (blank) ecoregional FQA (eFQA) data for Region 2. Ecoregions follow Omernik Level III Ecoregions in USEPA Region 2 for NJ and NY. Omernik Ecoregion Codes and Names in Legend. (Woods et al, 2007; Bryce et al, 2010).

Thus, our work focused on two sets of ecoregions: ecoregion 84 (coastal plain), where NJ had not been included in the creation of eC values for 84 as part of the Northeast project; and ecoregions 60, 61, the glaciated Allegheny plateau (Fig. 2). Other ecoregions in those two states, (USEPA 58, 59, 61, 62 64, 67) covered such small portions of those states that the eC values were simply adopted from the other projects.

PRIOR ECOREGIONAL C VALUE STUDIES

Mid-Atlantic (R3)

Ecoregional C-values were published for the Mid-Atlantic region by Chamberlain and Ingram (2012). That project -the Mid-Atlantic Floristic Quality Assessment Project (MAR-FQA) - was undertaken in 2009. It did not work directly at the level of individual ecoregions; rather it grouped closely related ecoregions (“ecoregion cluster”) as shown in their publication (Fig. 3). A regional plant species list was created, following the USDA PLANTS database available at that time, with plants being assigned to each ecoregion cluster, largely based on their county level distribution information from USDA PLANTS. Ecoregional coefficients were assigned by an expert team of botanists representing four states (Maryland, Pennsylvania, Virginia, and West Virginia). The scale used is shown in Table 2 below.

Table 2. Guiding definitions for coefficients of conservatism, or C values, assigned to the Mid-Atlantic native flora.

CoC	Criteria
0 to 3	Plants with a broad range of ecological tolerances that are found in a variety of plant communities.
4 to 6	Plants with an intermediate range of ecological tolerances that are associated with a specific plant community.
7 to 8	Plants with a narrow range of ecological tolerances that are associated with advanced successional stage.
9 to 10	Plants with a high degree of fidelity to a narrow range of pristine habitats.

The Mid-Atlantic team did not assign values to non-native species unless the species was native to a portion of the region. In these cases, the value assigned was assumed to apply only to the native portion of the range. In most cases (>95%), a single number was given to an individual species across all ecoregion clusters. However, two or more numbers were assigned, where warranted to highlight ecoregion differences. According to Chamberlain and Ingram “Varieties and subspecies that did not diverge ecologically from the typical variety were given the same coefficient value and hybrids were not assigned a value unless they behaved as a true species.” The overall project identified 4208 unique plant species within the ecoregion, of which about two-thirds (67%) were native to all or part of the region. Coefficients of conservatism were assigned to 2822 native taxa in the region, with only 118 receiving multiple coefficient values based on differences in species behavior across ecoregions. C value of 10 = 386 spp., 9 = 289, 8 = 435, 7 = 481, 6 = 339, and 1-5 = 927 (total = 2794).

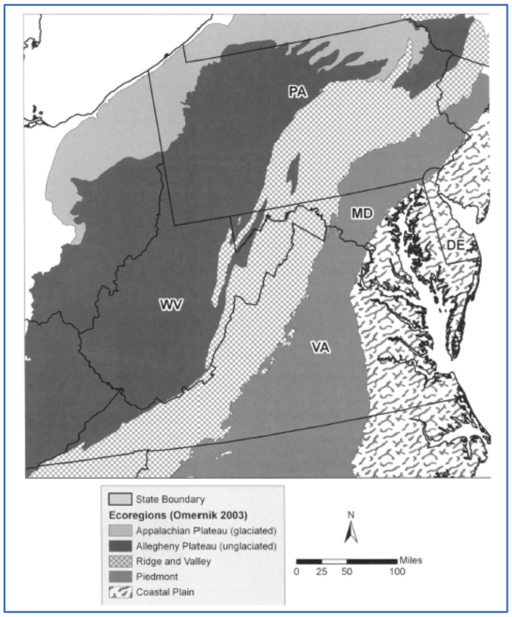

Figure 3. Map of the Mid-Atlantic region. Five groupings of EPA ecoregions (USEPA 2013) are shown: Coastal Plain (EPA 63, 65), Piedmont (EPA 45, 64), Ridge and Valley (EPA 67, 68) Allegheny Plateau - unglaciated (EPA 62, 69, 70) and Appalachian Plateau – glaciated (EPA 60, 61).

Northeast (R1)

Ecoregional C-values were published for the Northeast region by Faber-Langendoen et al. (2019). That project was undertaken in 2017. It worked directly at the level of individual ecoregions (Fig. 4), but because of funding limitations, only included ecoregions found in the six New England states. The evaluation extended across the entire ecoregion, including when it extended into New York; thus New York information was included for ecoregions 58, 59, 83, and 84. However funding did not permit consultation with New Jersey for ecoregion 84.

A regional plant species list was created, following the USDA PLANTS database available at that time, with plants being assigned to each ecoregion, largely based on their county level distribution information from USDA PLANTS (Fig 2). Ecoregional coefficients were assigned by an expert team of 5 botanists representing the 7 states. The scale used is shown in Table 3 below, which is similar, but not identical to the scale used for the Mid-Atlantic project (Table 2). For example, the Northeast project restricted the use of 0 to only exotic species. These differences are likely to only have a minor effect on assignment of the specific C values assigned from 0 to 10 across the two projects.

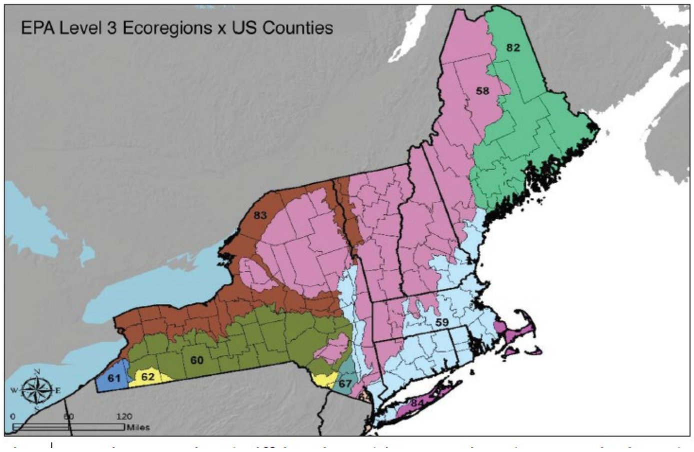

Figure 4. Level III ecoregions (Griffith et al. 2009) in EPA Region 1 (6 New England states). The map shows the full extent of the ecoregions in the US, except for Ecoregion 84, which extends into New Jersey's coastal plain. Also shown are the intersections of county borders with ecoregional boundaries. The large number of counties contained within one ecoregion made it feasible to use USDA PLANTS distribution to generate a first approximation of an ecoregional species list. Ecoregion names are: 58 = Northeastern Highlands; 59 = Northeastern Coastal Zone, 82 = Acadian Plains and Hills, 83 = Eastern Great Lakes Lowlands; and 84 = Atlantic Coastal Pine Barrens. Also shown are several ecoregions found in New York.

Table 3. Guiding definitions for coefficients of conservatism, or C values, assigned to the Northeast flora (Faber-Langendoen et al. 2019).

CoC	Criteria
0	Non-native with wide range of ecological tolerances. Often these are opportunistic of intact undisturbed habitats.
1 to 2	Native invasive or widespread native that is not typical of (or only marginally typical of) a particular plant community; tolerant of anthropogenic disturbance.
3 to 5	Native with an intermediate range of ecological tolerances and may typify a stable native community, but may also persist under some anthropogenic disturbance.
6 to 8	Native with a narrow range of ecological tolerances and typically associated with a stable community.
9 to 10	Native with a narrow range of ecological tolerances, high fidelity to particular habitat conditions, and sensitive to anthropogenic disturbance.

Because the starting point for the ecoregional C values in Region 1 was based on the available state C values, only in rare cases was a single number given to an individual species across all ecoregions (unlike the Mid-Atlantic project described above). As with the Mid-Atlantic project, varieties and subspecies that did not diverge ecologically from the typical variety were given the same coefficient value and hybrids were not assigned a value unless they behaved as a true species. The overall project identified 3411 unique plant species within the ecoregion, of which about 2343 (69%) were native to all or part of the region. Coefficients of conservatism were assigned to native taxa in the region. Whereas the mid-Atlantic region only had 118 taxa receiving multiple coefficient values based on differences in species behavior across ecoregions, the Northeast had 1524 (see Faber-Langendoen et al. 2019, Table 2). Of those 1524, 1493 had difference of 3 or less, leaving 31 with substantial differences among ecoregions.

ECOREGIONAL C VALUE EVALUATION PROCESS

Team

Our team consisted of two botanist/ecologists from the New Jersey Natural Heritage Program (Kathleen Walz NJ Natural Heritage Program Ecologist, Jason Hafstad, Regulatory Botanist, Endangered & Threatened Species Program, Watershed & Land Management), a botanist from the New York Natural Heritage Program (Rich Ring), a botanist from Pennsylvania Natural Heritage Program (Rachel Goad) and two NatureServe ecology and data management staff (Don Faber-Langendoen and Mary Harkness).

Evaluation Steps

Step 1. Compile a list of plant species from Northeast ecoregional, Mid-Atlantic ecoregional, NJ and NY state FQA lists. We standardized taxonomic nomenclature of all plant species across Omernik Ecoregions 58, 60, 61, 62, 63, 64, 67 and 84 in New Jersey and New York using USDA Plants Database. We focused our review on the glaciated Allegheny Plateau (USEPA 60, 61) and the Coastal Plain ecoregions (USEPA 84), where the eC values were most in need of review. We used county distribution to create the initial list of taxa by Level III ecoregion, since ecoregions encompass multiple counties (e.g., Fig. 2). County information was available through USDA PLANTS and was supplemented with county data from individual state floras where needed. Where counties straddle the ecoregion line, we added the species to both ecoregions. If a species was only reported from an ecoregion based on a county that straddled the line, we added a question mark to its ecoregion distribution. We added readily available information from PLANTS on nativity, growth form, and duration (annual, biennial, perennial). We also consulted available floras, such as the New England flora (*Flora Novae-Angliae*, Haines 2011), the recently revised catalogue of the vascular plants of New York (Werier 2017), and the state list of species from New Jersey (Walz et al., 2020) to help assess nativity and distribution.

Step 2. Compile Ecoregional Coefficient of Conservatism (eC) values for all taxa. We compiled the existing eC values for all species in each of the five ecoregions in Region 1 (Faber-Langendoen et al, 2019) and the four ecoregions in Region 3 databases (Chamberlain and Ingram 2012), based on the standardized USDA Plant taxonomy. We then added in any additional species from NJ and NY that were missing from the combined list. For the Allegheny Plateau glaciated region (60,61) we started with the eC values assigned by the Mid-Atlantic team, as they had simply extended the values from the Allegheny Plateau - unglaciated (EPA 62, 69, 70) into that region. Similarly, for the Atlantic Coastal Plain (84), we started with the values assigned by the Northeast project for the New England-New York part of that ecoregion.

Step 3. Assign Initial eC values, using automated methods. Ecoregional coefficient values were assigned to each taxon based on a scale of 0 to 10, following the definitions for C-values used for the

Northeast (Table 3, above). We first automated the process of establishing *e*C values for the two primary sets of ecoregions, using the state C values from New Jersey and New York. We used the following steps to automate the process:

We compiled all state-based C values from Walz et al. (2018) and Ring (2016) into our master database – EcoObs.

We calculate an *e*C value for each species, in each ecoregion in which it was reported, based on the average of the C values for each state, weighted by the percentage of the state's area found in the ecoregion. Using our work in Region 1, as an example, *Abies balsamea* occurs in Ecoregion 83, and in the two states, New York and Vermont, covered by the ecoregion. But in EPA ecoregion 83, NY contains 90.6% of the ecoregion and VT covers 9.4%. In NY, its state C value was 6, and in VT, its state C value was 3. The calculated *e*C value for ecoregion 83 is thus (.906 x 6) + (.094 X 3) = 5.72, which was rounded to 6. Expert review then lowered this rank to 5 (Fig. 5b).

w can be deleted)	Northeastern Highlands (58)											
- w can be deleted)	State-Assigned Coefficients						Ecoregional Coefficients - Summary and Final Values					
w can be deleted)	2%	5%	29%	16%	29%	17%						
Accepted Name	CT	MA	ME	NH	NY	VT	Wtd Avg CoC	Range (state CoC values)	Round Wtd CoC	Accept (Y/N)	Revised CoC	CoC Comment
Abies balsamea	8	7	3	3	6	3	4.2	5	4	Yes	4	

a)

Accepted Name	CoC_58	CoC_59	CoC_82	CoC_83	CoC_84	CoC Range
Abies balsamea	4	6	3	5		3

b)

Figure 5. Explanatory figures for generating automated ecoregional C values. Example is taken from Region 1 process (Faber-Langendoen et al. 2019) a) Calculation of an ecoregional score for Abies balsamea (balsam fir) in ecoergion 58, using the state C value and the proportion of a state found in the ecoregion. The initial calculation was then reviewed by the lead botanist for the ecoregion. If the rounded calculated score was rejected, a note was added. b) Summary of the ecoregional C values assigned to balsam fir in each of the ecoregions in which it occurs. The process is summarized for

Ecoegion 58 in Figure a, and the same process was used for the other ecoregions. The final column shows the ecoregional range of 3 (i.e., the lowest C value is 3 and the highest is 6).

For the NY part of ecoregion 62, and for the NY and NY parts of 58, 62, 64, and 67, all of which occur largely in other states and regions, we initially simply adopted the Mid-Atlantic or Northeast eC values that were brought into the database from those two projects. The net result was a comprehensive set of eC values across all 10 ecoregions.

Step 4. Hold cross-state regional meeting to review ecoregional C values. Team members from state Natural Heritage Program in NJ, NY, and PA worked together with NatureServe staff to review selected taxa where calculated scores suggest differences in eC values from the previously assigned eC values, where those existed. In addition, calculated eC values in the two primary ecoregions of concern did not always align with eC values in adjacent ecoregion. We prioritized our review as follows:

Our list initially contained 5559 taxa found across the 10 ecoregions. All non-native taxa in any given ecoregion were automatically assigned an *e*C value of 0 in any ecoregion in which they occurred (see Table 2 above). For the remaining initial list, we had a combination of native taxa x ecoregion for a total of 20,050 taxa/ecoregion combinations.

We examined all ecoregional differences for species with eC values of 3 or more. For example, as shown for our Northeast study, the spreadsheet showed preliminary *e*C values for *Abies balsamea* (balsam fir) had a preliminary ecoregional range of 3 (Fig. 5b above), whereas *Acer saccharinum* (silver maple) and *Acer saccharum* (sugar maple) (not shown) both had an ecoregional range of 1. Thus, we examined the *e*C values for *Abies balsamea* in our meetings but not for silver or sugar maple. We did not attempt to reconcile the range in eC values for differences of 1 or 2 (together species), as this was too demanding an effort, with little added value.

We conducted expert review for all species to see if there was an ecoregional basis for the distinction. For example, if the differences in *e*C values between ecoregions could be explained based on differences in species behavior to anthropogenic disturbances (i.e. more tolerant in one ecoregion, less so in another), then distinct *eC value*s were retained. Otherwise, we revised the *e*C values to be more consistent across ecoregions. For example, expert review supported the different ecoregional scores for *Abies balsamea*, as it occurs more commonly in both disturbed areas and undisturbed natural areas in more northern ecoregions, and was more restricted to undisturbed natural areas in ecoregion Northeastern Coastal Zone (59) (Fig. 5b). All expert-based *e*C values were added back into the database.

We minimized the use of subspecies and varieties. Applying FQA requires good botanical knowledge, and the need for this expertise can limit its application (DeBerry et al. 2015). This challenge increases when subspecies or varieties of a species have distinct C or *e*C values. We retained subspecies in our taxa list whenever they had *e*C values greater than 2. But this adds an additional taxonomic burden to the user, and we have added a species-based *e*C value for all species with differing subspecies or variety *e*C values, by taking the lower of the two values, except in the case of the native versus nonnative subspecies or variety, where we took the average. For example, high bush cranberry, which is treated as a single species in USDA PLANTS and in *Flora Novae*-angliae (*Viburnum opulus)*, contains a native subspecies *(Viburnum opulus* ssp. *trilobum*) and a European subspecies (*Viburnum opulus* ssp. *opulus*). The native subspecies has *e*C values that range from 3 (ecoregion 84) to 4 (ecoregions 58, 59, 83), whereas the nonnative subspecies has an *e*C value of 0 wherever it occurs.

The Mid-Atlantic project published the eC values in 2012. We were not tasked to work with them to produce an updated Mid-Atlantic product, so we did not change any eC values in their four major ecoregions. However, because NatureServe produced the Northeast project and has access to the Region 1 eC values, we did occasionally modify the 2019 published values. We will publish a revised set of Region 1 eC values to reflect the input from this Region 2 project (See Results and Discussion below).

Step 5. Publish all eC values on universalFQA.org. We transfer all of our results to universalFQA.org. We also manage all eC values in NatureServe's EcoObs database.

RESULTS AND DISCUSSION

REGIONAL FQA SPECIES LIST

We compiled 5559 taxa across all 10 ecoregions in EPA R1 – R3, including 4794 species, 73 hybrids, 192 subspecies and 540 varieties. By ecoregion, the number of native taxa varied from 1279 taxa in the Acadian Plains and Hills (82) to 2285 in the Northeastern Highlands (58). Across all ecoregions, 19% of the taxa had eC values of 0 (i.e., exotics), 7% of 1-2, 25% of 3-5, 36% of 6-8, and 13% of 9-10.

ECOREGIONAL C VALUES

There was minimal variation in the percentage of natives with a narrow range of ecological tolerances (i.e., C values of 9-10), with the majority (7 ecoregions) having 16-21%, though two (Acadian Plains and Hills, Northeastern Highlands) had 11-13%, and Atlantic Coastal Plain (84) had 4%. (Table 4).

Table 4. Range in Ecoregional C values across all 10 ecoregions.

Ecoregional C Value	Count of Taxa	Percentage of Taxa
0	4854	19%
1	614	2%
2	1211	5%
3	1434	6%
4	2002	8%
5	2641	11%
6	2946	12%
7	3074	12%
8	2877	12%
9	1597	6%
10	1654	7%
	24904	100%

When assessing maximal ecoregional differences for a taxa across all the ecoregions where it was reported and evaluated, we excluded differences caused by a taxon being exotic in one ecoregion and native in the other, as these can be difficult judgement calls. Thus, our comparison was restricted to 4940 taxa. Of the 4940 taxa evaluated, none had eC values with a maximal difference of 9, whereas 137

(2.8%) species varied by 5-8 (2.8%), another 630 (12.8%) varied by 3 or 4, and 4173 (84.5) % varied by 0, 1, or 2 (Table 5).

Table 5. Maximal Difference in Ecoregional C values for each species.

Maximal Difference in Ecoregional C Values	# of Taxa	Percentage of Taxa
	1059	21.4%
0	1828	37.0%
1	608	12.3%
2	678	13.7%
3	396	8.0%
4	234	4.7%
5	83	1.7%
6	32	0.6%
7	10	0.2%
8	12	0.2%
9	0	0.0%
	4940	100.0%

A summary of all species with maximal ecoregional differences of 5 or more is provided in Table 6, sorted alphabetically by taxon name (Table 6a) and in descending order by maximum ecoregional difference (Table 6b).

Table 6a. Taxa with maximal ecoregional differences (CoC range) of 5 or more, sorted alphabetically by taxon scientific name.

USDA Accepted Symbol	Accepted Name	Acadian Plains & Hlils (82) CoC	Northeast Highlands (58) CoC	Northeast Coastal (59) CoC	Eastern Great Lakes (83) CoC	Atlantic Coastal Pine Barrens (84) CoC	Allegheny Plateau, Glaciated (60,61) CoC	Allegheny Plateau, UNglaciated (62,69,70) CoC	Ridge & Valley (66,67,68) CoC	Piedmont (45, 64) CoC	Mid-Atlantic Coastal Plain (63,65) CoC	Min Ecoregional CoC	Max Ecoregional CoC	CoC Range
ABBA	Abies balsamea	3	4	6	5		9	9	9	9		3	9	6
ACVI	Acalypha virginica		7	6	8	3	3	3	3	3	3	3	8	5
AGMI2	Agrimonia macrocarpa		3	3			8	8	8	8	8	3	8	5
AGPA12	Agalinis paupercula	4	5	5	6	6	10	10	10	10	10	4	10	6
AMNA2	Amelanchier nantucketensis	4	7	7		8				10		4	10	6
ANAT	Angelica atropurpurea	4	4	4	5	6	7	7	7	7	9	4	9	5
CAAT2	Carex atherodes	3			3		5	5	9			3	9	6
CABI3	Carex bicknellii		5	5	5			8		10		5	10	5
CACA15	Carex caroliniana		10		10	7	6	5	5	5	5	5	10	5
CACO14	Carex conoidea	4	3	4	3	2	4	4	8	8	8	2	8	6
CACR4	Carex crawfordii	2	3	4	4	7						2	7	5
CACU3	Carex cumulata	3	5	4	6	5	6	8	8			3	8	5
CADE9	Carex deweyana	5	5	6	5		8	10	10			5	10	5
CADI6	Carex disperma	5	7	7	8	8	10	10	10			5	10	5
CAEC	Carex echinata	3	5	6	6	8	8	8	8	8	8	3	8	5
CAFL4	Carex flava	4	4	5	4		8		10			4	10	6
CAHA7	Carex haydenii	4	5	6	7				9	9		4	9	5
CALA16	Carex lacustris	4	5	5	5	8	6	9	9	9	9	4	9	5
CALU17	Carex lucorum	3	5	6	6	6	6	8	8	8	8	3	8	5
CAPS	Carex pseudocyperus	5	6	6	6	6			10			5	10	5
CASI6	Carex silicea	5	8	8	8	8					10	5	10	5
CATE3	Carex tenera	2	2	4	2	2	9	9	9	9		2	9	7
CATR10	Carex trisperma	5	6	6	7	7	10	10	10	10	10	5	10	5
CAWI7	Carex wiegandii	5	8	9				10				5	10	5
CETR	Cenchrus tribuloides	8	8	7	7	4	0	1		1	1	1	8	7

CHBE4	Chenopodium berlandieri	2	5	5	8	8	0	0	0	0	0	2	8	6
CLBO3	Clintonia borealis	5	5	7	7	7	8	10	10	10		5	10	5
COFL3	Corydalis flavula		7	8	7	6	5	3	3	3	3	3	8	5
CORA6	Cornus racemosa	4	3	3	2	2	5	5	5	5	8	2	8	6
COVE2	Collinsia verna		10		10		7	5	5			5	10	5
CRCA	Crataegus calpodendron		2		2		7	7	7	7		2	7	5
CRUN	Crataegus uniflora		2		2	5		7	7	7	7	2	7	5
CRVI2	Crataegus viridis									9	4	4	9	5
CUCE	Cuscuta cephalanthi		6	5	10	6	9	9	9	9	9	5	10	5
CUCO3	Cuscuta coryli		7	7	7	7	5	5	5	10	5	5	10	5
CUPE3	Cuscuta pentagona		8	6	7	7	3	3	3	3	3	3	8	5
CYEC2	Cyperus echinatus		8	0		3	6	4	4	4	4	3	8	5
CYFL	Cyperus flavescens		10	0	10	5	4	3	3	3	3	3	10	7
CYOD	Cyperus engelmannii		9	9	9	3						3	9	6
CYSQ	Cyperus squarrosus	4	4	4	3	2		6	6	1	1	1	6	5
DENU5	Desmodium nuttallii		10		10		7	5	5	5	5	5	10	5
DIBO	Dichanthelium boreale	3	4	5	4	5	5	8	8	8	8	3	8	5
DIFI	Digitaria filiformis		7	5	9	5	4	1	1	1	1	1	9	8
DISPI	Dichanthelium sphaerocarpon var. isophyllum		10	10	10	7	6	5	5		5	5	10	5
DIVI5	Diospyros virginiana		8	9	8	6		4	4	4	4	4	9	5
DRRO	Drosera rotundifolia	4	5	7	6	7	10	10	10	9	9	4	10	6
ELEL4	Eleocharis elliptica	4	4	4	5	4	7		10	10		4	10	6
ELGL3	Elymus glabriflorus		10	6	10	10		2	2	2		2	10	8
ELTU	Eleocharis tuberculosa		9	8		8				9	3	3	9	6
EPLE2	Epilobium leptophyllum	4	5	6	6	6	7	9	9	9	9	4	9	5
EPPA	Epilobium palustre	5	5	6	7	7			10			5	10	5
EPST	Epilobium strictum	5	5	6	7	7	8	10	10	10		5	10	5
ERHY	Eragrostis hypnoides		4	5	3	4	4	4	4	4	8	3	8	5
ERPU	Erigeron pulchellus	2	3	3	3	4	7	7	7	7	7	2	7	5
EUAL2	Eupatorium album		10	10	10	4		5	5	5	5	4	10	6
EUHYH	Eupatorium hyssopifolium var. hyssopifolium		10	10	10	2						2	10	8

FUPU	Fuirena pumila		9	9		6					4	4	9	5
FUSQ	Fuirena squarrosa		10		10	7					3	3	10	7
GARE2	Galactia regularis		10		10	5	8	8	8	8	4	4	10	6
GATR2	Galium trifidum	4	5	6	6	9	8	8	8			4	9	5
GEAL3	Geum aleppicum	3	4	4	3	3	9	9	9	9	9	3	9	6
GECR2	Gentianopsis crinita	4	5	5	5	8	8	10	10	10	10	4	10	6
GELI3	Gentiana linearis	6	5		5	6	7	10	10			5	10	5
HEBI2	Helianthemum bicknellii	4	5	5	7	8				10		4	10	6
HYMA2	Hypericum majus	4	4	5	5	5				10	10	4	10	6
HYRA	Hydrocotyle ranunculoides		10		10				7	5	5	5	10	5
HYUM	Hydrocotyle umbellata		8	8		7		6		6	3	3	8	5
IOLI2	Ionactis linariifolius	4	5	4	7	5		9	9	9	9	4	9	5
IPPA	Ipomoea pandurata		10	0	10	4	7	4	4	4	4	4	10	6
JUCO6	Juniperus communis	3	3	4	4	6	7	8	8	8	8	3	8	5
JUGE	Juncus gerardii	6		7	7	8	0	3	3	3	3	3	8	5
JUNO2	Juncus nodosus	6	5	6	4	4	4	4	4	4	9	4	9	5
JUSC	Juncus scirpoides		10	10	10	7		5	6	6	4	4	10	6
LAHI	Lactuca hirsuta	3	4	5	5	8	5	5	5	5	5	3	8	5
LALA	Larix laricina	4	5	7	5	6	10	10	10			4	10	6
LEFUF	Leptochloa fusca ssp. fascicularis		6	9	6	8	1	1	1	1	1	1	9	8
LEIN	Lechea intermedia	3	4	4	4	4	6	8	8	8	8	3	8	5
LEMO8	Leymus mollis	6	5	8		10						5	10	5
LILI3	Liparis liliifolia		7	7	7	10	7	5	5	5	5	5	10	5
LIME2	Linum medium	3	4	5	4	4		10	10	10	10	3	10	7
LIST2	Liquidambar styraciflua			6	6	6		5	1	1	1	1	6	5
LISU4	Linum sulcatum		5	7	5		5	10	10	10	10	5	10	5
LUSP	Ludwigia sphaerocarpa		9	9	9	9					4	4	9	5
LYAL4	Lythrum alatum		4	6	3	7	9	9	9	9	9	3	9	6
LYIN2	Lycopodiella inundata	4	5	6	6	6	8	9	9	9	9	4	9	5
LYSA	Lycopodium sabinifolium	4	5		6		10	10	10			4	10	6
MACA4	Maianthemum canadense	3	3	4	4	4	5	8	8	8	8	3	8	5
MOME	Monarda media		1	2	1		5	6	6	6	6	1	6	5

NELU	Nelumbo lutea		10	0	10	10	0	5	5	5	5	5	10	5
OLUN	Oldenlandia uniflora		10		10	7					5	5	10	5
PAAN	Panicum anceps		10		10	4	0	4	4	4	4	4	10	6
PALA10	Paspalum laeve		10	8	10	4	0	3	3	3	3	3	10	7
PIRE	Pinus resinosa	5	5	6	7				10			5	10	5
PIRU	Picea rubens	4	5	6	5	6	9	9	9	9		4	9	5
POBU2	Polygonum buxiforme	7	4	5	1	5	0	0		0	0	1	7	6
POCA8	Polygonum careyi	2	3	3	4	4		8	8			2	8	6
POCH2	Poa chapmaniana	0	0	0	0		7	7	7	2	2	2	7	5
PODO3	Polanisia dodecandra		7	7	7	6	3	1	1	1	1	1	7	6
POER2	Polygonum erectum	2	4	5	8	6	1	0	0	0	0	1	8	7
POFR3	Potamogeton friesii	5	8	9	9	9	10	10	10			5	10	5
POMA8	Polygala mariana		10		10	5				5	5	5	10	5
POPUT3	Potamogeton pusillus ssp. tenuissimus			2	2	4	7	7				2	7	5
PORA3	Polygonum ramosissimum	5	4	6	1	6	0	0		0	0	1	6	5
POVA5	Polemonium vanbruntiae	5	6		7		10	10	10	10		5	10	5
RAFL2	Ranunculus flammula	5	6	6	7		8	10	10	10	10	5	10	5
RHCA6	Rhododendron canadense	5	6	7	8	8	10	10	10			5	10	5
RHKN	Rhynchospora knieskernii					5					10	5	10	5
RHMA	Rhexia mariana		10		10	7	0	5	5	5	5	5	10	5
ROBL	Rosa blanda	5	4	4	3	5	9	9	9	9	9	3	9	6
RORA	Rotala ramosior		9	9		3	6	2	2	2	2	2	9	7
RUAL4	Rumex altissimus	0	7	6	10	9	2	2	2	2	2	2	10	8
RUHA2	Rumex hastatulus		9	9	9	9				1	1	1	10	8
RUOR2	Rumex orbiculatus	5	6	4	7	4	10	10	10	10	10	4	10	6
RUSE	Rubus setosus	3	3	3	3	2	8	8	8	8	8	2	8	6
SAAM2	Salix amygdaloides		3		3	0	8	8	8			3	8	5
SAAN	Sabatia angularis		6	0	6	4	3	1	1	1	1	1	6	5
SABE2	Salix bebbiana	3	3	3	3	3	5	8	8	8	8	3	8	5
SALY2	Salvia lyrata		10	3	10	4	0	2	2	2	2	2	10	8
SCAT4	Scirpus atrocinctus	3	4	5	5		9	9	9			3	9	6
SCGA	Scutellaria galericulata	4	5	5	6	5	6	9	9	9	9	4	9	5

SCIN2	Scutellaria integrifolia		10	10	10	5	7	5	5	5	5	5	10	5
SCMI2	Scirpus microcarpus	4	4	5	6	5	6	9	9	9	9	4	9	5
SEMA3	Sesuvium maritimum		10		10	10					4	4	10	6
SIAL3	Sisyrinchium albidum		10		10		7	5	5	5	5	5	10	5
SIAT	Sisyrinchium atlanticum	3	3	3	2	5		7	7	7	7	2	7	5
SPRO	Spiranthes romanzoffiana	5	6	8	8				10			5	10	5
STUM2	Strophostyles umbellata		10	10	10	3		2	2	2	2	2	10	8
SYER	Symphyotrichum ericoides	3	2	3	1	3	1	9	9	9	9	1	9	8
SYPH3	Symphyotrichum phlogifolium		1	1	1	4	8	8	8	8	8	1	8	7
THOC2	Thuja occidentalis	3	5	8	5	7	8	10	10	10		3	10	7
TORY	Toxicodendron rydbergii	5	4	3	4			8	8			3	8	5
VACH	Valerianella chenopodiifolia		10		10		6	2	2	2	2	2	10	8
VAMA	Vaccinium macrocarpon	5	6	6	7	7	9	10	10	10	9	5	10	5
VARA	Valerianella radiata		9	8		1	2	2		2	2	1	9	8
VESI	Verbena simplex		9	8	9	4	5	5	5	5	5	4	9	5
VIBI	Viola bicolor			9	9	1	5	1	1	1	1	1	9	8
VIMA2	Viola macloskeyi	3	4	5	4	8						3	8	5

Table 6b. Taxa with maximal ecoregional differences (CoC Range) of 5 or more, sorted by descending maximal difference.

USDA Accepted Symbol	Accepted Name	Acadian Plains & Hills (82) CoC	Northeast Highlands (58) CoC	Northeast Coastal (59) CoC	Eastern Great Lakes (83) CoC	Atlantic Coastal Pine Barrens (84) CoC	Allegheny Plateau, Glaciated (60,61) CoC	Allegheny Plateau, UNglaciated (62,69,70) CoC	Ridge & Valley (66,67,68) CoC	Piedmont (45, 64) CoC	Mid-Atlantic Coastal Plain (63,65) CoC	Min Ecoregional CoC	Max Ecoregional CoC	CoC Range
DIFI	Digitaria filiformis		7	5	9	5	4	1	1	1	1	1	9	8
ELGL3	Elymus glabriflorus		10	6	10	10		2	2	2		2	10	8
EUHYH	Eupatorium hyssopifolium var. hyssopifolium		10	10	10	2						2	10	8
LEFUF	Leptochloa fusca ssp. fascicularis		6	9	6	8	1	1	1	1	1	1	9	8
RUAL4	Rumex altissimus	0	7	6	10	9	2	2	2	2	2	2	10	8
RUHA2	Rumex hastatulus		9	9	9	9				1	1	1	10	8
SALY2	Salvia lyrata		10	3	10	4	0	2	2	2	2	2	10	8
STUM2	Strophostyles umbellata		10	10	10	3		2	2	2	2	2	10	8
SYER	Symphyotrichum ericoides	3	2	3	1	3	1	9	9	9	9	1	9	8
VACH	Valerianella chenopodiifolia		10		10		6	2	2	2	2	2	10	8
VARA	Valerianella radiata		9	8		1	2	2		2	2	1	9	8
VIBI	Viola bicolor			9	9	1	5	1	1	1	1	1	9	8
CATE3	Carex tenera	2	2	4	2	2	9	9	9	9		2	9	7
CETR	Cenchrus tribuloides	8	8	7	7	4	0	1		1	1	1	8	7
CYFL	Cyperus flavescens		10	0	10	5	4	3	3	3	3	3	10	7
FUSQ	Fuirena squarrosa		10		10	7					3	3	10	7
LIME2	Linum medium	3	4	5	4	4		10	10	10	10	3	10	7
PALA10	Paspalum laeve		10	8	10	4	0	3	3	3	3	3	10	7
POER2	Polygonum erectum	2	4	5	8	6	1	0	0	0	0	1	8	7
RORA	Rotala ramosior		9	9		3	6	2	2	2	2	2	9	7
SYPH3	Symphyotrichum phlogifolium		1	1	1	4	8	8	8	8	8	1	8	7
THOC2	Thuja occidentalis	3	5	8	5	7	8	10	10	10		3	10	7
ABBA	Abies balsamea	3	4	6	5		9	9	9	9		3	9	6
AGPA12	Agalinis paupercula	4	5	5	6	6	10	10	10	10	10	4	10	6
AMNA2	Amelanchier nantucketensis	4	7	7		8				10		4	10	6
CAAT2	Carex atherodes	3			3		5	5	9			3	9	6
CACO14	Carex conoidea	4	3	4	3	2	4	4	8	8	8	2	8	6
CAFL4	Carex flava	4	4	5	4		8		10			4	10	6

CHBE4	Chenopodium berlandieri	2	5	5	8	8	0	0	0	0	0	2	8	6
CORA6	Cornus racemosa	4	3	3	2	2	5	5	5	5	8	2	8	6
CYOD	Cyperus engelmannii		9	9	9	3						3	9	6
DRRO	Drosera rotundifolia	4	5	7	6	7	10	10	10	9	9	4	10	6
ELEL4	Eleocharis elliptica	4	4	4	5	4	7		10	10		4	10	6
ELTU	Eleocharis tuberculosa		9	8		8				9	3	3	9	6
EUAL2	Eupatorium album		10	10	10	4		5	5	5	5	4	10	6
GARE2	Galactia regularis		10		10	5	8	8	8	8	4	4	10	6
GEAL3	Geum aleppicum	3	4	4	3	3	9	9	9	9	9	3	9	6
GECR2	Gentianopsis crinita	4	5	5	5	8	8	10	10	10	10	4	10	6
HEBI2	Helianthemum bicknellii	4	5	5	7	8				10		4	10	6
HYMA2	Hypericum majus	4	4	5	5	5				10	10	4	10	6
IPPA	Ipomoea pandurata		10	0	10	4	7	4	4	4	4	4	10	6
JUSC	Juncus scirpoides		10	10	10	7		5	6	6	4	4	10	6
LALA	Larix laricina	4	5	7	5	6	10	10	10			4	10	6
LYAL4	Lythrum alatum		4	6	3	7	9	9	9	9	9	3	9	6
LYSA	Lycopodium sabinifolium	4	5		6		10	10	10			4	10	6
PAAN	Panicum anceps		10		10	4	0	4	4	4	4	4	10	6
POBU2	Polygonum buxiforme	7	4	5	1	5	0	0		0	0	1	7	6
POCA8	Polygonum careyi	2	3	3	4	4		8	8			2	8	6
PODO3	Polanisia dodecandra		7	7	7	6	3	1	1	1	1	1	7	6
ROBL	Rosa blanda	5	4	4	3	5	9	9	9	9	9	3	9	6
RUOR2	Rumex orbiculatus	5	6	4	7	4	10	10	10	10	10	4	10	6
RUSE	Rubus setosus	3	3	3	3	2	8	8	8	8	8	2	8	6
SCAT4	Scirpus atrocinctus	3	4	5	5		9	9	9			3	9	6
SEMA3	Sesuvium maritimum		10		10	10					4	4	10	6
ACVI	Acalypha virginica		7	6	8	3	3	3	3	3	3	3	8	5
AGMI2	Agrimonia microcarpa		3	3			8	8	8	8	8	3	8	5
ANAT	Angelica atropurpurea	4	4	4	5	6	7	7	7	7	9	4	9	5
CABI3	Carex bicknellii		5	5	5			8		10		5	10	5
CACA15	Carex caroliniana		10		10	7	6	5	5	5	5	5	10	5
CACR4	Carex crawfordii	2	3	4	4	7						2	7	5
CACU3	Carex cumulata	3	5	4	6	5	6	8	8			3	8	5
CADE9	Carex deweyana	5	5	6	5		8	10	10			5	10	5
CADI6	Carex disperma	5	7	7	8	8	10	10	10			5	10	5
CAEC	Carex echinata	3	5	6	6	8	8	8	8	8	8	3	8	5
CAHA7	Carex haydenii	4	5	6	7				9	9		4	9	5
CALA16	Carex lacustris	4	5	5	5	8	6	9	9	9	9	4	9	5
CALU17	Carex lucorum	3	5	6	6	6	6	8	8	8	8	3	8	5
CAPS	Carex pseudocyperus	5	6	6	6	6			10			5	10	5

CASI6	Carex silicea	5	8	8	8	8					10	5	10	5
CATR10	Carex trisperma	5	6	6	7	7	10	10	10	10	10	5	10	5
CAWI7	Carex wiegandii	5	8	9				10				5	10	5
CLBO3	Clintonia borealis	5	5	7	7	7	8	10	10	10		5	10	5
COFL3	Corydalis flavula		7	8	7	6	5	3	3	3	3	3	8	5
COVE2	Collinsia verna		10		10		7	5	5			5	10	5
CRCA	Crataegus calpodendron		2		2		7	7	7	7		2	7	5
CRUN	Crataegus uniflora		2		2	5		7	7	7	7	2	7	5
CRVI2	Crataegus viridis									9	4	4	9	5
CUCE	Cuscuta cephalanthi		6	5	10	6	9	9	9	9	9	5	10	5
CUCO3	Cuscuta coryli		7	7	7	7	5	5	5	10	5	5	10	5
CUPE3	Cuscuta pentagona		8	6	7	7	3	3	3	3	3	3	8	5
CYEC2	Cyperus echinatus		8	0		3	6	4	4	4	4	3	8	5
CYSQ	Cyperus squarrosus	4	4	4	3	2		6	6	1	1	1	6	5
DENU5	Desmodium nuttallii		10		10		7	5	5	5	5	5	10	5
DIBO	Dichanthelium boreale	3	4	5	4	5	5	8	8	8	8	3	8	5
DISPI	Dichanthelium sphaerocarpon var. isophyllum		10	10	10	7	6	5	5		5	5	10	5
DIVI5	Diospyros virginiana		8	9	8	6		4	4	4	4	4	9	5
EPLE2	Epilobium leptophyllum	4	5	6	6	6	7	9	9	9	9	4	9	5
EPPA	Epilobium palustre	5	5	6	7	7			10			5	10	5
EPST	Epilobium strictum	5	5	6	7	7	8	10	10	10		5	10	5
ERHY	Eragrostis hypnoides		4	5	3	4	4	4	4	4	8	3	8	5
ERPU	Erigeron pulchellus	2	3	3	3	4	7	7	7	7	7	2	7	5
FUPU	Fuirena pumila		9	9		6					4	4	9	5
GATR2	Galium trifidum	4	5	6	6	9	8	8	8			4	9	5
GELI3	Gentiana linearis	6	5		5	6	7	10	10			5	10	5
HYRA	Hydrocotyle ranunculoides		10		10				7	5	5	5	10	5
HYUM	Hydrocotyle umbellata		8	8		7		6		6	3	3	8	5
IOLI2	Ionactis linariifolius	4	5	4	7	5		9	9	9	9	4	9	5
JUCO6	Juniperus communis	3	3	4	4	6	7	8	8	8	8	3	8	5
JUGE	Juncus gerardii	6		7	7	8	0	3	3	3	3	3	8	5
JUNO2	Juncus nodosus	6	5	6	4	4	4	4	4	4	9	4	9	5
LAHI	Lactuca hirsuta	3	4	5	5	8	5	5	5	5	5	3	8	5
LEIN	Lechea intermedia	3	4	4	4	4	6	8	8	8	8	3	8	5
LEMO8	Leymus mollis	6	5	8		10						5	10	5
LILI3	Liparis liliifolia		7	7	7	10	7	5	5	5	5	5	10	5
LIST2	Liquidambar styraciflua			6	6	6		5	1	1	1	1	6	5
LISU4	Linum sulcatum		5	7	5		5	10	10	10	10	5	10	5
LUSP	Ludwigia sphaerocarpa		9	9	9	9					4	4	9	5

LYIN2	Lycopodiella inundata	4	5	6	6	6	8	9	9	9	9	4	9	5
MACA4	Maianthemum canadense	3	3	4	4	4	5	8	8	8	8	3	8	5
MOME	Monarda media		1	2	1		5	6	6	6	6	1	6	5
NELU	Nelumbo lutea		10	0	10	10	0	5	5	5	5	5	10	5
OLUN	Oldenlandia uniflora		10		10	7					5	5	10	5
PIRE	Pinus resinosa	5	5	6	7				10			5	10	5
PIRU	Picea rubens	4	5	6	5	6	9	9	9	9		4	9	5
POCH2	Poa chapmaniana	0	0	0	0		7	7	7	2	2	2	7	5
POFR3	Potamogeton friesii	5	8	9	9	9	10	10	10			5	10	5
POMA8	Polygala mariana		10		10	5				5	5	5	10	5
POPUT3	Potamogeton pusillus ssp. tenuissimus			2	2	4	7	7				2	7	5
PORA3	Polygonum ramosissimum	5	4	6	1	6	0	0		0	0	1	6	5
POVA5	Polemonium vanbruntiae	5	6		7		10	10	10	10		5	10	5
RAFL2	Ranunculus flammula	5	6	6	7		8	10	10	10	10	5	10	5
RHCA6	Rhododendron canadense	5	6	7	8	8	10	10	10			5	10	5
RHKN	Rhynchospora knieskernii					5					10	5	10	5
RHMA	Rhexia mariana		10		10	7	0	5	5	5	5	5	10	5
SAAM2	Salix amygdaloides		3		3	0	8	8	8			3	8	5
SAAN	Sabatia angularis		6	0	6	4	3	1	1	1	1	1	6	5
SABE2	Salix bebbiana	3	3	3	3	3	5	8	8	8	8	3	8	5
SCGA	Scutellaria galericulata	4	5	5	6	5	6	9	9	9	9	4	9	5
SCIN2	Scutellaria integrifolia		10	10	10	5	7	5	5	5	5	5	10	5
SCMI2	Scirpus microcarpus	4	4	5	6	5	6	9	9	9	9	4	9	5
SIAL3	Sisyrinchium albidum		10		10		7	5	5	5	5	5	10	5
SIAT	Sisyrinchium atlanticum	3	3	3	2	5		7	7	7	7	2	7	5
SPRO	Spiranthes romanzoffiana	5	6	8	8				10			5	10	5
TORY	Toxicodendron rydbergii	5	4	3	4			8	8			3	8	5
VAMA	Vaccinium macrocarpon	5	6	6	7	7	9	10	10	10	9	5	10	5
VESI	Verbena simplex		9	8	9	4	5	5	5	5	5	4	9	5
VIMA2	Viola macloskeyi	3	4	5	4	8						3	8	5

These tables highlight important variation in species behavior across the ecoregions. For example, *Abies balsamea* (balsam fir), which already showed an increasingly conservation C value north to south in Region 1, continues to increase in conservatism in the Mid-Atlantic region, where it received C values of 9 and 10. A similar pattern is shown for *Symphotrichum ericoides* (heath-American aster), which had a maximum ecoregional difference of 8, with an eC value of 1 in the eastern Great Lakes (83) and 2 or 3 in other northeastern regions, whereas it had eC values of 9 in Mid-Atlantic ecoregions). Similarly, *Thuja occidentalis* (Northern white cedar) had a maximum ecoregional difference of 7, eC values of 3 in the Acadian Plains and Hills and 5 in the Northeaster Highlands (58), whereas it had 10 in Mid-Atlantic ecoregions. These differences represent important ecological shifts in species behavior, and valuable for improving FQA metrics.

IMPACT OF OUR WORK ON PREVIOUS PRODUCTS

The previous studies in Region 1 (Faber-Langendoen et al. 2019) and Region 3 (Chamberlain and Ingram) did not include the full range of the ecoregions found in their Region. Thus, it's not surprising that some of their eC values needed adjustments. The majority of changes occurred in the two ecoregions that were the focus of our work, the Atlantic Coastal Pine Barrens (84) and Allegheny Plateau, Glaciated (60,61) (Table 7). Although we suggest changes to Allegheny Plateau, Unglaciated and Ridge & Valley, we did not make these changes yet, as any changes need to be coordinated with team leaders from that region.

Table 7. Changes to existing ecoregional C values from Region 1 (Faber-Langendoen et al. 2019) and Region 3 (Chamberlain and Ingram).

Ecoregion	Ecoregion Code(s)	# of Taxa Updated or Proposed Updated
Atlantic Coastal Pine Barrens	84	155
Allegheny Plateau, Glaciated	60,61	194
Allegheny Plateau, Unglaciated	62,69,70	8
Ridge & Valley	66,67,68	3
Eastern Great Lakes Lowlands	83	13
Northeastern Highlands	58	9
Northeastern Coastal Zone	59	7
Acadian Plains & Hills	82	2

CONCLUSION

Despite the challenges of developing species list at the ecoregional level, assessment of C values at this level, point to important and substantial differences in a small subset of species across the ecoregions. Thus some 15% of the flora have maximal differences in C values of 3 or more, though only 3% have a differences of 5 or more. More review is needed to substantiate these patterns.

Although we focused on species level C values, as that is the most practical level for field biologists, but eventually we also retained 73 hybrids, 192 subspecies and 540 varieties in our total of 5559 taxa.

These taxa had sufficient differences from species level to warrant their inclusion, though in some cases, the subspecies or variety retained is the only one in the region, so this is still an overcount of the need to retain these infra-specific taxa when applying FQA metrics.

The upgraded eC values are posted on the Universal FQA Calculator. Both the website and the database now contain the full set of ecoregional spreadsheets across the 3 regions developed for this project. Together these improvements provide a scientifically defensible and publicly accessible ecoregionally-based FQA method across the northeastern USA.

The completion of this product expands the opportunity for developing regional wetland reference datasets that can serve as benchmark sites for multiple projects across the East, including restoration and mitigation evaluations and statewide wetland assessments (Brooks et al. 2016). As an example, the eFQA tool will be integrated into recommended monitoring protocols for wetland mitigation site evaluations in the NJDEP Mitigation Technical Manual. These efforts will be further enhanced by consistent regional and national classification systems, such as the U.S. National Vegetation Classification and the National Wetland Inventory, that allow wetland ecologists to standardize the use of FQA metrics by wetland types (Bourdaghs 2012).

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