Correspondence of Fish Assemblages in Warmwater Streams to Ecoregions, ECS Sections and Drainage Basins in Minnesota

Lane Urtel
Department of Resource Analysis, Saint Mary's University of Minnesota, Winona, MN 55987

Keywords: Ecoregions, Ecological Classification System, Drainage Basins, Fish Assemblages, Minnesota, GIS, Lance-Williams Dissimilarity Metric, Cluster Analysis

Abstract

The Minnesota Pollution Control Agency (MPCA) was interested in determining if their current drainage basin classification for streams and rivers was the best option in identifying fish assemblage variation in Minnesota. In this study, the statewide database of 1200 stream and river sample sites were tested to verify if Omernik's ecoregions, Ecological Classification System (ECS) sections, or the current drainage basins identified more fish assemblage variability. 248 reference sites were identified by intersections with specific drainage basins, ecoregions, or ECS sections and separated into five size classes based on the area of the watershed a sample site drains. Fish assemblages found at these sites were tested against each other using the Lance-Williams Dissimilarity measure, resulting in 94 dissimilarity matrices, based on the regional framework used for classification. From these matrices, variances of Lance-Williams scores were determined using one-way ANOVA. Only a moderate size class, classified by ECS sections, had fish assemblage variance that was not statistically significant ($p = 0.425$). All other frameworks displayed high amounts of variance in fish assemblages across all size classes (min $p = 0.000$, max $p = 0.031$). Similarity increased as size of the stream increased across all regional frameworks. Cluster analysis was run for each size class to isolate any groupings of sites based on regional framework. Based on the results of this study, variability in stream fish assemblages was independent of Omernik's ecoregions, ECS sections, and drainage basins.

Introduction

In the field of bioassessment, there has been an attempt to classify regions in different manners. Classification of aquatic systems allows for more integrated management of aquatic resources (Omernik, 1995). Presently there are two types of regional framework classifications at the forefront of this discussion: ecological or hydrologic based.

Historically, hydrologic units have been utilized by various government agencies for classification, but ecological regionalization is becoming more popular due to its more holistic approach to classifying ecological regions (Omernik & Bailey, 1997). There has been much research on

Urtel, Lane. 2006. Correspondence of Fish Assemblages in Warmwater Streams to Ecoregions, ECS Sections, and Drainage Basins across Minnesota. Volume 8, Papers in Resource Analysis. 17 pp. Saint Mary's University of Minnesota Central Services Press. Winona, MN. Retrieved (date) from http://www.gis.smumn.edu/Pages/GraduateProjects.htm

the effectiveness of various spatial frameworks in classifying streams across the United States (Van Sickle & Hughes, 2000; Lyons, 1996; Lyons, 1989). There are a few ways in which regions have been defined based on ecological attributes. Just like ecosystems, ecological regional frameworks can be defined at different scales. James Omernik (1995) detailed one regional framework, "ecoregions." There are currently three ecoregional scales developed for the conterminous United States developed by the US Environmental Protection Agency. Level I is the most general and level III is the most detailed (currently the EPA is working with individual states to define a more detailed level IV ecoregions). Ecoregions can be described as areas in which the aggregate of all terrestrial and aquatic ecosystems is different than in other areas (Omernik, 1995; Omernik, 1997).

MN Department of Natural Resources (MDNR) has adopted another regional framework based on ecosystems, called the Ecological Classification System (ECS). ECS is a hierarchical system that systematically breaks areas into progressively smaller pieces termed ecological units, and are based on biotic and abiotic factors such as climate, glacial deposits, topographic relief, soils, flora, and lake/stream/ wetland patterns (Interagency Information Cooperative, 2005).

Similar to ecoregions, there are multiple ECS developed at different scales. Provinces are the most general, with Minnesota comprising three provinces. Sections are the next level in the hierarchy, followed by sub sections and landform associations. MNDNR adopted the ECS framework due to increased awareness of ecosystems and their inter-relationships (Interagency Information Cooperative, 2005).

Historically, streams and rivers have been classified by drainage basins. A drainage basin most simply defined as the topographic area within which apparent surface water runoff drains to a specific point (Omernik & Bailey, 1997). MPCA has identified 10 major drainage basins for the state of Minnesota.

MPCA as been conducting a survey of fish assemblages found in streams and rivers across Minnesota, and is interested in identifying the regional framework that identifies the largest amount of biological variation found in Minnesota's streams and rivers. The goal of this study was to determine if either of these regional frameworks, ecoregions, ECS sections, or drainage basins, better defines the variability found in fish assemblages.

It is hypothesized that the more holistic ecological classifications would better describe variability in fish assemblages across the state than drainage basins.

Methods

Database

The database used for this study was obtained from MPCA Biological Monitoring unit, which contained fish assemblage and habitat data collected for more than 2000 stream and river segments across the state of Minnesota over the last 40 years. Key information used in this project included the fish species identified at each site, various physical characteristics found at each site, land-use for the site's watershed, as well as Global Positioning System (GPS) location of the sample site. For this study, a site was defined as one sample location that encompasses a specific segment of stream or river that was sampled for fish and various habitat measures (Niemela & Feist, 2000). Habitat measures entailed shoreline vegetation, stream morphology, and other physical and chemical parameters.

The database contained more information than required for this study, so necessary tables were exported into a new Microsoft Access database to simplify the database structure. Exported tables were limited to contain only data that was directly relevant to the project; which included GPS location, numbers and type of fish found at each site, watershed landuse, amount of land drained by each site, and various other physical parameters found at each site, such as water temperature, riparian buffer, etc.

Data prep

To assure that data was collected consistently, all data before 1992 was removed from the analysis. MPCA staff previously identified sites as reportable, duplicate, or non-reportable. Only reportable sites were used in the analysis, thus further limiting the number of sites available for analysis.

There are significant differences in fish community structure between cold and warm water streams and rivers. This difference makes it impossible to analyze cold and warm water steams and rivers together; therefore, coldwater streams, those with a temperature less than 72°F, were removed from the data set.

Sites located in the Rainy River Basin were also removed from the database because sampling in this basin was incomplete at the time of this study (Figure 1).

There is much research that supports that as the size of streams increase, the number of species of fish found in those waters also increases (Niemela & Feist, 2000; Lyons, 1996).

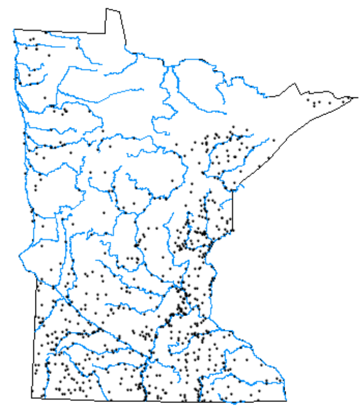


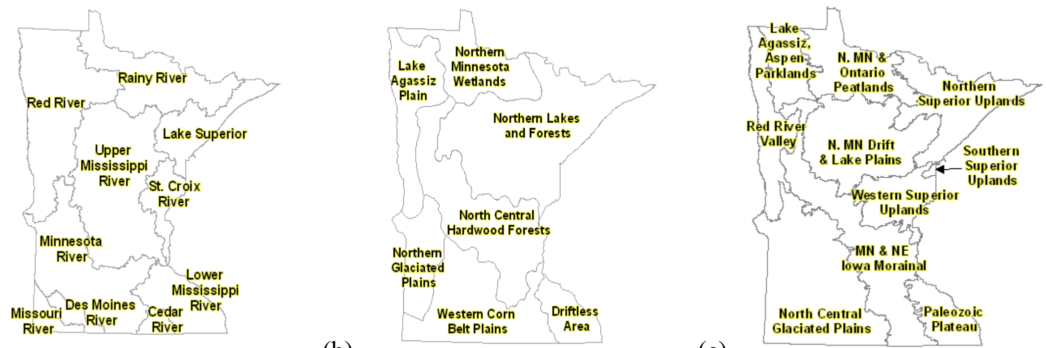
Figure 1. Warmwater stream sample sites by MPCA biological monitoring 1992-2004 and rivers of Minnesota.

Five size classes were created where species richness no longer was correlated with stream drainage area, in square miles (Table 1). To do this, the number of species was plotted against the $\log_{10}$ of the size of the stream drainage (Niemela & Feist, 2000). Five size classes were split out such that species richness was no longer correlated ($\alpha < 0.05$) with drainage area, in square miles (Figure 2).

In order to create a spatial dataset from the non-spatial database, the sample sites were correlated with a spatial location using Geographic Information System (GIS). Using the GPS locations taken at the mid point of each site, the x and y coordinates were joined to the attributes of each site in Microsoft Access 2003. From this table, an x, y event layer was created and exported as a personal geodatabase feature class in ESRI's ArcMap 9.x.

Table 1. Stream size classifications and drainage area ranges.

Size Class	Drainage Area mi^2 (KM^2)	reference sites
1	0-20 (0-51.79)	53
2	20-50 (51.79-129.5)	40
3	50-175 (129.5-453.25)	60
4	175-4000 (453.25-10360)	61
5	4000 + (10360 +)	34
Total	N/A	248



(a) (b) (c)

Figure 2. Three regional frameworks identified for the State of Minnesota.
(a) Drainage basins of Minnesota as defined by Minnesota Pollution Control Agency.
(b) Level III Ecoregions of MN, defined by United States Environmental Protection Agency.
(c) ECS Sections of MN, defined by the Minnesota Department of Natural Resources.

Attributes for ECS section and ecoregion were added to the feature class table and calculated in various ways. The national coverage of level III ecoregions, downloaded from US Environmental Protection Agency (EPA) website, were clipped to the state of Minnesota using the 'clip' geoprocessing tool found in Arc Toolbox, which resulted in seven ecoregions that are found across Minnesota (Figure 2b). The ecoregion coverage was created by, and obtained from the EPA.

ECS sections were downloaded from MNDNR's "Data Deli" website. There was no need to clip it to the boundaries of the state; the data was already set to the political boundary of Minnesota when downloaded from the MNDNR data deli.

The ecoregion and ECS section layers were intersected with the sites and the representative ecoregion or ECS section was attributed to each sample site, a drainage basin was already associated with each sample site.

Reference Site Selection

Reference sites were selected in an attempt to limit the influence of human behavior on the fish assemblages. There is sufficient evidence that shows human development in watersheds can affect the species of fish present; therefore, sites were ranked based on the percentage of disturbed landuse within their watersheds (Omernik, 1995). Disturbed landuse, included mining operations, urban development and agriculture and were provided by MPCA personnel. This information was attributed to each sample site using a custom ArcObjects script. This script was developed because a table relationship or join were not appropriate since only one field was desired from a table.

Selecting reference sites in this manner, resulted in sites being localized in the northeast corner of the state, and not evenly distributed across the state; as was needed for this project. To select reference sites, a generic grid was created so reference sites would uniformly cover the state. This grid was a set of 30 square cells measuring five columns by six rows. The cells were shifted spatially to minimize area found outside the study area. Cells that fell outside the state boundary were removed, with the remaining 21 being sufficient to cover the entire state (Figure 3). The cell sizes were estimated based on the mean size of a regional framework (basins, ECS sections, or ecoregions), and to harness a large enough sample set.

To obtain reference sites, the four least disturbed sites, based on watershed landuse statistics, were selected and added to the reference table. This procedure was repeated for each cell across all five size classes. If one size class did not have four acceptable sites within a cell, as many as possible were identified.

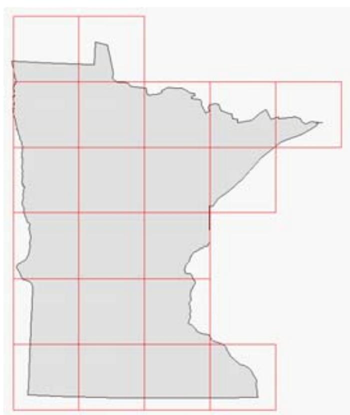


Figure 3. Grid utilized for selecting reference sites to ensure even distribution across MN.

Ideally, sites with missing landuse scores were not used as reference sites. There were exceptions in size class 5, and were required to obtain a large enough sample set for this size class. The resulting 248 reference sites were then exported into their own feature class for simplicity reasons (Figure 4).

Once the reference sites were determined, a table from the original database detailing the fish found at each site was related to the reference sites feature class. Fish assemblages for each site were then queried from every size class based on each regional framework. This created 94 separate query tables that detailed the fish assemblages found at each site based on its size class and regional framework (ex. size class 3 in the St. Croix River drainage basin).

Data Analysis

The queried fish assemblage tables were the focus of future statistical analysis. All statistical analysis was run in SPSS 13.0. The fish assemblages were tested for presence/absence and not relative abundance; therefore, each query table was converted from containing the relative abundance of fish found, to showing the presence/absence of species. A field with a value of 1 was added to the fish table, and the 94 fish assemblage queries described above were re-run and saved as DBF tables.

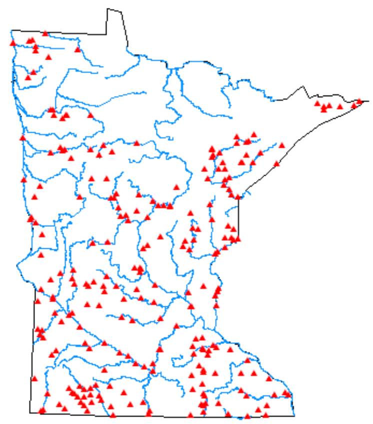


Figure 4. Reference sites identified for analysis of warm water streams with major rivers of MN.

Rare (found at less than 5% of sites) and exotic species were not identified or removed from these queries. It has been shown that rare and exotic species can cause noise in statistical analysis; these results were based on analyses using relative abundance, not presence/absence (Lyons, 1996; Van Sickle & Hughes, 2000). For this study, it was assumed that analyzing presence/absence limited the impact of rare and exotic species, and was thus, left in for analysis.

All query tables were pivoted to make them compatible with the Lance-Williams dissimilarity analysis function in SPSS. Tables were pivoted in Microsoft Excel and saved in DBF table format, so they could be brought into SPSS easily. After pivoting each table, the result was a binary table relating the presence or absence of fish species at each site found in a size class – regional framework classification (Table 2).

The Lance-Williams non-parametric analysis created a dissimilarity matrix for each size class

Table 2. Sample pivoted table ready for import into SPSS for Lance-Williams dissimilarity matrix creation.

Fish Species Identifier	**Sample Site Identifier**				
	63	64	69	75	**Presence /absence of fish species found at sample site**
162153	1	1	0	1	
163363	1	1	0	1	
163376	1	1	1	1	
163382	1	1	1	1	
163395	1	0	0	1	
163446	1	0	0	0	
163517	1	1	0	0	
163592	1	1	1	1	
163594	0	1	0	0	
163836	1	1	1	1	
163873	1	1	1	0	
163895	1	1	1	1	

and classification scheme (Table 3). Each site was analyzed with every other site in its size class and regional framework independently. The calculation determined the dissimilarity between two features with a dissimilarity score range from 0-1. As values approach 1, the two sites are considered

Table 3. Sample Lance-Williams dissimilarity matrix created for table 2 above.

	Binary Lance-Williams Nonmetric Measure			
	63	**64**	**69**	**75**
63	.000	.200	.304	.250
64	.200	.000	.300	.238
69	.304	.300	.000	.368
75	.250	.238	.368	.000

dissimilar, and as the dissimilarity score approaches 0, the two sties are more similar.

The formula to calculate the Lance-Williams dissimilarity value for two sites, detailed below, is repeated for each site pair within a particular set of sites creating a dissimilarity matrix (Table 3).

$BLWMN_{(x,y)} = (b + c)/(2a + b + c)$

x = site x
y = site y
a = count of species present in site x
b = count of species present in site y
c = count of species common to sites x and y

Dissimilarity values were plotted as box plots for each framework (Appendix 1). Box plots were created for each size class and framework to display any trends in dissimilarity of fish assemblages.

The mean dissimilarity value was then calculated for each size class and regional framework. These mean values were tested for across group variance using one-way ANOVA, as well as graphically plotted to view general trends. Box plots were created to visualize relationships better between sites of one regional framework to the sites based on another regional framework (Appendix 1).

Hierarchical cluster analysis was utilized to identify any natural groupings. Mean Lance-Williams scores for each size class and regional framework was tested using SPSS hierarchical classification functionality. Distances were calculated as Euclidean distances. The cluster analysis was then visually represented as dendrograms for each size class (Appendix 2).

Table 4. Within group variance of Lance-Williams scores for all three regional frameworks. Bold values indicate size classes where variance is considered equal; F values generated from One-way ANOVA analysis.

	River Basins		ECS Sections		Ecoregions	
Size Class	F-Value	p-value	F-Value	p-value	F-Value	p-value
1	10.976	0.000	22.450	0.000	4.892	0.001
2	3.436	0.006	5.600	0.000	14.199	0.000
3	4.298	0.000	**1.010**	**0.425**	7.795	0.000
4	10.73	0.000	3.226	0.003	6.651	0.000
5	2.773	0.031	3.561	0.008	7.326	0.000

Results

Box plots of the Lance-Williams scores revealed two patterns. First, mean Lance-Williams scores did not seem to differ across regional framework. Secondly, similarity seemed to increase with size class (Appendix A, Figure 5). Similarity of sites within a given regional framework differed significantly (Appendix 1). Based on the sample sites analyzed, only one of the regional frameworks explained the variability found within a group sample sites; ECS section for size class 3 (Table 4).

Table 5. Total mean calculated Lance-Williams Non-Metric dissimilarity scores by size class across regional framework.

Size Class	Drainage Basin	Eco-Region	Eco-Section
1	0.62	0.71	0.62
2	0.51	0.53	0.55
3	0.46	0.55	0.51
4	0.44	0.50	0.49
5	0.37	0.39	0.38

Similarity of sites across regional framework showed the same general trend; as size class increased, the dissimilarity values decreased. In other words, as drainage size increased, so did the similarity of sites (Appendix A, Table 5). Table 5 shows mean Lance-Williams scores for the three regional frameworks broken down by size class. Table 5 also displays that as size class increased, dissimilarity decreased. Between class variance calculated for each size class showed no significant difference.

The three regional frameworks only show general trends. The drainage basin framework always had the lowest dissimilarity score as compared to the other regional frameworks for each size class (Table 5 and Figure 5). Similarly, Ecoregions had the highest dissimilarity for each size class except for size class 2 (Figure 5). Neither of these trends displayed any statistical importance at a confidence level of $\alpha = 0.05$. In size class one, the drainage basin and ECS section frameworks had the same mean dissimilarity scores and ecoregions displayed a higher mean dissimilarity (Figure 5). Other information gleaned from figure 5, includes that increasing size classes displayed more similar fish assemblages than smaller size classes (Appendix A).

There was no clustering of any framework based on fish assemblage dissimilarity (Appendix B). None of the frameworks clustered with any regularity for any size class.

Conclusions

It was expected that fish assemblage similarity would be more influenced by

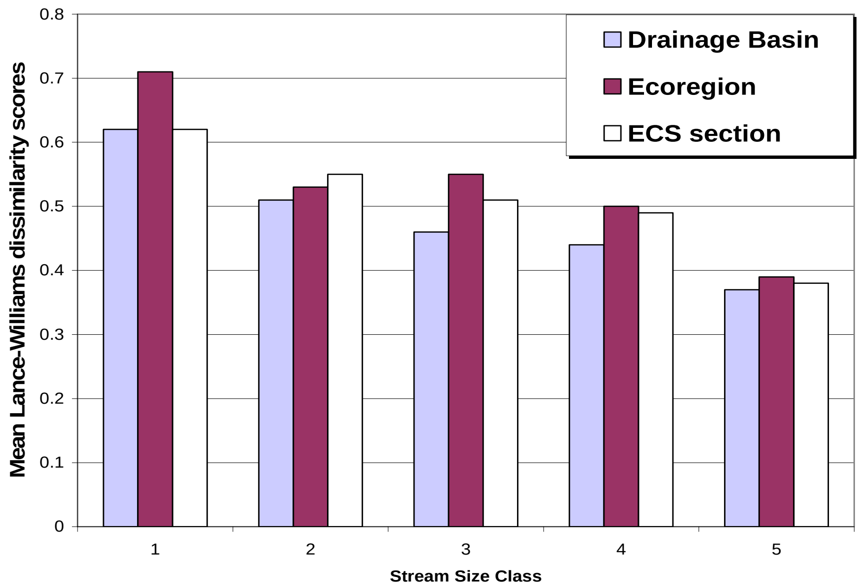


Figure 5. Mean Lance-Williams scores for each size class across each regional Framework.

either ecoregions or ECS sections than drainage basins. It is apparent that a small amount of biological variance is explained by these frameworks, but drainage size shows more correlation to fish assemblage variance (Appendix 1). This occurrence may be due to connectivity of streams and rivers. Sample sites in smaller streams were much more isolated from each other than large rivers. Due to the lack of sampling locations, the very large size class sample sites (size class 4 and 5), it was often easy to visualize these sites as part of the same river systems, and thus have a higher amount of connectivity (Figure 4). This connectivity allows for migration of fish species, which may result in higher rates of assemblage similarity.

With sites being part of the same river system, connectivity of sites seemed to make more sense in explaining what types of fish species were found at each sample site. If connectivity were important in what species are found in a particular stream or river, then the basin regional framework would be the best fit for explaining fish assemblages in the state of Minnesota.

Looking at Figure 5, the basin framework mean Lance Williams dissimilarity score was always the lowest of the three. This difference is not statistical, but qualitative. Using the same arguments as above, that stream connectivity created more similar fish assemblages, the trend of basins having more similar fish assemblages is strengthened.

One other explanation of larger streams and rivers having fish assemblages more similar than those of smaller streams is that of scale. Both ecoregions and ECS sections were developed on a national scale and encompass geo-climatic observations. The geo-climactic observations are based on small-scale data, and do not incorporate localized phenomenon (Omernik & Bailey, 1997). Since larger riverine systems are more influenced by these larger scale climatic occurrences than small streams, it seems that larger streams and rivers tend to show more correspondence with ecoregions or ECS sections.

The method used for creating reference sites was simplistic, only looking at the percentage of disturbed landuse. There is much literature that describes the plethora of attributes in streams that affect the communities found within them (Lyons, 1996; Van Sickle & Hughes, 2000). Using the percent of disturbed landuse as the only parameter for a reference site created a non-uniform set of sample sites, resulting in a higher amount in variability at these sites. Disturbed landuse percentages generally increased from north to south. The term reference site can be better termed "best available." In order to create a true reference site, a more robust detailing of sample sites would be required.

Not only was reference site selection simplistic, it did not account for the variability inherent in ecoregions. Hughes et al (1994) describe that development of reference sites can be hindered by the heterogeneity of ecoregions. This variability of reference sites, could have led to increasing the base level of variability found in streams based on any regional framework.

Lyons (1996) identified gradient as important in determining fish assemblages as stream temperature (cold vs. warm). The database used in this project contained gradient for some of the sites, but not all. This attribute was not used in the selection of reference sites because the number of sites with null gradients seemed to be too large to obtain an acceptable dataset for analysis.

Lyons (1996) found that ecoregional classification of streams was important in explaining variation in fish assemblage composition. Results of this paper were not in line with these findings. In his analysis, Lyons looked at both fish assemblages and basic habitat such as stream temperature, drainage area, and gradient. This paper followed Lyons's format in isolating stream temperature and drainage area, but did not consider stream gradient for defining sites analyzed. Gradient was not utilized in this paper because of the lack of data. If incorporated, a much more complex dataset would have resulted.

Defining reference sites based on gradient would have doubled the number of classes being tested. Fish assemblages are vastly different in a low gradient stream from the assemblage found in a high gradient stream (Thorn & Anderson, 1999). It was assumed that the ecosystem-based frameworks would account for this variation, but the scale of frameworks was not effective in isolating this variability.

Lyons (1996) found that stream temperature (coldwater vs. warmwater), drainage size, and ecoregion were the three most important factors in classifying the streams of Wisconsin. This paper isolated both stream temperature and drainage area by only analyzing warmwater streams, and the creation of the size classes. However, it became apparent that ecoregions did not explain the amount of variation found in the fish assemblages in Minnesota when ignoring stream gradient.

Research has been conducted that indicate that rare and exotic species can complicate statistical computations (Lyons, 1996). It was assumed that since the Lance-Williams statistic only relies on species presence/absence, the effect of rare and exotic species was minimized. No attempt was made to isolate any one, or group, of fish species for any part of analysis; fish assemblages were analyzed in their entirety. The resulting variability may have skewed dissimilarity measures, but are also representative of what fish are found in the streams and rivers of Minnesota

Similarly, using the Lance-Williams dissimilarity test required the loss of species abundance data. Since the statistic only tests for presence/absence of species, certain results will be altered. For instance, if two sites each have species A and B, they will be considered similar. The issue stems from the relative abundance of species A. In site 1, there may be a single individual of that species, where as in site 2, species A comprises more than 50% of the assemblage. Does the fact that the species is present enough to say it is similar to another site?

Feminella (2000) found that macroinvertebrate communities were approximately as similar within ecoregions as drainage basins. The results of this study indicate the same kind of result; ecoregions and drainage basins show similar assemblages of aquatic fauna.

In the state of Minnesota, classifying streams using ecoregions, ECS sections, or drainage basins does not show any difference in explaining fish assemblage variability. More research should be considered to analyze species abundance, not just presence/absence, as well as utilizing more stringent criteria for selecting reference sites. In the criteria for reference sites, gradient and other stream morphology should be taken into account.

The complexity of the ecosystems in Minnesota is great and ecoregions, ECS sections, or basins are not complex enough to use as classification schemes alone. Van Sickle & Hughes (2000), found that taking a combination of ecoregion and drainage basin as a valid classification scheme for streams and rivers in Oregon. A similar test should be run in Minnesota to see if the hybrid of drainage basin and ecoregion, or ECS section, best describes the variability in fish assemblages than ecoregions, ECS sections, or drainage basins individually.

Acknowledgements

I would like to thank those of the Biological Monitoring unit of the Minnesota Pollution Control Agency, especially Scott Niemela, Roy Wetzell, and Bob Murzyn for their assistance and technical guidance. Thank you to Dr. David McConville and Mr. John Ebert in the department of Resource Analysis at Saint Mary's University for your ongoing support in all phases of this project. I would also like to thank Mr. Ryan Kiefer and Mr. Chad Richtman of Saint Mary's University of Minnesota for help with custom scripts and assistance in deriving statistical relationships.

Literature Cited

Feminella, Jack W. 2000. Correspondence Between Stream Macroinvertebrate Assemblages and 4 Ecoregions of the Southeastern USA. Journal of the North American Benthological Society. 19(3): 442-461.

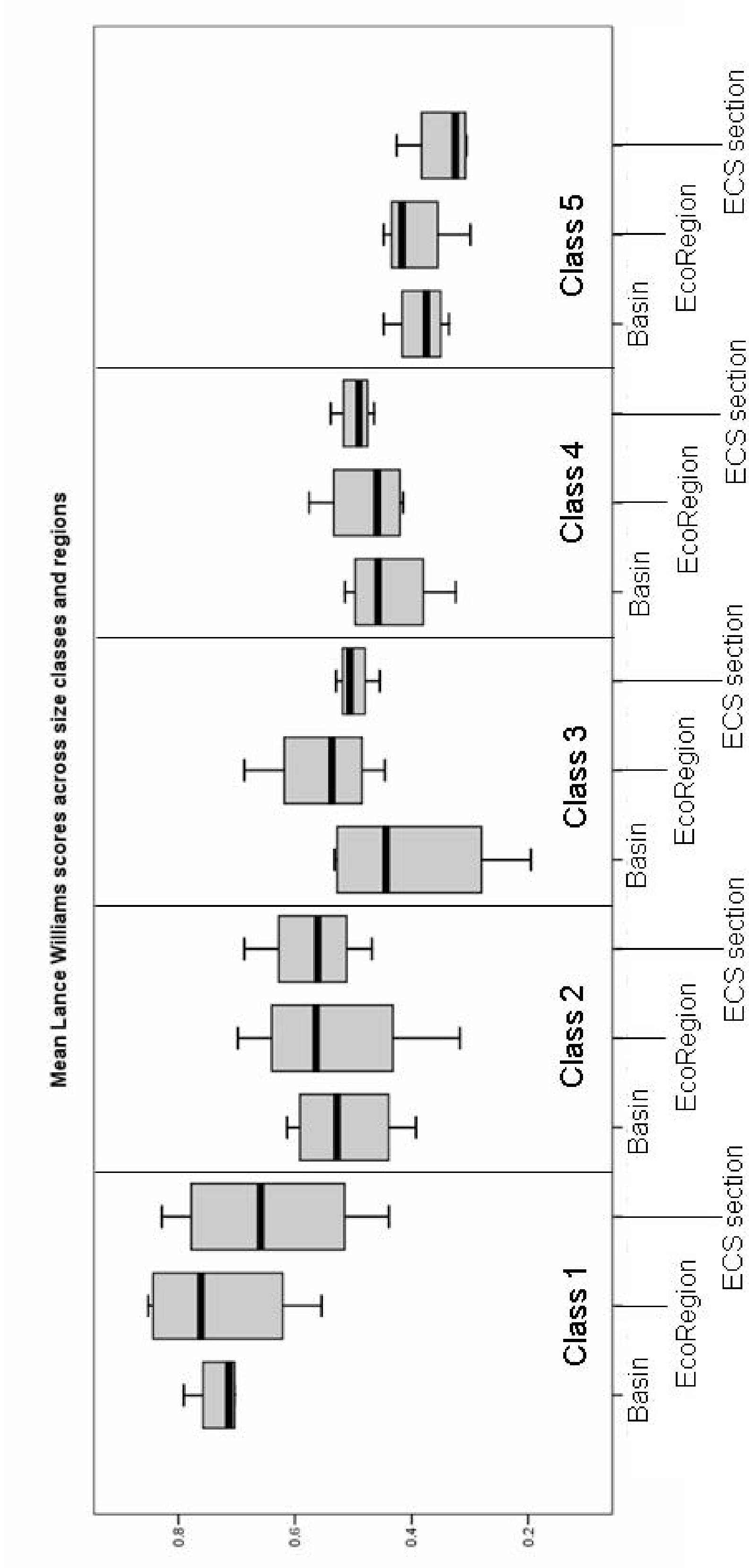
Hughes, R.M., Steven A. Heiskary, William J. Matthews, Chris O. Yoder. 1994. Use of Ecoregions in Biological Monitoring. *In* S.L. Loeb and A. Spacie, editors. Biological Monitoring of Aquatic Systems. Lewis Publications, Ann Arbor. pp 125-154.

Interagency Information Cooperative. 2005. What is Ecological Classification System (ECS)?. http://iic.gis.umn.edu/finfo/ecs/ecs2.htm.

Lyons, John. 1996. Patterns in the Species Composition of Fish

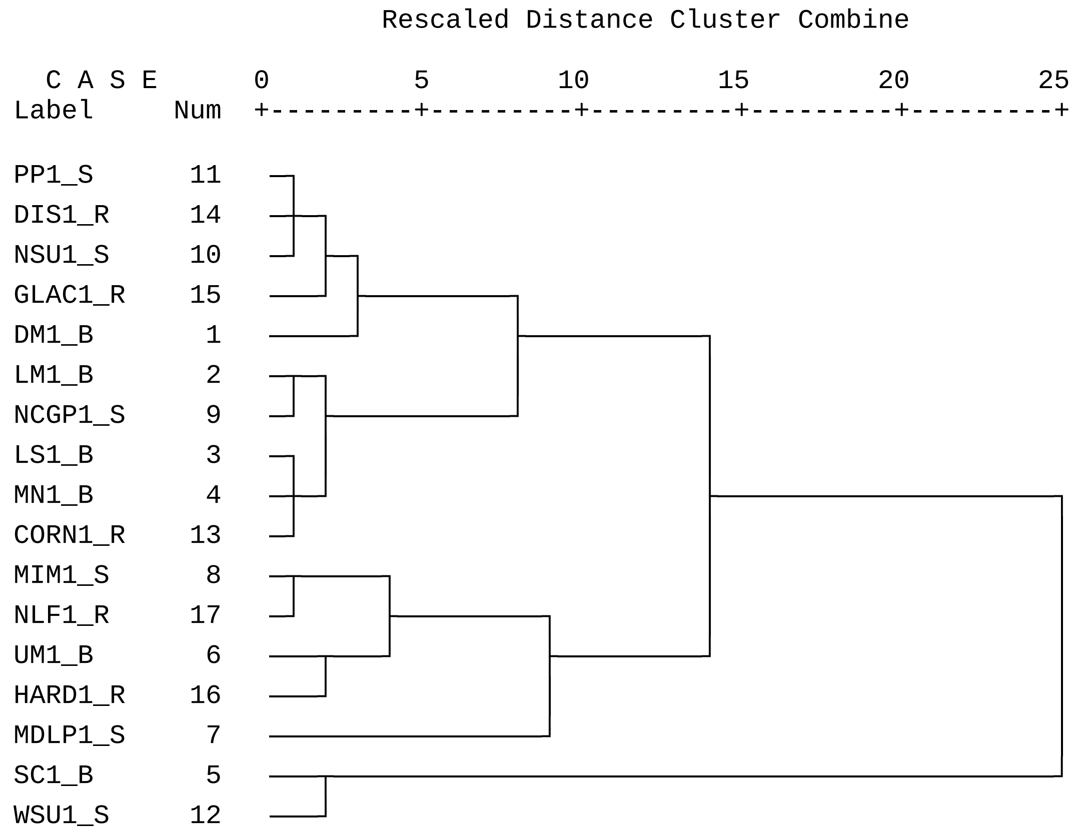
Assemblages Among Wisconsin Streams. Environmental Biology of Fishes. 45:329-341.
Lyons, John. 1989. Correspondence Between the Distribution of Fish Assemblages in Wisconsin Streams and Omernik's Ecoregions. American Midland Naturalist, 122(1): 163-182.
Niemela, Scott, Michael Feist. 2000. Index of Biotic Integrity Guidance for Coolwater Rivers and Streams of the St. Croix River Basin in Minnesota. St. Paul, MN: Minnesota Pollution Control Agency. 47 p.
Omernik, James M. 1995. Ecoregions: A Spatial Framework for Environmental Management. *In* W.S Davis and T.P. Simon editors. Biological Assessment and Criteria, Tools for Watershed Resource Planning and Decision Making. Lewis Publisthers, Boca Raton, FL pp 45-65.
Omernik, James M., Robert G. Bailey. 1997. Distinguishing Between Watersheds and Ecoregions. Journal of the American Water Resources Association. 33(5):935-949.
Thorn, William C., Charles S. Anderson. 1999. A Provisional Classification of Minnesota Rivers with Associated Fish Communities. Minnesota Department of Natural Resources Special Publication 153.
Van Sickle, John and Robert M. Hughes. 2000. Classification strengths of ecoregions, catchments and geographic clusters for aquatic vertebrates in Oregon. Journal of the North American Benthological Society. 19(3):370-384.

Appendix A. Box plots for Lance-Williams scores for fish assemblage dissimilarity for streams and rivers across Minnesota.



Appendix B. Cluster analysis dendrograms for size classes 1 – 5 respectively. Sites with shorter horizontal linkage are more closely related. Abbreviations identify name of framework unit, size class, and framework identifier. *_S = ECS section framework, *_R = Ecoregion framework, *_B = drainage basin framework

Size Class 1



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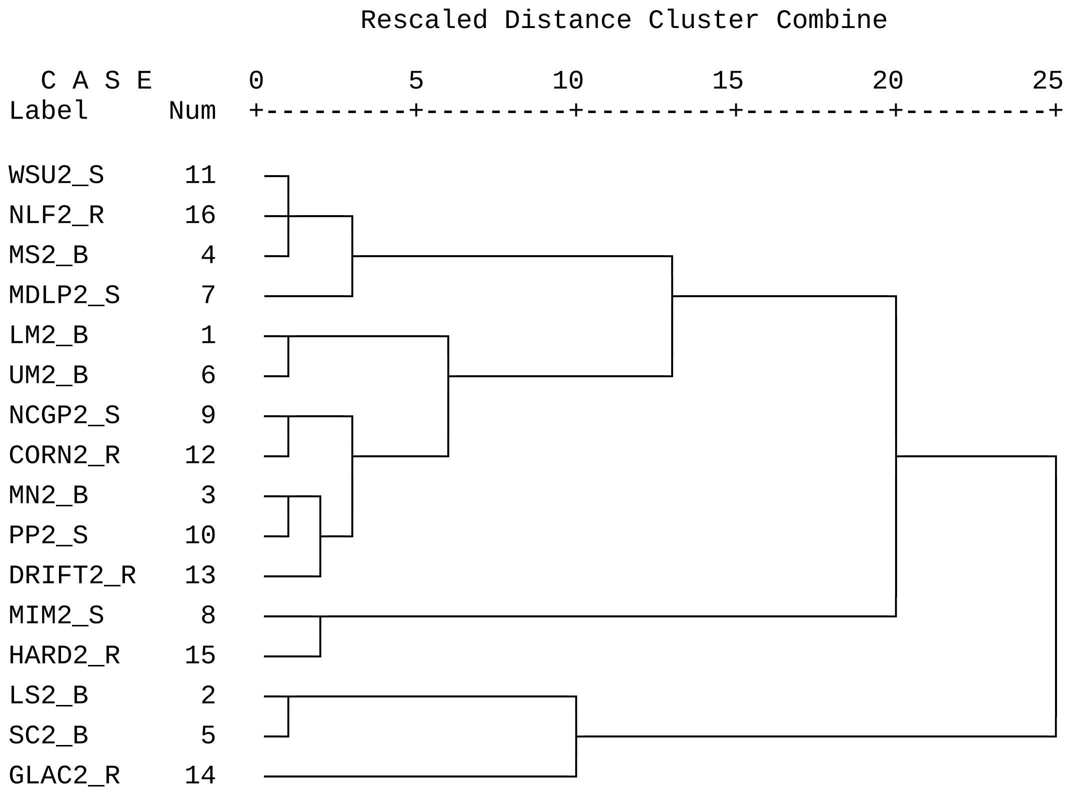
Size Class 2



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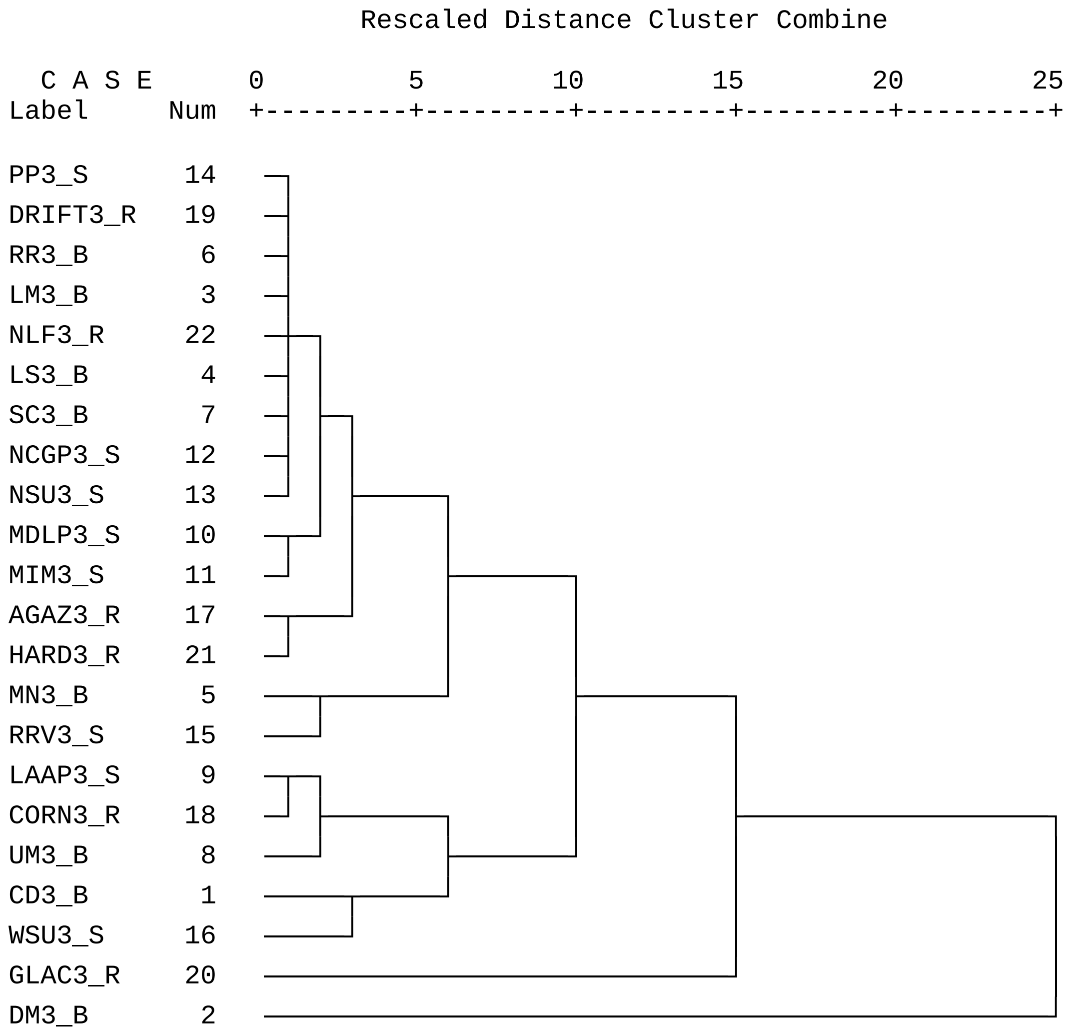
Size Class 3



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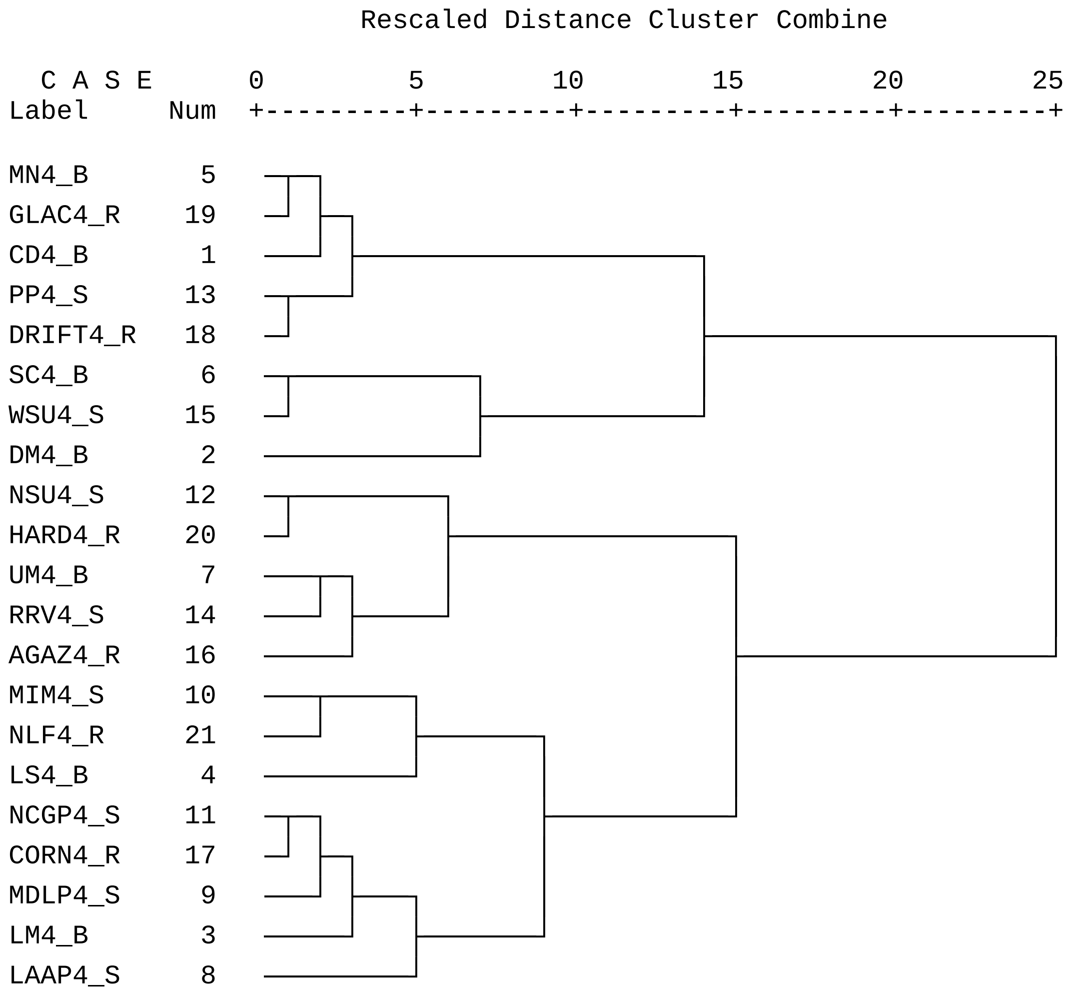
Size Class 4



Appendix B continued.

Size Class 5