

DEVELOPMENT OF A FLORISTIC QUALITY ASSESSMENT METHODOLOGY FOR WISCONSIN

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EXECUTIVE SUMMARY

The Wisconsin Department of Natural Resources (DNR) is developing a wetland monitoring program to assess the biotic condition of wetlands in Wisconsin, using a suite of complementary assessment tools at both the site-specific and landscape scales. The Wisconsin Floristic Quality Assessment (WFQA) method has been developed to provide an intensive measure of wetland biological integrity at the site level based on the condition of the plant community. The WFQA can also be applied to any tract of land with a developed plant community, including non-wetlands.

The WFQA is an adaptation for use in Wisconsin of the original floristic quality assessment method developed by Floyd Swink and Gerould Wilhelm for the Chicago Region. The basis of floristic quality assessment is the concept of species conservatism, the degree to which a species can tolerate disturbance and its fidelity to undegraded conditions. Conservatism is not always equated with rarity. The method uses the aggregate conservatism of all species found on a site as a measure of the site's intactness, an indication of its ecological integrity.

The method requires the *a priori* assignment of "coefficients of conservatism" to every native vascular plant species in a regional flora, relying on the collective knowledge of a group of experts. The coefficients for the WFQA were assigned by a core group of seven expert Wisconsin botanists, aided by Gerould Wilhelm, and using survey results from a larger group of Wisconsin botanists. The coefficients assigned previously by a group of aquatic ecologists led by Stanley Nichols were accepted for aquatic plants.

The method requires an accurate and complete inventory of vascular flora on a site. The appropriate coefficient is applied to each species, and an average coefficient of conservatism (Mean C) is calculated for the entire site or sample unit. The Floristic Quality Index (FQI) adds a weighted measure of species richness by multiplying the Mean C by the square root of the total number of native species. Higher Mean C and FQI numbers indicate higher floristic integrity and a lower level of disturbance impacts to the site. Mean C and FQI values are affected by the timing, sampling effort, and accuracy of the vegetation inventory and can vary by plant community type. The size and heterogeneity of the assessment area can also affect FQI values. These limitations must be taken into account when interpreting WFQA results.

WFQA is recommended for assessing ambient wetland biological conditions, and for monitoring the effects of restoration and management actions. Periodic assessments carried out in a consistent manner can provide data on long-term trends at a site. WFQA can provide a measure of vegetative integrity as part of a wetland functions and values assessment, but cannot substitute as a stand alone comprehensive functional assessment.

Several important steps remain to be taken to implement the use of the Wisconsin FQA.

1. Test its consistency with other biological assessment methodologies.
2. Test its feasibility for use in a wetland monitoring program.
3. Account for and control sources of variability in designing future monitoring studies using the WFQA, especially for trends monitoring.
4. Provide a computer program to easily calculate FQA statistics.
5. Develop a database of FQA site values, including a range of reference sites by ecoregion and wetland type.

INTRODUCTION

*This study builds upon the recommendations of a study funded under a previous USEPA Wetland Grant (#CD985491-01-0) for developing a wetland monitoring program. That study recommended the development of a suite of wetland assessment methods that work at a variety of scales (Bernthal, 2001). The Wisconsin Floristic Quality Assessment (WFQA) is one of three lines of methodology development funded under USEPA Wetland Grant CD97511501-0. Two other complementary methods developed under this EPA grant are summarized in separate publications: **Refinement and Expansion of Biological Indices for Wisconsin Wetlands** (Lillie, et al., 2002) and **Development of a Landscape Level Monitoring Methodology Based on Mapping Invasive Species** (Bernthal and Willis, in prep.).*

A principal goal of the Clean Water Act is to maintain and restore the physical, chemical and biological integrity of the waters of the United States (33 U.S.C. §1251(a)). Section 305(b) of the Clean Water Act requires states to monitor and report on the condition of their waters, including the maintenance of biological integrity. Biological integrity has been defined as "... the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region" (Karr and Dudley 1981). The concept of ecological integrity and ecosystem health has been described in the following way.

"A biological system is healthy and has ecological integrity when its inherent potential is realized, its condition is 'stable,' its capacity for self-repair is maintained, and external support for maintenance is minimal. Integrity implies an unimpaired condition or quality or state of being undivided." (Karr 1993)

The Wisconsin DNR Wetland Team has committed to developing an assessment and monitoring program to assess the biological integrity, or condition, of wetlands in Wisconsin (WDNR Wetland Team 2000, Bernthal 2001). Assessing the ecological integrity of the wetland itself contrasts with the broader assessment of "functions and values" or "functional values" that is conducted for impact assessment, typically in a regulatory context. The uses for condition assessment are for management and restoration of wetlands, planning for the preservation of wetlands, development and refinement of wetland water quality standards, and periodic reporting on wetland condition to the public as required under Section 305(b) of the Clean Water Act.

The development of tools for assessing and reporting site condition differs somewhat from the development of long-term trends monitoring tools. Long-term monitoring programs may choose to identify a few key variables that can be consistently measured over time to show environmental trends, such as Secchi-disk readings and ice-on and ice-off dates for lakes. Site assessment methods are more focused on integrating measures of the current state of the system being assessed and thus can be of more immediate relevance to managers and decision-makers. There are trade-offs involved in each approach.

Because the primary uses we envision for wetland assessment and monitoring information are geared toward management, restoration, and planning, we are focusing on condition assessment as the primary goal, with the potential for repeated or periodic assessments to indicate longer-term trends.

The wetland monitoring strategy (Bernthal 2001) calls for developing complementary tools that can be used across the broad spectrum of wetland types at both the site-specific and landscape scale. The department chose to develop a Wisconsin version of the Floristic Quality Assessment as an intensive site-level assessment method for several reasons:

- Floristic quality assessment offers the ability to assess any wetland plant community, giving us a method that can be immediately employed while multi-metric biological integrity indexes are being developed for the wide variety of wetland types present in Wisconsin.
- Floristic quality assessment provides a standard, unbiased, repeatable method, and thus holds promise for monitoring trends over time, and comparing sites within a region.
- Compared to biological indexes requiring extensive laboratory processing, floristic quality assessment can be mainly accomplished directly in the field, although this depends on observer expertise.
- Metrics for plant based biological integrity indexes can be developed that incorporate coefficient of conservatism values as has been done in Ohio (Mack, et al. 2000).
- In addition to wetland assessment, floristic quality assessment can also be used in land management, restoration, and identification, evaluation, and comparison of natural areas. The approach can also be used to assess terrestrial systems, offering a useful tool to a wide range of users.
- Floristic quality assessment methods have been or are being developed and used in other states including Ohio (Andreas and Lichvar 1995), Illinois (Taft, et al. 1997), and Michigan (Herman, et al. 2001).

Wisconsin Floristic Quality Assessment (WFQA) Method

The Wisconsin Floristic Quality Assessment (WFQA) is an adaptation of the floristic quality assessment method for use in Wisconsin, treating the entire state as a single region. Floyd Swink and Gerould Wilhelm (1979, 1994) developed the original methodology for the Chicago Region, as a standardized, repeatable means of evaluating

natural area quality. The method allows for comparing the floristic quality among many sites and for tracking changes at the same site over time, whether undergoing natural succession or being actively managed.

The method is based on the concept of species conservatism. Each native plant species occurring in a regional flora is assigned a coefficient of conservatism (C) representing an estimated probability that a species is likely to occur in a landscape relatively unaltered from what is believed to be a pre-settlement condition. The most conservative species require a narrow range of ecological conditions, are intolerant of disturbance, and are unlikely to be found outside undegraded remnant natural areas, while the least conservative species can be found in a wide variety of settings and thrive on disturbance. Coefficients range from 0 (highly tolerant of disturbance, little fidelity to any natural community) to 10 (highly intolerant of disturbance, restricted to pre-settlement remnants). Conceptually this 10-point scale can be subdivided into several ranges. The following description of coefficient ranges combines the discussions presented by Taft, et al. (1997) and Francis, et al. (2000; describing concepts used in Oldham 1995):

0-3: taxa found in a wide variety of plant communities and very tolerant of disturbance

4-6: taxa typically associated with a specific plant community, but tolerate moderate disturbance

7-8: taxa found in a narrow range of plant communities in advanced stages of succession, but can tolerate minor disturbance

9-10: taxa restricted to a narrow range of synecological conditions, with low tolerance of disturbance.

Conservatism and rarity, or special conservation concern status, are not always equated, however. Many species of conservation concern are both highly conservative and restricted to specific remnant natural communities. An example is *Chamaesyce polygonifolia*, seaside spurge, a “special concern” species, confined to sandy beaches and dunes along the Great Lakes. It is assigned a conservatism coefficient of 10. In contrast, some rare species are found in highly disturbed areas and are not conservative. An example is *Carex pallescens*, pale sedge, another “special concern” species. It is assigned a conservatism coefficient of 1, because it can be found locally in moist disturbed roadsides, fields, clearings, and borders of woods in the North. In other cases, rare species may now be found increasingly in disturbed habitats in addition to remnant undisturbed sites, as in the case of *Gentiana alba*, yellow gentian, a “threatened species” assigned a coefficient of 7. It is native to deep soil, mesic to moist prairies, but is now also found on roadsides, embankments, old fields, and logging roads. Many conservative species are not at all rare in Wisconsin. An example is *Kalmia polifolia*, swamp laurel, a shrub restricted to bogs, which is assigned a 10, but it is not endangered because bog habitat is still common in northern Wisconsin.

Floristic quality assessment uses two related, but separate, measures: 1) the average coefficient of conservatism or Mean C, and 2) the Floristic Quality Index or FQI. To use the WFQA, the plant community is inventoried or sampled to compile an accurate and complete species list of vascular flora on a site. The choice of a sampling methodology is not dictated. The appropriate coefficient of conservatism is applied to each species, and the mean is calculated for the assessment area.

$$\text{Mean C} = \sum(c_1+c_2+c_3+\dots c_n)/N \quad \text{Formula (1)}$$

where *c* is the coefficient of conservatism for each native species identified on the site and *N* is the total number of native species inventoried in the assessment area.

The Floristic Quality Index (FQI) is calculated by multiplying the Mean C by the square root of the total number of native species.

$$\text{FQI} = \text{Mean C} * \sqrt{N}$$

or

$$\text{FQI} = \sum(c_1+c_2+c_3+\dots c_n)/\sqrt{N} \quad \text{Formula (2)}$$

These values can also be calculated “with adventives” by counting non-native species, but assigning them a value of “0.”

Researchers have debated the relative merits of using Mean C versus FQI. FQI can be biased by size of the site, especially in communities such as sedge meadows, in which species richness is strongly influenced by increasing area (Mathews 2003). Higher FQI values can result on sites where disturbance through part of the area allows weedy species to invade, rather than reflecting higher quality, less disturbed habitat (Rooney and Rogers 2002). Francis, et al. (2000) suggest that by combining Mean C and a measure of species richness, the FQI obscures important information, and suggest looking at each component (Mean C and species richness) separately. Lopez and Fennessy (2002) demonstrated the effectiveness of the FQI (described in their terminology as FQAI – Floristic Quality Assessment Index,) as a plant community-based biological assessment tool by showing a correlation between FQAI score and an independent ranking of disturbance for 20 depressional wetlands in Ohio.

It appears useful to compute and interpret both the Mean C and the FQI value. FQI values will be sensitive to factors that increase species richness, while Mean C relates directly to aggregate conservatism. This enables the assessor to sort out situations where species richness is increased due to factors not related to aggregate conservatism of the site. A good description of the assessment area is necessary to interpret these values. In some cases the user may want to calculate separate values for distinct plant communities on a given site.

Repeated sampling over the course of a growing season will allow the closest approximation of the “true” Mean C and FQI values, but this is not likely to be feasible in many situations. A study of 17 isolated depressional wetlands in Wisconsin, sampled by

the same observer during early July and again in mid-August provides an estimate of the effect of sample timing (Judziewicz, 2002). The effect of adding new species from the second site visit increased the cumulative FQI by an average of 8.9% compared to the first visit, while the cumulative Mean C decreased an average of 2.5%. Judziewicz (2002) concludes that for this set of wetlands a single site visit, conducted between mid-June and late August could be sufficient for reasonable results. Lopez and Fennessy (2002) found an average increase of 15 species from summer sampling to combined summer-autumn sampling and found an average increase of three points in the FQI values, but little change in the relative ranking of sites.

DEVELOPMENT OF THE WFQA

The key to the development of a regional floristic quality assessment method is the *a priori* assignment of the coefficient of conservatism for every native species in the regional flora. At the outset, the theoretical limitations inherent in treating the entire state as a single region were recognized. A decision was made, however, to continue on that basis as the most practical approach to completing the development of the method and avoiding the confusion of a proliferation of regional approaches within the state.

In developing the coefficients of conservatism for Wisconsin, an attempt was made to take full advantage of the expertise of botanists working across the state, while basing the final assignments on the collective effort of a smaller core group working face-to-face. This was done to include the experience of a larger group, and to allow the core group to consider the judgement of those who were familiar with a narrower range of Wisconsin flora, or familiar with a smaller localized areas, rather than the entire state.

At the beginning of the project a forum was held to bring together botanists from around the state to discuss the floristic quality assessment methodology, its advantages and limitations and generate a consensus on the desirability of the project. Anton Reznicek, a participant in development of Michigan's floristic quality assessment, presented Michigan's experience in developing and using the method. Gerould Wilhelm discussed the conceptual basis for floristic quality assessment, his experience assisting other states in developing coefficients of conservatism, and the appropriate uses of the method.

A survey was sent to over 30 botanists asking them to assign coefficients to those plants they know well. An Excel spreadsheet provided by the University of Wisconsin Herbarium from its database of 1,788 vascular plant species that are considered native to Wisconsin was provided. Information on these species is displayed as the "Checklist of the Vascular Plants of Wisconsin" on the following web site:
<http://www.botany.wisc.edu/wisflora/vindex.asp/>.

To establish a consistent basis for assigning coefficients, guidelines accompanied the survey that outlined the concept of conservatism and gave some examples of ranges of conservatism from earlier efforts (Taft, et al. 1997, Herman, et al. 2001). The difficulty of considering the entire state as a single region was acknowledged and examples from the Michigan report on averaging (Herman, et al. 2001) were included in the survey guidelines. Members of the core group were also sent the survey and guidelines and some submitted preliminary coefficients. This helped them prepare for their intensive meeting.

Twelve respondents submitted preliminary coefficients. Survey responses were compiled and summarized. Out of the 1,788 native species, 1,671 species were assigned a coefficient by at least one person, while 116 went unrated. The final coefficient values were assigned by consensus of the core group of seven botanists and field ecologists from across the state, meeting intensively with a facilitator for two consecutive days. The survey results served as a guide to facilitate the final assignment of coefficients.

For each plant species, the group could consider the average “survey coefficient,” the range of survey coefficients, and the number of people who assigned a value. The core group used the survey results, but ultimately based the final assignments on their collective experience with the flora of Wisconsin. Gerould Wilhelm helped the group maintain a consistent focus on the concept of conservatism and aided them in their decisions. For aquatic plants the coefficients assigned previously by a group of aquatic ecologists led by Stanley Nichols were accepted with only a small number of adjustments.

The Wisconsin Floristic Quality Assessment can now be carried out using the coefficient of conservatism values, contained in the table in the Appendix of this report. The table also contains additional plant information: physiognomy, conservation status, and regional wetland indicator status based on the *National List of Plant Species that Occur in Wetlands: 1988 Wisconsin*. Mean Coefficient of conservatism and floristic quality index values can be calculated using the coefficients of conservatism published here and Formulas (1) and (2). Coefficients of conservatism and wetland indicator status for Wisconsin vascular flora are available on the University of Wisconsin-Madison Herbarium’s “Checklist of the Vascular Plants of Wisconsin” at <http://www.botany.wisc.edu/wisflora/vindex.asp/>.

A computer program is being developed to facilitate use of the WFQA. The program will allow users to enter site location data, plant community type (based on Wisconsin Natural Heritage Inventory classification), enter species occurrences from a catalog in an inventory format or by transect/quadrat entry, with options to enter cover and frequency data. The program will generate reports with FQA statistics.

POTENTIAL USES OF THE WFQA

Floristic quality assessment is capable of being used for a number of applications. Swink and Wilhelm (1994) discuss four applications: 1) identification of Natural Areas, 2) comparisons among different sites, 3) long-term monitoring of natural quality, and 4) monitoring of habitat restoration projects. Research interest in using floristic quality assessment statistics to analyze vegetation sample data is also increasing, often with the purpose of demonstrating differences in plant assemblages in response to environmental variables. (Werner and Zedler 2002, Kercher in preparation, Carpenter unpublished data).

The purpose for developing the WFQA in this project is to:

1. provide a plant community-based intensive site assessment method for wetland biological integrity,
2. provide a tool for monitoring plant community response to restoration and management actions, and
3. provide an intensive measure of one component of an impact assessment methodology for regulatory decision making.

WFQA for Assessing Biological Integrity

The EPA National Wetlands Monitoring Workgroup has been preparing a framework for developing wetland monitoring programs to meet the mandate of the Clean Water Act to report on the biological integrity of the waters of the nation (USEPA 2002, in draft). The Working group has endorsed the concept of a Level 1, 2, 3 approach to monitoring. Level 1 is Landscape Assessment relying on coarse, landscape-scale inventory information, typically gathered through remote sensing and preferably displayed in a geographic information systems (GIS) format. Level 2 is Rapid Assessment at the specific wetland site scale, using relatively simple, rapid protocols for the sake of feasibility. Level 2 assessment protocols are to be validated by and calibrated to Level 3 assessments. Level 3 is Intensive Site Assessment using detailed, intensive ecological evaluation methodologies, particularly research-derived, multi-metric indexes of biological integrity.

Floristic quality assessment was originally developed to provide a method for evaluating natural area quality to support conservation management decisions (Wilhelm and Ladd 1988, Swink and Wilhelm 1994). The method relies on the understanding of individual plant species responses to disturbance, and fidelity to habitat integrity within a given region. Methodologies for assessing biological integrity are based on research efforts that identify a stressor-response relationship between levels of human disturbance and elements of the biological system (Karr and Chu 1997).

In general higher Mean C and FQI numbers for a site indicate higher floristic quality and biological integrity and a lower level of disturbance impacts. It is likely, however, that the range of floristic quality assessment values will vary by plant community type, limiting comparisons of sites with divergent types. Rooney and Rogers (2002) have demonstrated this for some Wisconsin plant communities. Matthews (2003) concludes that valid comparison of FQI values for wetland plant communities requires similar type, size, heterogeneity, and time of survey.

The Wisconsin Floristic Quality Assessment can be considered a Level 3 method for assessing the biological integrity of the plant community. To be used as such, additional study of reference wetlands must be conducted to establish the range of WFQA values associated with varying levels of disturbance. Such studies should control for wetland plant community type and hydrogeomorphic setting, following the approach of Lopez and Fennessy (2002). Ecoregional variance should also be analyzed, similar to the process employed by Nichols (2001) in analyzing lake aquatic plant communities.

Another approach to be considered is incorporation of FQA components into a vegetation-based multi-metric biological integrity index. FQ(A)I score and metrics derived from “tolerance ranges” based on coefficient of conservatism ranges have been incorporated into the Ohio Vegetation Indices of Biotic Integrity (Mack, et al. 2001).

Floristic quality assessment should be recognized as **one** indicator of biological integrity based on the response of the plant community to disturbance. Ideally other components of ecosystem response in addition to vegetation should be developed into indices of biological integrity. In Wisconsin, multi-metric indices based on plants, macroinvertebrates, zooplankton, and amphibians have been developed for isolated depressional wetlands (Lillie, et al. 2002). However, we lack methodologies for riverine, slope (saturated soils), and lacustrine wetlands. Development of additional indices for other wetland classes will require additional research. In the absence of Level 3 methodologies for these wetland types, WFQA assessments can serve as the best available indicator of biological integrity, and can be used to calibrate the development of Level 2 Rapid Assessment methodologies.

WFQA for Monitoring Response to Restoration and Management Activities

Floristic Quality Assessment can be valuable for restoration evaluation. It can be applied to mitigation projects that occur as a result of regulatory decisions or for evaluating “voluntary” restoration and management activities undertaken by agencies and non-profit conservation groups.

Floristic quality assessment has been required as a monitoring measure for mitigation projects, and in the Chicago region performance standards have been based on FQI and Mean C values. In reviewing project performance, however, the Mitigation Bank Review Team noted that the FQI values set in performance standards were difficult if not impossible to meet. For this reason they no longer use FQA scores as performance

standards for mitigation banking projects (Elston, personal communication). Swink and Wilhelm reported that for habitat restoration projects Mean C and FQI values are initially very low, tend to rise steadily in the first years, and tend to stabilize after 4-5 years, with Mean C values between 3.0 and 3.7, and FQI values between 25 and 35 (Swink and Wilhelm, 1994). Mushet, et al. (2002) noted in their study of restored and natural wetland complexes, that restored wetlands rarely exceeded FQI values of 22 while the FQI of natural wetlands in the study rarely dipped below 22. Wilhelm (1993) has suggested that in the Chicago region sites with FQI values above 35 are not “mitigatable” because restoration projects are unlikely to achieve the floristic quality of the site under consideration for a permitted impact. With sufficient reference data it appears that FQA values can be used as one factor both in evaluating permit decisions and setting realistic expectations for compensatory mitigation projects.

Floristic Quality Assessment can also be used to monitor the plant community response to management actions, such as controlled burning. It can be used to track restoration projects, or management of natural areas. The FQA can be used in conjunction with a suite of sampling options, from repeated general site inventories to more quantitative transect designs. Some of these are described in Swink and Wilhelm (1994). With transect studies, additional parameters can be studied, such as calculating a Mean C and FQI for each quadrat, developing the average of these values for a transect and comparing quadrat values to transect values to determine floristic quality across a gradient.

WFQA for Impact Assessment in Regulatory Decision Making

Floristic Quality Assessment results, based on the coefficients developed by Swink and Wilhelm for the Chicago Region (1994) have been reported by consultants as part of impact assessment and evaluations of functional significance of wetlands subject to a permit application or environmental review. The Chicago Region as defined by Swink and Wilhelm includes three southeastern Wisconsin counties. WFQA results will be based on coefficients developed for the entire state. When properly interpreted, they can provide valuable information on the plant community quality and can serve as an indicator of overall ecological integrity. WFQA results can supplement or help document the significance rating of floristic diversity in the Wisconsin Rapid Assessment Methodology. Sampling date and methods must be considered when interpreting results.

WFQA results cannot provide the sole basis for impact analysis for regulatory decisions, because other functions and values must be considered as well as floristic quality. WFQA is not intended to directly assess other wetland functions and values, such as habitat for aquatic life and other wildlife, shoreline stabilization, water quality maintenance, flood and storm water attenuation, and human uses.

ADVANTAGES AND LIMITATIONS OF THE WFQA

The WFQA methodology can be most appropriately used with an understanding of its advantages and acknowledgment of its limitations. These are summarized below.

Advantages

Coupled with accurate, timely, and complete vegetation sampling WFQA offers:

1. A consistent, quantitative measure of plant community integrity.
2. A method that can be used in any plant community (IBI methods are necessarily restricted to a class of similar habitats).
3. A repeatable method that can be used to assess trends.
4. A subjective but expert-based system. Coefficients of conservatism are based on the collective knowledge of those familiar with a regional flora.
5. A simple method that does not require extensive sampling equipment or laboratory processing.
6. A method that can be applied to existing data, such as plant inventories.

Limitations

1. Floristic quality is one aspect of ecological condition; the aggregate conservatism of the plant community. WFQA does not directly assess wildlife habitat structure – some wildlife species can thrive in sites with degraded plant communities. WFQA does not directly assess all wetland functions or human use values. For these reasons WFQA should not be used as a stand-alone method for regulatory purposes.
2. Comparability of results across wetland types is limited. Some wetland types, such as temporary ponds, may have naturally low plant diversity. Lopez and Fennessy (2002) have suggested the need to narrowly define the hydrogeomorphic class in testing the relationship between index scores and a disturbance gradient. This suggests caution in comparing FQI and Mean C scores across wetland types and landscape settings.
3. Results may be strongly affected by observer expertise, restricting the comparability of results between observers of different skill levels. The level of skill required for acceptable results is still unknown. More skilled observers are likely to identify more species and therefore generate higher FQI values. More skilled observers are also likely to find the more conservative species, and would tend to generate higher Mean C values.

4. The time of year and intensity of sampling affect results. Many species will not be observable or identifiable by even the most skilled observer at certain times of the year. Repeated sampling over the course of a growing season will allow the closest approximation of the “true” Mean C and FQI values, but this is not likely to be feasible in many situations.

RECOMMENDATIONS FOR IMPLEMENTATION

This author recommends the use of WFQA for assessing ambient wetland biological condition, for monitoring the effects of restoration and management actions, and for assessing vegetative integrity as part of a functions and values assessment. Several important steps remain to be taken to implement the use of the WFQA. There is a need to:

1. Test its consistency with other biological assessment methodologies.

As a follow-up to this project, the Wisconsin DNR is currently carrying out a study comparing the results generated by employing the Depressional Wisconsin Wetland Multi Metric Index of Biological Integrity (Depressional WWMBI) and the WFQA on a set of 17 wetlands. Results will be reported in 2003.

2. Test its feasibility of use.

Several questions about the feasibility of using the WFQA in a monitoring program need to be resolved to better understand how to deploy the method and interpret results. These include the effect of time of year of sampling and observer expertise, and comparability of types from different regions of the state. Though these effects have been reported (Rogers and Rooney, 2002, Judziewicz 2002, Kline, unpublished data 2002) the strength of these effects is not well understood.

3. Account for and control sources of variability in designing future monitoring studies using the WFQA, especially for trends monitoring.

To the extent possible, when attempting to use WFQA to assess trends, or compare floristic quality among sites, results from the same observer or observers with equivalent expertise should be used, and the sampling methods and area should be consistent. Repeat sampling to assess trends should be done as close as possible to the same date as baseline sampling.

4. Provide a computer program to easily calculate FQA statistics.

As of this writing a computer program is being developed to calculate floristic quality parameters and is being tested. This program should be made widely available, so that users have a convenient and consistent means of calculating FQA parameters, generated from a single set of conservatism coefficients, based on a single authoritative flora for the state.

5. Develop a database of FQA site values.

FQA parameters are relative values and gain meaning only in relation to baseline and reference data. In order to understand the significance of the Mean C and FQI for a site, the evaluator must know the range of values for that plant community and hydrogeomorphic type in that region. For example, the Mean C and FQI values for a sedge meadow in Waukesha County gain some meaning if one knows the range of Mean C values across the state, and greater meaning if one knows the range of values for sites in the ecoregion of occurrence. There is a need to collect FQA site values as investigations using the method are carried out, whether by the Wisconsin DNR or others, as long as the quality aspects of the data are known, such as the expertise of the observer, the time of observations, and the sampling method used.

A good start to developing the database can be made simply by re-evaluating existing data of known quality and sufficient documentation of site characteristics. Coefficients of conservatism can be applied to existing plant inventory data of known quality to calculate FQA parameters. Much of the higher quality data from highly qualified botanists exist in the files of agencies conducting land inventories especially for those evaluating natural heritage value. It will be important to set criteria for defining plant communities. Site location data and site descriptions can be used to allow analysis by ecoregion and potentially hydrogeomorphic type. The Wisconsin DNR intends to develop a database of FQA site values by re-evaluating existing data, soliciting data from cooperating investigators using the FQA methodology, and by carrying out studies as funding becomes available.

LITERATURE CITED

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Appendix

The Wisconsin Floristic Quality Assessment can now be carried out using the coefficient of conservatism values, contained in the table in this Appendix. The table contains:

- 1) scientific and common names for all Wisconsin vascular plants (Full scientific names may be truncated when space is limited. Species not native to Wisconsin are capitalized),
- 2) the coefficient of conservatism values discussed in this report,
- 3) regional wetland indicator status based on the *National List of Plant Species that Occur in Wetlands: 1988 Wisconsin*,
- 4) conservation status based on the Natural Heritage Inventory working list, and
- 5) physiognomy (growth form).

Mean Coefficient of conservatism and floristic quality index values can be calculated using the coefficients of conservatism published here and Formulas (1) and (2) found elsewhere in this report.