ADAPTATION OF THE QBR INDEX FOR USE IN RIPARIAN FORESTS OF CENTRAL OHIO

Stephanie R. Colwell and David M. Hix[1]

Abstract.—Although high quality riparian forests are an endangered ecosystem type throughout the world, there has been no ecological index to measure the habitat quality of riparian forests in Ohio. The QBR (qualitat del bosc de ribera, or riparian forest quality) index was developed to assess the quality of habitat in Mediterranean forested riparian areas, and we have modified this index for use in central Ohio. Only a few changes were made to the original QBR index to adapt it for use in central Ohio. The changes resulted in scores that reflected the habitat quality of riparian forests along central Ohio streams more accurately than the original index would have. Sixty study sites were chosen for testing this index in three study watersheds (Big Darby Creek, Little Darby Creek, and Walnut Creek) and all sites were placed into habitat quality categories based on their scores. The QBR index appears to be useable to assess riparian forest habitats in central Ohio, and can be used to assess the progress of restoration projects, determine high quality riparian areas for conservation, and assess the quality of habitat for entire watersheds or study areas.

INTRODUCTION

A riparian area is defined as the transitional zone between a river or stream and the adjoining terrestrial upland ecosystem, including both the stream channel itself and the surrounding land that is influenced by fluctuating water levels (Corbacho and others 2003, Goebel and others 2003). These forested areas support high biodiversity, provide water quality protection, naturally control floods, stabilize stream banks, provide wildlife habitat, and allow for direct human benefits such as recreation and aesthetics (Carver and others 2004, Greenwald and Brubaker 2001, Opperman and Merenlender 2000, Tockner and Stanford 2002). Although all of the services provided by these ecosystems are critical ecological functions, riparian forests are among the most threatened ecosystem types in the world (Tockner and Stanford 2002, Alpert and others 1999).

Degradation of riparian forests occurs for many reasons. Riparian areas are subjected to several natural disturbance types, such as flooding, fire, wind, insects, and diseases. Humans have introduced disturbances into this ecosystem type and have also altered the natural disturbance regimes (Miller and others 2006, Yates and others 2004). The building of dams, channelization of streams, agricultural conversion, and urban development destroy natural vegetation and floodplains, and alter flooding cycles for the riparian area (Bunn and others 1999, Friedman and Scott 1995, Raven and others 1998, Salinas and others 2000).

The QBR index ("qualitat del bosc de ribera" or riparian forest quality) is an easy-to-use field method for assessing the habitat quality of riparian forests. It was designed and developed for use in Mediterranean streams in Spain (Munné and others 2003). The index is based upon four main aspects of the riparian area being studied, and unlike indices currently in use which assess the water quality itself or the habitat directly

[1]Student (SRC), Ohio State University, School of Environment and Natural Resources, 5769 Sylvia Dr. Dublin, OH 43016; and Associate Professor (DMH), The Ohio State University, School of Environment and Natural Resources, 2021 Coffey Rd. Columbus, OH 43210-1085. SRC is corresponding author: to contact, call (614)648-1429 or email at colwell.19@osu.edu.

adjacent to the stream, the QBR index assesses a site's entire floodplain. It generates a score that can then be used to contrast sites, to compare sites to ideal conditions, or to assess the success of restoration projects over time.

In this study, we adapted the QBR index for use in central Ohio watersheds. The following specific objectives for the project are:

1. Alteration of any terms and requirements of the index that are region-specific to the Mediterranean area
2. Development of lists of native and non-native trees and shrubs found in central Ohio
3. Testing of the adapted index in three central Ohio watersheds: the Big Darby, Little Darby, and Walnut Creeks
4. Assessment of the usefulness of the adapted index in watershed management and planning

STUDY AREAS

Three central Ohio watersheds—Big Darby Creek, the Little Darby Creek, and the Walnut Creek—were used to test the adaptation of the QBR index. The Big Darby and the Little Darby are both State and National Scenic Rivers, and have exceptional water quality in large portions of the watersheds. Walnut Creek is also a stream of high water quality. All three watersheds provide habitat to a wide range of species including fish, macroinvertebrates, mussels, amphibians, mammals, and birds. Land ownership along these streams is a mix of private and public entities. The Columbus Metro Parks is one of the public landowners.

Twenty forested sites were chosen within each of these watersheds. Only sites with trees (either a forested area or a buffer) were chosen since the QBR index assesses the habitat quality of riparian forests. Sites were chosen to capture the range of forest area from sites with only a strip of trees on one stream bank to sites located within a continuous forest.

Because recent political and environmental activities along the Darby Creeks, access to the creeks has become limited, therefore, only portions of the watersheds could be sampled. Sites were thus chosen in these watersheds based on landowner approval and accessibility to the creeks. Sampling in the Walnut Creek watershed was conducted with fewer restrictions, as the work was conducted in conjunction with the stream quality monitoring by the Ohio Environmental Protection Agency (OEPA). Study sites in this watershed were chosen by the OEPA based on the amount of land area that is drained at each point along the length of the main stream and its tributaries.

METHODS

The QBR index developed by Munné and others (2003) was created for assessing the riparian forests of Mediterranean area streams. Several changes, therefore, were needed to make it applicable to the riparian forests of central Ohio streams. All of the components of the index were evaluated to determine whether the scoring requirements were adequate as they were originally developed, or whether they needed to be altered to more accurately reflect the quality of the riparian forests in central Ohio based on a search of the literature. If any part of the index was found to need revision, another literature review was then conducted to determine how the section could be modified to more accurately reflect the local conditions and relationships.

Once the components of the index were altered, it was tested in the three separate watersheds to determine whether or not the modifications accurately reflected the quality of central Ohio riparian forests. Within

each of these watersheds, 20 study sites were chosen, resulting in a total sample of 60 sites. Sample sites in the Walnut Creek watershed were chosen from the study plan created by the OEPA for its stream quality monitoring, and were sampled during the summer of 2005 water quality testing. Sites within the Big and Little Darby watersheds were chosen based on accessibility of the creek and adjacent forests.

Each study site was centered on the streambed and was 50 meters in length following the stream channel. The width was variable, extending through the riparian forest to the edge of the floodplain. Floodplain width was based on the bank topography, position of terraces or dikes, and presence of piles of debris left by previous flooding, as well as through plant indicator species. In areas with a narrow riparian forest corridor, the forest edge itself was taken to be the edge of the floodplain for the purposes of this study.

After each site location was chosen, the 50-meter length measured upstream and the edge of the floodplain marked out, the QBR index was completed. This work was done in four parts following the four sections of the field sheet. Each part was assessed separately, and then all were combined at the end for scoring purposes (see Appendix). All field work was conducted during the summer of 2005, following the methodology of Munné and others (2003) after the leaf flush of the trees was finished and before the leaves started falling. Cover conditions, therefore, were relatively similar for all measurement periods.

After the field work was completed, we used the original QBR index to assess the data collected at all of the study sites for this project, and these results were compared with the results scored in the field. A one-way ANOVA was then run, comparing the final scores from each of the three watersheds to determine whether any statistical difference exists between them. The alpha level was set at 0.05, with a sample size (n) of three.

RESULTS

Alterations to the QBR Index

Several changes to the original QBR index were needed to adapt it to central Ohio riparian forests. Section one of the field sheet was the only section to remain the same in the altered index as in the original QBR. All three of the other sections were at least slightly altered to reflect the differences between the floodplains of Spain's Mediterranean streams and those of the streams of central Ohio.

The minor changes made to the second section of the index were needed to clarify the application of the index in the field. For the amount of tree and shrub cover, the numbers in the scoring were changed from 10-25 percent to 10-24 percent, since 25 percent was also included in the category above this one. A similar change was made to the part of section two dealing with the helophyte and shrub edge cover. Also in this section, in the component dealing with the distribution of trees and shrubland cover, the second scoring category was changed to shrubland of <50 percent, since 50 percent was not included in either option.

The third section of the index had the most important changes among all of the sections. The first change made to this section was to adjust the number of species required for each habitat type and score (Table 1). The number of tree species required was changed from the original numbers presented by Munné and others (2003) to double that number for the adapted index for central Ohio. Also in this section, the number of shrub species was increased to reflect the difference in species richness between Mediterranean Spain and central Ohio. The next change in section three of the index was to remove the gallery structure

Table 1.—Stream types and characteristics used in section 3 of the QBR index and native species requirements for scoring purposes in section 3 of the QBR index

Stream Type	Type 1	Type 2	Type 3
Characteristics	Closed riparian habitats. Riparian trees, if present, reduced to small strip. Headwaters.	Headwaters or midland riparian habitats. Forests may be large. First or second order streams.	Large riparian habitats. Potentially extensive forests. Third or higher order streams.
Minimum no. of species	>2	2	1
Middle no. of species	>4	4	3
Maximum no. of species	>6	6	5
No. of shrubs	>3	>4	>5

of the scoring for the riparian area because this structure did not apply to central Ohio. Finally in section three, the negative scoring for the presence of non-native trees was changed to apply to non-native shrubs as well.

In the fourth section of the index, changes were made to the scoring requirements for modifications of the channel. The scores given by Munné and others (2003) in the original index were kept, but factors contributing to that score were changed to require that both stream banks be modified to receive these scores. New categories were added to include sample sites with only one bank modified. The first category created was "fluvial terrace on one bank modified and constraining river channel" with an associated score of 15. The second category created was "channel modified by rigid structures along one margin" with an associated score of 10.

Minor changes were also made in this section concerning the riparian habitat type and were similar to the changes made in section two. The width of the islands categories were changed so that the first option included 5 meters, as the original options were greater than 5 meters and less than 5 meters. The percentage classes for the hard substrata were also changed to clarify which class each measurement belonged to as the classes overlapped. All scores associated with these classes remained the same.

The final changes made to the index were format changes. The setup of the field sheet was altered and locations to record species and to take notes were added. All of these changes were made to make the field sheet easier both to follow and to complete.

Comparison of the Original and Adapted QBR Indices

Scores from each site were computed for both the original index as created by Munné and others (2003) and for the adapted index. Some differences were found between the scores. Of the 60 sites, two scored higher with the adapted index and four scored lower with the adapted index. All other sites received the same score with both indices. Of the six sites with varying scores, only one was placed in a higher habitat quality class when the adapted index was used.

The sections of the index with the most variability in scores between the original and the adapted index were sections three and four. Several sites received higher scores with the adapted index due to the addition

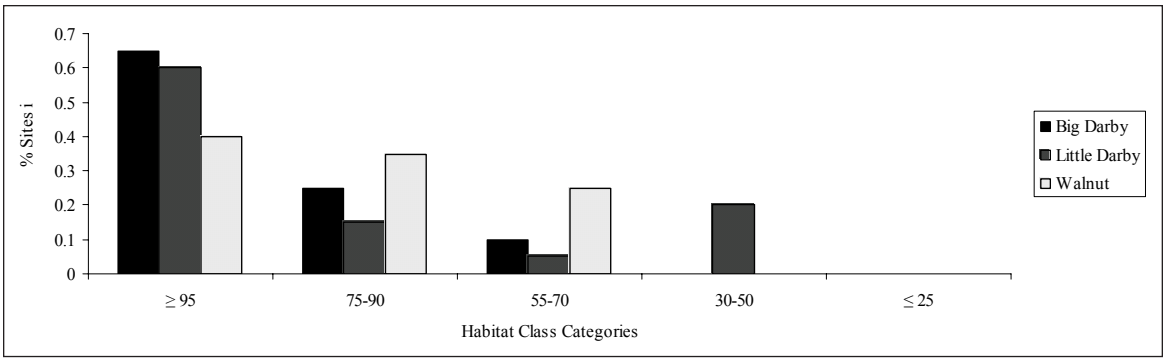

Figure 1.—Percentage of study sites in central Ohio within each score category by watershed.

of score classes in section four if only one side of the stream channel was altered. One site, however, received a lower score with the adapted index due to the changes in the number of tree and shrub species. Other sites also received lower scores due to the addition of non-native shrubs to the non-native trees category.

Riparian Forest Habitat Quality

Overall, site scores with the adapted index ranged from 45 to 100 (Fig. 1), compared to scores from 50 to 100 with the original index. No statistical differences were determined between the habitat qualities within the three watersheds (F=0.94, P=0.397). For both indices, individual section scores ranged from zero to 25, with many of the sections scoring beyond these set limits. These additional and negative points in the sections contributed to various sites' scores, but were not counted because the index is required to give each section an equal weight in the overall score.

No sites were in the very poor habitat class, and only four sites, all within the Little Darby watershed in highly agricultural areas, were in the poor quality class. Most sites, however, were in the fair, good, or excellent habitat quality classes (Table 2). All of the sample sites studied were of the second or third habitat types, which are characterized by having wider floodplains.

Section one was usually the lowest scoring section of the index. These scores ranged from zero to 25. The scores for section two of the adapted QBR Index were generally higher than those of section one. Scores for this section ranged from five to 25. The third section of the index had the highest scores for all three watersheds. The baseline score for section three was based on the native tree species richness. Richness was generally relatively high in all three watersheds. Section four of the index also ranged from zero to 25 points. All of the sites scored zero in the agricultural areas of the Little Darby watershed.

Table 2.—Classes of habitat quality and associated scores required from the QBR index.

Riparian Habitat Class	QBR Score
Riparian habitat in natural condition, excellent quality	≥95
Some disturbance, good quality	75-90
Disturbance important, fair quality	55-70
Strong alteration, poor quality	30-50
Extreme degradation, very poor quality	≤25

DISCUSSION

Alterations to the QBR Index

The changes made to the original QBR index did not result in major changes to the scores of the sites utilized in this study, indicating that some of the indicators of riparian forest habitats in the QBR index may be applicable to riparian forests in many different areas. The changes, however, resulted in a better reflection of the habitat quality when the individual components were assessed. The number of native species required in the third section of the index was increased to reflect the differences between the native tree and shrub diversity in Spain and that of the United States. Even with this increase in the number required, only one site had less than the number of tree species needed for the maximum points for the score of that section. The increase in the number of shrub species appears to be a needed increase since eleven of the total sites had the minimum number of species required for the extra points to section three's scores.

The other changes also appear to be supported by the data collected in the field testing. No sites were found to be structured in a gallery, so the removal of this portion of the index did not affect the overall scores of the index. The change in scoring from having both stream banks modified to having one or both modified reflected more accurately the available habitat and establishment area for trees and shrubs when only one bank is modified as opposed to those sites with both banks modified. Changing the category of non-native trees to non-native trees and shrubs was needed since only one non-native tree species was recorded in the study area, but four non-native shrub species were found, as opposed to no native shrub species in the study by Munné and others (2003). This component of the index is important in central Ohio where bush honeysuckle (*Lonicera maackii*) is present in the many human-disturbed ecosystems.

Even with the changes to the original index, no sites in any of the watersheds were scored in the poor or very poor habitat classes. The omission of these classes prevents a complete analysis of the adaptation of the index to central Ohio. It is unknown how well this index will assess riparian forests in these classes. We do not know whether the index scores all sites high, resulting in more sites in the upper classes and few or no sites in the lower classes.

All of the changes made to the index, however, appear to be supported by the field testing. The adapted index appears to be a more accurate reflection of the habitat quality in central Ohio riparian forests than the original index. The QBR index, as developed by Munné and others (2003), provided the basic guidelines in determining habitat quality for the sections of riparian forest under study. Further studies, though, are needed to test the index in the poorer habitat quality classes.

Riparian Forest Habitat Quality

Although the results of the one-way ANOVA indicated no statistical differences between the riparian forest habitat qualities of the three study watersheds, the Big Darby Creek watershed had the most sites in the excellent habitat quality class. The Little Darby Creek and the Walnut Creek watershed had fewer sites in the excellent habitat quality class. These trends were anticipated at the beginning of the study, since the Darby Watersheds are National and State Scenic Rivers, and the Big Darby is known for high water quality. In many areas, the riparian forest has been preserved and has been left intact along the stream banks. We did not expect, however, to find significant differences among the three watersheds.

Differences between the watersheds may be detected, however, if the portions of the watersheds where there are no riparian forests are included in the overall comparisons. Since this study focused only on the forested portions of the watersheds, the entire watershed was not included in the final analysis.

Management Implications

The QBR index provides a basic habitat quality value for a sample site. The results obtained from the testing of the index could be utilized in several ways. Most of the study sites in the study watersheds scored relatively high, indicating that further studies are needed in the lower range of the index. The high scoring in these streams may indicate that these are areas where conservation efforts should be directed; in several cases, conservation efforts already have been directed to these areas. Those sites that did not score in the excellent habitat quality class could be areas where management measures could be concentrated to improve the habitat over the whole watershed.

This index may also allow watershed managers to determine which attributes of the riparian forest are the most limiting factors for habitat. Most sites sampled that obtained less than excellent scores received lower scores because of reduced riparian and tree cover and reduced connectivity with adjacent woodlots. Improving the habitat quality by increasing cover requires planning, funding, and time. Plantings could increase cover in some of these areas, but it would take years to increase the tree cover. Given time and good management planning, however, the riparian forest habitat quality may be increased.

In other watersheds, this index could be used in restoration projects to follow the succession of forests as they mature. By using this index every 5 to 10 years, the changes in these areas could be determined and documented. The limiting components of the forests would also be assessed, and as needed, changes could be made to the management plans for the area to account for and improve any deficiencies in the riparian areas.

The QBR index also shows that it is possible for a methodology applied to a specific habitat type in one part of the world to be used in other parts of the world. This index was relatively easy to adapt for use in Ohio, and there may be other indices and methods from specific regions in the world that can be modified fairly easily to be applicable elsewhere.

CONCLUSIONS

The QBR index is needed in central Ohio for several reasons. There currently is no method for assessing the habitat quality of riparian forests based on direct measurements of the forest characteristics themselves. Although there are several indices for assessing the quality of riparian areas such as the qualitative habitat evaluation index (QHEI) and the vegetation index of biotic integrity (VIBI) for wetlands, the QHEI does not directly measure the characteristics of the riparian forest area. The riparian zone is only one of six characteristics studied in the QHEI. This index measures the width of the riparian vegetation, which includes not only forests but also grasslands, the floodplain quality, which is a recording of the type of habitat present along each stream bank, and erosion of the stream banks. On the other hand, the VIBI is used only for wetlands. Although wetlands are included in the scoring requirements of the QBR index, they are not the only portion of the riparian forest area studied.

Riparian forests are some of the most diverse habitat types in Ohio, with high species richness and many important functions in ecosystem processes (Innis and others 2000). They are also some of the most endangered ecosystems in the world today. The QBR index is a method for assessing the habitat quality of riparian forests. This index may be used to assess the current quality of riparian forests, and it may also be used to follow the progress of restoration projects in riparian areas. It could also be used, with careful planning and considerations, to determine areas in a watershed that need the most attention, and to allocate funds for improving the riparian forests and water quality.

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Appendix: Front Page of the Scoring Sheet for the QBR Index

Location: _____ RM: _____ Date: _____

Observer(s): _____ Time Sampled: _____

Score of each section cannot be negative or exceed 25 points

Section 1: Total Riparian Cover

Score	*Riparian Cover Includes Trees, Shrubs, and Helophytes, but not Annuals*
25	>80% of riparian cover (excluding annual plants)
10	50 - 80% of riparian cover
5	10 -50% of riparian cover
0	<10% of riparian cover
+10	If connectivity between riparian forest and adjacent woodland total
+5	If the connectivity is higher than 50%
-5	If the connectivity is between 25 - 50%
-10	If the connectivity is <25%
	Total Score for Section 1

Section 2: Cover Structure

25	>75% of tree cover
10	50-75% of tree cover or 25-50% of tree cover but 25% shrub cover
5	Tree cover <50% but shrub cover between 10 - 25%
0	<10% of either tree or shrub cover
+10	At least 50% of channel has helophytes or shrubs
+5	If 25 - 50% of channel has helophytes or shrubs
+5	If trees and shrubs are in the same patches
-5	If trees are regularly distributed, and shrubland is >50%
-5	If trees and shrubs are in separate patches, without continuity
-10	Trees are distributed regularly, and shrubland is <50%
	Total Score for Section 2

Section 3: Cover Quality (based on geomorphological type)

	Type	1	2	3
25	Number of native tree species	>2	>4	>6
10	Number of native tree species	2	4	6
5	Number of native tree species	1	≤	≤
0	Absence of native tree species			
+10	If tree community is continuous along river and covers ≥75% of the edge riparian area			
+5	Tree community is nearly continuous and covers at least 50% of the riparian area			
+5	When the number of shrub species is	>3	>4	>5
-5	If there are some man-made buildings in the riparian area			
-5	If there are some isolated species of non-native trees/shrubs			
-10	Presence of communities of non-native trees/shrubs			
-10	Presence of garbage			
	Total Score for Section 3			

Section 4: Channel Alteration

25	Unmodified river channel
10	Fluvial terraces modified and constraining river channel
5	Channel modified by rigid structures along the margin
0	Channelized river
-10	River bed with rigid structures (e.g., wells)
-10	Transverse structures into the channel (e.g., weirs or river crossings)
	Total Score for Section 4

	Final QBR Index Score (Sum of all four sections)