Methodology for Using Field Data to Identify and Correct Wisconsin Stream "Natural Community" Misclassifications

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Summary

All stream and river segments within Wisconsin are classified into one of nine fish-based Natural Communities for bioassessment based on long-term summer maximum water temperature and minimum flow patterns. Temperature and flow values are estimated from landscape-scale, GIS-based, predictive statistical models. These models perform quite well but nonetheless yield inaccurate values for many segments, leading to Natural Community misclassifications. The methodology described here uses actual fish data from bioassessment samples to determine if the predicted Natural Community of a stream segment is appropriate and, if it is not, to assign the segment to the correct Natural Community. The methodology has up to four steps. First, the proportions of the fish catch in different thermal and stream-size guilds are calculated and compared with expectations for the predicted Natural Community. If catches are within the expected ranges, then the predicted Natural Community is retained. If they fall outside these ranges, the second step occurs. In this second step, the proportions of intolerant and tolerant individuals in the fish catch are compared with expected values for the Natural Community. If both proportions are outside expected ranges, then differences between observed and expected thermal and stream-size guilds are likely due to degradation, in which case the predicted Natural Community is retained. If fish catches do not suggest degradation, the third step takes place. In this third step, air temperature and precipitation data are compiled from the nearest weather station. If the mean air temperature in the month before sampling or the total precipitation in the 12 months before sampling were in the top or bottom 10% of values over the last 25 or more years and the nature of the weather was consistent with the mismatch between observed and expected fish catches (e.g., coldwater fish less than expected in an unusually warm period), then weather conditions may have modified fish community characteristics temporarily, and the validity of the predicted Natural Community cannot be determined. A second fish community sample from a non-extreme weather period must be analyzed beginning at step one to determine the appropriate Natural Community for the reach. However, if weather conditions prior to sampling were not extreme or the extreme weather could not explain fish community patterns, the fourth and final step occurs. In this step, best professional judgment is employed to determine if other segment- or sample-specific factors could account for differences between expected and observed proportions of fish thermal and stream-size guilds. If these other factors are judged to be sufficiently important, the predicted Natural Community should be retained. However, if they are judged not sufficiently important, then the Natural Community designation should be changed to match the observed proportions of the fish thermal and stream-size guilds.

Background

Wisconsin streams are highly diverse and contain a wide range of biological communities. This natural diversity must be considered when conducting bioassessments. Presently, inherent variation in fish communities among streams is accounted for through the "Natural Community" classification system. Each of the many stream segments in the state is grouped into one of nine Natural Communities based on estimates of long-term average stream low flow (annual 90% exceedence flow) and summer maximum water temperature (maximum daily mean water temperature) (Table 1), environmental factors that are particularly important in determining stream fish communities. Analyses indicate that stream fish communities from relatively undegraded streams within a particular Natural Community are more similar to each other than they are to fish communities from relatively undegraded streams in other Natural Communities. Each of the Natural Communities has a specific Index of Biotic Integrity (IBI) that is optimized for use in bioassessment.

Wisconsin has over 160,000 discrete stream segments, and relatively few of these have data on flow, water temperature, or fish communities. Thus, segments are initially classified into Natural Communities based on landscape-scale statistical models that predict long-term flows and temperatures from watershed characteristics such as watershed size, surficial and bedrock geology, topography, climate, and land cover. These predictions represent the realistic potential Natural Community of the segment under current land-cover and climate conditions in the absence of significant site-specific human impacts, such as local riparian degradation. In independent validation tests, the models were found to be largely unbiased and to predict the correct Natural Community for about 70-75% of test segments. However, for some test segments the predicted Natural Community was different from the Natural Community that actually occurred.

Errors in Natural Community classification will reduce the accuracy of bioassessment. Misclassified streams will be assessed with the wrong IBI, and their environmental condition may be misjudged. This could lead to some segments being rated as in good condition when in fact they were in poor condition, in which case they would not receive appropriate regulatory and restoration attention. Alternatively, other segments could be scored as poor when they were actually good, and effort could be wasted in trying to restore them unnecessarily. Misclassified segments can only be detected through collection of appropriate field data. However, there are no guidelines on what types of data should be collected, how the data should be interpreted, and how new classifications should be determined. This white paper proposes protocols for using field data to identify misclassified stream segments and to determine their appropriate Natural Community classification.

The Issue

Since the statistical models of flow and water temperature misclassify some stream segments into the wrong Natural Communities, when and how should field data be used to assign individual stream segments into different and more appropriate Natural Communities?

Proposed Methodology

Detection:

A potentially misclassified stream segment can be detected either during a field survey or via a review of existing field data. Conceptually, misclassification could be indicated by discrepancies between predicted and actual measurements of flow, water temperature, or the fish community. However, for several reasons, the most reliable and cost-effective indicator of misclassification will be fish community data. The Natural Community classification is based on predicted average summer maximum temperature and annual low flow over a 20-year period. Neither value can be measured directly without an expensive long-term monitoring program, impractical in nearly all cases. Short-term approximations are possible, but they require multiple site visits, and the estimated values are highly variable and particularly sensitive to short-term variations in weather (e.g., droughts and floods, heat-waves and cold-spells). Fish data, on the other hand, require only a single site visit, utilize the same information as the actual bioassessment, and are relatively more stable and less influenced by weather extremes than water temperature and stream flow measures.

Fish data can provide insight into both the thermal and flow (stream-size) attributes of stream segments. In the absence of major environmental degradation, each Natural Community has a characteristic fish community, with expected ranges of coldwater, transitional, and warmwater individuals (Table 2), and small-stream, medium-stream, and large-river individuals (Table 3). The observed relative abundances of fish thermal and stream-size guilds can indicate whether the designated Natural Community is correct.

However, not all mismatches between expected and observed fish community characteristics represent a Natural Community misclassification. Often, fish communities have been modified by environmental degradation of the stream segment. Or fish may display temporary distribution and abundance shifts in response to unusual weather conditions. The predicted Natural Community classification represents the potential of the segment in the absence of major site-specific environmental impacts and under average climate conditions, whereas the observed conditions will incorporate the effects of weather extremes and local human activities in and along the stream. The segment may have fish community values outside the range of its predicted Natural Community because it has poor environmental quality or because of atypical weather, not because it has been misclassified. Thus, when predicted and observed values do not agree, the challenge is determining whether this disagreement occurs because the predictions are wrong or because the predictions are correct but the segment has been environmentally degraded or has recently experienced extreme precipitation or air temperatures.

It is important to note that the process of determining whether the designated Natural Community of a stream segment is accurate is separate and different from the process of bioassessment of that segment with the IBI, even though both processes use the same fish catch data. The Natural Community process takes place first and must be completed before the IBI process can begin. The IBI process relies on an accurate Natural Community classification to determine which IBI should be employed. The fish metrics used to determine the appropriate Natural Community are largely different from those used in the IBI bioassessment; only the percentage tolerant fish metric occurs in both. The determination of segment degradation in the Natural Community process is not a substitute for bioassessment, and the ultimate determination of the ecological health of the segment should rely on the IBI analysis.

Data Interpretation:

Two types of data are necessary to assess the accuracy of the designated Natural Community classification of a stream segment: fish community data and weather and climate information.

Fish Community: Standard fish bioassessment procedures can be used to determine the relative abundances of fish individuals within each of the thermal and stream-size guilds at a stream segment. These abundances can then be compared with expectations for the predicted Natural Community from Tables 2 and 3. If the observed abundances differ from the expected abundances (e.g., the sample yields a high percentage of coldwater individuals but the expectation is that coldwater individuals should be rare), then the segment may be misclassified. However, before a final determination can be made, the environmental quality of the segments and the recent weather it has experienced need to be considered. Environmental quality can be inferred from the fish community data. Environmental degradation tends to eliminate intolerant species and elevate the relative abundance of tolerant individuals. If a site has both no intolerant species and more tolerant individuals than expected (Table 4), then the fish community may be reflecting human impacts rather than an inappropriate Natural Community classification. If abundances of either intolerant or tolerant individuals or both are within appropriate ranges, then weather and climate information needs to be examined.

Weather and Climate: Weather extremes complicate determination of the appropriate Natural Community because fish may shift locations and increase or decrease in abundance in response to unusual air temperatures and amounts of precipitation. Local data on recent weather and long-term climate patterns are available statewide from weather stations. Long-term climate information provides the average monthly air temperature and total annual precipitation for a stream segment, whereas recent weather reveals the actual air temperatures and precipitation the segment experienced just before the fish community was sampled. If air temperatures during the month before sampling or total precipitation during the 12 months previous to sampling are not extreme – not in the top or bottom 10% of values over the last 25 or more years – then unusual weather probably does not explain differences between observed and expected fish relative abundances, and a Natural Community misclassification is likely. Conversely, if air temperatures or precipitation are extreme, then unusual weather may account for the differences, in which case the direction of those differences becomes important. Differences in fish communities consistent with the weather extremes, such as more coldwater and large-river species than expected during unusually cold and wet periods or fewer coldwater and large-river species during unusually hot and dry periods, could merely reflect atypical weather and not indicate a Natural Community misclassification. The fish community would need to be re-sampled when air temperatures and precipitation were closer to average to determine the appropriate classification. However, differences inconsistent with weather extremes, such as fewer coldwater and large-river species than expected during unusually cold and wet periods or more coldwater and large-river species during unusually hot and dry periods, would be evidence that the segment was misclassified.

Determining the Appropriate Natural Community:

The use of field data to determine the appropriate Natural Community classification of a stream segment involves a process of answering up to four questions:

Question 1: **Does the actual catch of fish in the three thermal and three stream-size guilds match the expectations for the designated Natural Community of the segment?** Fish data should be collected from the study segment following standardized bioassessment procedures. All fish collected (excluding those that appeared to have been stocked or released/escaped from a bait bucket or ornamental pond or tank within the last 90 days) should be classified into the appropriate thermal and stream-size guilds based on Table 5. Percentages of the fish catch in each of the three thermal guilds (based on numbers of individuals) should be compared with the expected range for that thermal guild from Table 2 for the designated Natural Community of the segment. If all the observed percentages are within the expected ranges, then the designated thermal Natural Community is probably appropriate and should be retained. However, if one or more of the observed thermal guild percentages falls outside the expected range then the designated thermal Natural Community may be inappropriate and the analysis should continue to Question 2. Similarly, percentages of the fish catch in each of the three stream-size guilds (based on numbers of individuals) should be compared with the expected range for that stream-size guild from Table 3 for the designated Natural Community of the segment. If all the observed percentages are within the expected ranges, then the designated Natural Community is probably appropriate and should be retained. However, if one or more of the observed stream-size guild percentages falls outside the expected range then the designated stream-size Natural Community may be inappropriate and the analysis should continue to Question 2.

Question 2: **Can environmental degradation at the segment explain differences between observed and expected percentages for the thermal or stream-size guilds?** Fish should be classified into the appropriate tolerance guilds based on Table 5 and then the percentages of the fish catch in the intolerant and tolerant tolerance guilds (based on numbers of individuals) should be compared with the expected range from Table 4 for the designated Natural Community of the segment. If intolerant species are absent and the percentage of tolerant individuals is higher than expected (both must be true) then the segment is likely degraded, and deviations from expected ranges for the thermal or stream-size guilds could have been caused by the degradation rather than a Natural Community misclassification. In such a case the designated Natural Community is probably appropriate and should be retained. However, if intolerant species are present or the percentage of tolerant species is within the expected range, or both, then the segment is unlikely to be degraded, and therefore degradation cannot explain deviations from expected ranges for the thermal or stream-size guilds. In that case, the analysis should continue to Question 3.

Question 3: **Can recent weather extremes at the segment explain differences between observed and expected percentages for the thermal or stream-size guilds?** Long-term ($\geq$ 25 year period) data on mean air temperatures for the month before sampling and total annual precipitation for the 12 months before sampling should be obtained from the weather station nearest to the segment, and the mean monthly air temperature for the month prior to the sampling and the total precipitation for the 12 months prior to sampling should be calculated. Values for monthly mean air temperature and total annual precipitation should be compared with the values from previous years to determine if weather conditions just before sampling were extreme for that segment, that is, in the bottom 10% or top 90% of values across all years. If the weather was not extreme, then the analysis should continue to Question 4. If the weather was extreme, then the nature of the weather extremes should be examined. Unusually cold conditions could lead to relatively more coldwater or transitional individuals and fewer warmwater individuals but would be unlikely to lead to fewer coldwater or transitional individuals and more warmwater individuals. Unusually wet conditions could lead to relatively more medium-stream or large-river individuals and fewer small-stream individuals but would be unlikely to lead to fewer medium-stream or large-river individuals and more small-stream individuals. The opposite expectations would be likely for unusually warm or dry conditions. If extreme weather conditions just before sampling were consistent with differences between observed and expected fish communities, then the recent weather conditions might account for these differences, and fish sampling would need to be repeated during a non-extreme year and the resulting data analyzed beginning with Question 1 in order to determine if the designated Natural Community was appropriate. However if the extreme weather conditions just prior to sampling were inconsistent with the differences between observed and expected fish communities, then recent weather conditions would be unlikely to account for the differences, and the analysis should continue to Question 4.

Question 4: **Considering other available information on fish, weather, and segment characteristics and location, and employing Best Professional Judgment (BPJ), is there sufficient justification for changing the Natural Community classification of the segment?** The determination of whether to change the Natural Community classification cannot be a completely automated process and must consider other relevant information, sometimes qualitative or anecdotal in nature, which could influence which fish were actually captured from a stream segment. Even if the answers to the previous three questions support a change in the Natural Community designation for a segment, a biologist familiar with the segment and more generally the streams and rivers of the region should review all available information and use BPJ to decide whether a change is actually warranted. Consideration should be given to factors besides degradation and unusual weather that might account for differences between observed and expected fish abundances. These could include factors that call into question the representativeness of the fish sample (e.g., difficult sampling conditions because of high water or bad weather, or equipment problems that reduced effectiveness) and suggest that a new sample should be collected and analyzed, and factors related to unique characteristics of the segment that might account for differences between observed and expected fish percentages (e.g., a cool-cold headwater segment that emptied directly into a large warmwater river might have more warmwater and large-river fish than expected because of strays from the river) and suggest that the existing Natural Community classification should be retained.

However, if the sample thought to be representative, and the segment is judged to not have unique characteristics, then a new Natural Community classification should be assigned based on the observed relative abundances of fish thermal and stream-size guilds using the criteria in Tables 2 and 3. The new classification, along with supporting data and analyses, should be documented in a standardized format (See Appendix) and made available for incorporation into the statewide stream Natural Community database.

Example Calculation:
Little Scarboro Creek, Kewaunee County; October 29, 2008; 100 m backpack sample
Designated Natural Community – Cool-Cold Transition Headwater

<u>Fish catch</u>
American Brook Lamprey N=2 (Transitional, Medium-Stream, Intolerant)
Western Blacknose Dace N=1 (Transitional, Small-Steam, Tolerant)
Creek Chub N=25 (Transitional, Small-Stream, Tolerant)
Central Mudminnow N =1 (Transitional, Small-Stream, Tolerant)
Coho Salmon N=7 (Coldwater, Medium-Stream, Intermediate)
Rainbow Trout N=15 (Coldwater, Medium-Stream, Intermediate)
Brook Trout N = 61 (Coldwater, Small-Stream, Intolerant)
Mottled Sculpin N=46 (Coldwater, Small-Stream, Intolerant)
Total Fish = 158 individuals

<u>Observed Guild Percentages</u>
Thermal: Coldwater = 82% (129/158); Transitional = 18% (29/158); Warmwater = 0% (0/158)
Stream-Size: Small-Stream = 85% (135/158); Medium-Stream =15% (23/158); Large-River = 0% (0/158)
Tolerance: Intolerant = 69% (109/158); Intermediate = 14% (22/158); Tolerant = 18% (27/158)

<u>Expected Guild Percentages for Cool-Cold Transitional Headwater (from Tables 2-4)</u>
Thermal: Coldwater 0-75%; Transitional 25-100%; Warmwater 0-25%
Stream-Size: Small-Stream 50-100%; Medium-Stream 0-50%; Large-River 0-10%
Tolerance: Intolerant – > 0% (i.e., Present); Intermediate – Not applicable; Tolerant 0-75%

Question 1: Does the actual percentages of fish in the three thermal and three stream-size guilds match the expectations for the designated Natural Community of the segment?
Thermal: Higher percentage of coldwater individuals than expected (0-75% < **82%** [observed values in bold]), lower percentage of transitional individuals than expected (**18%** < 25-100%), within expected range of warmwater individuals (0% ≤ **0%** < 25%).
Conclusion: Possible Thermal Natural Community Misclassification (Cool-Cold Transition expectations not met; observed fish match expectations for Coldwater).
Stream-Size: Percentages of small-stream (50% < **85%** < 100%); medium-stream (0% < **15%** < 50%), and large-river individuals (0% ≤ **0%** < 10%) all within expectations.
Conclusion: Stream-Size Natural Community Appropriate (Headwater).

Question 2: Can environmental degradation at the segment explain differences between observed and expected percentages for the thermal or stream-size guilds?
Intolerant individuals are present (0% < **69%**) and the percentage of tolerant individuals (0% < 1**8%** < 75%) are within expectations for a non-degraded cool-cold transition headwater stream.
Conclusion: Segment likely NOT degraded.

Question 3: Can recent weather extremes at the segment explain differences between observed and expected percentages for the thermal or stream-size guilds?
Data from the nearest weather station at Kewaunee (station 474195) from 1977-2008:
Mean September Air Temperature range: 55.2 F (1993) – 64.5 F (1998); 2008 @ 60.8 F. Of the 30 years with data, 2008 had the 19th coldest and 11th warmest mean air temperature for the month of September. The 10th percentile mean September air temperature was 57.1 F and the 90th was 63.6 F. Therefore, 2008 @ 60.8 F was within the 10th to 90th percentile range.
Total Annual (October – September) Precipitation range: 19.94 inches (1994-1996) – 42.12 inches (1985-1986); October 2007- September 2008 @ 28.07 inches; Of the 21 years with complete precipitation data, 2007-2008 was the 7th driest and 14th wettest year. The 10th percentile total annual precipitation was 24.80 inches and the 90th was 38.84 inches. Therefore, 2007-2008 @ 28.07 inches was within the 10th to 90th percentile range.
Conclusion: September 2008 was NOT an unusually hot or cold month and October 2007- September 2008 was NOT an unusually wet or dry period. Therefore, there was no extreme weather just before sampling.

Question 4: Considering other available information on fish, weather, and segment characteristics and location, and employing Best Professional Judgment (BPJ), is there sufficient justification for changing the Natural Community classification of the segment?
Observed thermal guild percentages were distinctly different from expectations and outside the realm of normal sampling variation. No flow, weather, or equipment issues affected sampling effectiveness. The segment was not close to a very different Natural Community where strays would have potentially influenced fish thermal guild percentages. In 2008, the fish community sample was collected outside of the standard May-September sampling time frame. However, fish collections in 2007, 2009, and 2010 yielded similar results to 2008, indicating that the discrepancies between observations and expectations were real and not merely the result of a sampling date later in the fall.

There were no unusual features of the sampling or the segment or of the 2007-08 weather patterns that could explain the discrepancies between expected and observed fish thermal-guild percentages.
Conclusion: Based on existing data and my knowledge of Little Scarboro Creek and similar nearby streams, a thermal Natural Community misclassification of the segment seems likely.

Overall Conclusion: Change Thermal Classification from Cool-Cold Transition to Coldwater. Retain Stream-Size Classification as Headwater
(Note: the Coldwater Natural Community does not have separate Headwater and Mainstem Stream-Size classifications, so the overall new Natural Community becomes **Coldwater**)

Table 1 – Modeled water temperature and flow criteria used to predict Natural Communities in healthy Wisconsin streams and the primary index of biotic integrity (IBI) for bioassessment associated with each Natural Community.

Natural Community	Long-Term Average Maximum Daily Mean Water Temperature (˚F)	Long-Term Average Annual 90% Exceedence Flow (ft^3/s)	Primary Index of Biotic Integrity
Macroinvertebrate	Any	< 0.03	Macroinvertebrate
Coldwater	< 69.3	0.03-150	Coldwater Fish
Cool-Cold Headwater	69.3 - 72.5	0.03-3.0	Small-Stream (Intermittent) Fish
Cool-Cold Mainstem	69.3 - 72.5	3.0-150	Cool-Cold Transition (Coolwater) Fish
Cool-Warm Headwater	72.6 - 76.3	0.03 - 3.0	Small-Stream (Intermittent) Fish
Cool-Warm Mainstem	72.6 - 76.3	3.0-150	Cool-Warm Transition (Coolwater) Fish
Warm Headwater	> 76.3	0.03 - 3.0	Small-Stream (Intermittent) Fish
Warm Mainstem	> 76.3	3.0 - 110.0	Warmwater Fish
Nonwadeable Warm River	> 76.3	> 150.0	Large River Fish

Table 2 – Fish thermal guild expectations (percentage of total individuals collected) for Natural Communities in non-degraded Wisconsin streams. See Table 5 for fish species thermal guild assignments. Species that belong to the “lake” stream-size guild in Table 5 should be excluded from calculations. At least 25 total fish must be collected from the stream segment to apply these criteria. Fish that are known or thought to have been stocked (including bait bucket and ornamental pond/tank escapees/releases) within 90 days of the sampling should be excluded from all calculations.

Natural Community	Coldwater Individuals	Transitional Individuals	Warmwater Individuals
Macroinvertebrate	Not applicable	Not applicable	Not applicable
Coldwater	25-100%	0-75%	0-5%
Cool-Cold Headwater	0-75%	25-100%	0-25%
Cool-Cold Mainstem	0-75%	25-100%	0-25%
Cool-Warm Headwater	0-25%	25-100%	0-75%
Cool-Warm Mainstem	0-25%	25-100%	0-75%
Warm Headwater	0-5%	0-25%	75-100%
Warm Mainstem	0-5%	0-25%	75-100%
Nonwadeable Warm River	0-5%	0-25%	75-100%

Table 3 – Fish stream-size guild expectations (percentage of total individuals collected) for Natural Communities in non-degraded Wisconsin streams. See Table 5 for fish stream-size guild assignments. Species that belong to the lake guild should be excluded from calculations. At least 25 total fish must be collected from the segment to apply any of the percentage criteria. Fish that are known or thought to have been stocked (including bait bucket and ornamental pond/tank escapees/releases) within 90 days of the sampling should be excluded from calculations.

Natural Community	Small-Stream Individuals	Medium-Stream Individuals	Large-River Individuals
Macroinvertebrate	Total catch of fish (all size guilds combined) less than 25 individuals in at least 100 m wetted stream length sampled		
Coldwater	0-100%	0-100%	0-100%
Cool-Cold Headwater	50-100%	0-50%	0-10%
Cool-Cold Mainstem	0-50%	50-100%	0-50%
Cool-Warm Headwater	50-100%	0-50%	0-10%
Cool-Warm Mainstem	0-50%	50-100%	0-50%
Warm Headwater	50-100%	0-50%	0-10%
Warm Mainstem	0-50%	50-100%	0-50%
Nonwadeable Warm River	0-10%	0-25%	75-100%

Table 4 – Fish tolerance guild expectations (percentage of total individuals collected) for Natural Communities in non-degraded Wisconsin streams. See Table 5 for fish species tolerance guild assignments. Species that belong to the “lake” stream-size guild in Table 5 should be excluded from calculations. Fish that are known or thought to have been stocked (including bait bucket or ornamental pond/tank escapees/releases) within 90 days of the sampling should be excluded from all calculations. Note: For purposes of Natural Community verification, the percentage of intermediate individuals is not used to determine degradation status.

Natural Community	Intolerant Individuals	Intermediate Individuals	Tolerant Individuals
Macroinvertebrate	Not applicable	Not applicable	Not applicable
Coldwater	> 0% (i.e., Present)	Not applicable	0-25%
Cool-Cold Headwater	> 0% (i.e., Present)	Not applicable	0-75%
Cool-Cold Mainstem	> 0% (i.e., Present)	Not applicable	0-70%
Cool-Warm Headwater	> 0% (i.e., Present)	Not applicable	0-75%
Cool-Warm Mainstem	> 0% (i.e., Present)	Not applicable	0-60%
Warm Headwater	> 0% (i.e., Present)	Not applicable	0-75%
Warm Mainstem	> 0% (i.e., Present)	Not applicable	0-50%
Nonwadeable Warm River	> 0% (i.e., Present)	Not applicable	0-15%

Table 5 – Thermal, stream-size, and tolerance guilds of Wisconsin fishes. Lake indicates a species that primarily inhabits lakes in Wisconsin. Such species may occasionally be collected in the lower reaches of tributaries, especially during their spawning seasons, but they are not regular stream or river inhabitants and should be excluding from thermal-, stream-size-, and tolerance-guild percentage calculations.

Common Name	Scientific Name	Thermal	Stream-Size	Tolerance
LAMPREYS	PETROMYZONTIDAE			
Chestnut Lamprey	*Ichthyomyzon castaneus*	Warmwater	Large	Intolerant
Northern Brook Lamprey	*Ichthyomyzon fossor*	Transitional	Medium	Intolerant
Southern Brook Lamprey	*Ichthyomyzon gagei*	Transitional	Medium	Intolerant
Silver Lamprey	*Ichthyomyzon unicuspis*	Warmwater	Large	Intolerant
American Brook Lamprey	*Lampetra appendix*	Transitional	Medium	Intolerant
Sea Lamprey	*Petromyzon marinus*	Transitional	Medium	Intolerant
STURGEONS	ACIPENSERIDAE			
Lake Sturgeon	*Acipenser fulvescens*	Transitional	Large	Intermediate
Shovelnose Sturgeon	*Scaphirhynchus platorynchus*	Warmwater	Large	Intermediate
PADDLEFISHES	POLYODONTIDAE			
Paddlefish	*Polyodon spathula*	Warmwater	Large	Intermediate
GARS	LEPISOSTEIDAE			
Longnose Gar	*Lepisosteus osseus*	Warmwater	Large	Intermediate
Shortnose Gar	*Lepisosteus platostomus*	Warmwater	Large	Intermediate
BOWFINS	AMIIDAE			
Bowfin	*Amia calva*	Warmwater	Large	Intermediate
MOONEYES	HIODONTIDAE			
Goldeye	*Hiodon alosoides*	Warmwater	Large	Intermediate
Mooneye	*Hiodon tergisus*	Warmwater	Large	Intermediate
FRESHWATER EELS	ANGUILLIDAE			
American Eel	*Anguilla rostrata*	Warmwater	Large	Intermediate
HERRINGS	CLUPEIDAE			
Skipjack Herring	*Alosa chrysochloris*	Warmwater	Large	Intermediate
Alewife	*Alosa pseudoharengus*	Transitional	Lake	Intermediate
Gizzard Shad	*Dorosoma cepedianum*	Warmwater	Large	Intermediate
MINNOWS	CYPRINIDAE			
Central Stoneroller	*Campostoma anomalum*	Warmwater	Small	Intermediate
Largescale Stoneroller	*Campostoma oligolepis*	Warmwater	Small	Intermediate
Goldfish	*Carassius auratus*	Warmwater	Medium	Tolerant
Redside Dace	*Clinostomus elongatus*	Transitional	Small	Intolerant
Lake Chub	*Couesius plumbeus*	Transitional	Lake	Intermediate
Spotfin Shiner	*Cyprinella spiloptera*	Warmwater	Large	Intermediate
Common Carp	*Cyprinus carpio*	Warmwater	Large	Tolerant
Gravel Chub	*Erimystax x-punctatus*	Warmwater	Large	Intolerant
Brassy Minnow	*Hybognathus hankinsoni*	Transitional	Small	Intermediate
Mississippi Silvery Minnow	*Hybognathus nuchalis*	Warmwater	Large	Intolerant
Pallid Shiner	*Hybopsis amnis*	Warmwater	Large	Intolerant
Striped Shiner	*Luxilus chrysocephalus*	Warmwater	Medium	Intermediate
Common Shiner	*Luxilus cornutus*	Warmwater	Medium	Intermediate
Redfin Shiner	*Lythrurus umbratilis*	Warmwater	Medium	Intermediate
Shoal (Speckled) Chub	*Macrhybopsis hyostoma*	Warmwater	Large	Intolerant
Silver Chub	*Macrhybopsis storeriana*	Warmwater	Large	Intermediate
Pearl Dace	*Margariscus margarita*	Transitional	Small	Intermediate
Hornyhead Chub	*Nocomis biguttatus*	Warmwater	Medium	Intermediate

Golden Shiner	*Notemigonus crysoleucas*	Warmwater	Medium	Tolerant
Pugnose Shiner	*Notropis anogenus*	Transitional	Medium	Intolerant
Emerald Shiner	*Notropis atherinoides*	Warmwater	Large	Intermediate
River Shiner	*Notropis blennius*	Warmwater	Large	Intermediate
Ghost Shiner	*Notropis buchanani*	Warmwater	Large	Intolerant
Ironcolor Shiner	*Notropis chalybaeus*	Warmwater	Medium	Intermediate
Bigmouth Shiner	*Notropis dorsalis*	Warmwater	Medium	Intermediate
Blackchin Shiner	*Notropis heterodon*	Transitional	Medium	Intolerant
Blacknose Shiner	*Notropis heterolepis*	Transitional	Medium	Intolerant
Spottail Shiner	*Notropis hudsonius*	Warmwater	Large	Intolerant
Ozark Minnow	*Notropis nubilus*	Warmwater	Medium	Intolerant
Carmine Shiner	*Notropis percobromus*	Warmwater	Medium	Intolerant
Rosyface Shiner	*Notropis rubellus*	Warmwater	Medium	Intolerant
Sand Shiner	*Notropis stramineus*	Warmwater	Large	Intermediate
Weed Shiner	*Notropis texanus*	Warmwater	Large	Intolerant
Mimic Shiner	*Notropis volucellus*	Warmwater	Large	Intermediate
Channel Shiner	*Notropis wickliffi*	Warmwater	Large	Intermediate
Pugnose Minnow	*Opsopoeodus emiliae*	Warmwater	Large	Intermediate
Suckermouth Minnow	*Phenacobius mirabilis*	Warmwater	Medium	Intermediate
Northern Redbelly Dace	*Phoxinus eos*	Transitional	Small	Intermediate
Southern Redbelly Dace	*Phoxinus erythrogaster*	Warmwater	Small	Intermediate
Finescale Dace	*Phoxinus neogaeus*	Transitional	Small	Intermediate
Bluntnose Minnow	*Pimephales notatus*	Warmwater	Medium	Tolerant
Fathead Minnow	*Pimephales promelas*	Warmwater	Small	Tolerant
Bullhead Minnow	*Pimephales vigilax*	Warmwater	Large	Intermediate
Longnose Dace	*Rhinichthys cataractae*	Transitional	Medium	Intermediate
Western Blacknose Dace	*Rhinichthys obtusus*	Transitional	Small	Tolerant
Creek Chub	*Semotilus atromaculatus*	Transitional	Small	Tolerant
SUCKERS	CATOSTOMIDAE			
River Carpsucker	*Carpiodes carpio*	Warmwater	Large	Intermediate
Quillback	*Carpiodes cyprinus*	Warmwater	Large	Intermediate
Highfin Carpsucker	*Carpiodes velifer*	Warmwater	Large	Intolerant
Longnose Sucker	*Catostomus catostomus*	Coldwater	Medium	Intolerant
White Sucker	*Catostomus commersonii*	Transitional	Medium	Tolerant
Blue Sucker	*Cycleptus elongatus*	Warmwater	Large	Intolerant
Creek Chubsucker	*Erimyzon oblongus*	Warmwater	Medium	Intermediate
Lake Chubsucker	*Erimyzon sucetta*	Warmwater	Medium	Intermediate
Northern Hog Sucker	*Hypentelium nigricans*	Transitional	Medium	Intolerant
Smallmouth Buffalo	*Ictiobus bubalus*	Warmwater	Large	Intermediate
Bigmouth Buffalo	*Ictiobus cyprinellus*	Warmwater	Large	Intermediate
Black Buffalo	*Ictiobus niger*	Warmwater	Large	Intolerant
Spotted Sucker	*Minytrema melanops*	Warmwater	Large	Intolerant
Silver Redhorse	*Moxostoma anisurum*	Warmwater	Large	Intermediate
River Redhorse	*Moxostoma carinatum*	Warmwater	Large	Intermediate
Black Redhorse	*Moxostoma duquesnei*	Warmwater	Large	Intolerant
Golden Redhorse	*Moxostoma erythrurum*	Warmwater	Medium	Intermediate
Shorthead Redhorse	*Moxostoma macrolepidotum*	Warmwater	Large	Intermediate
Greater Redhorse	*Moxostoma valenciennesi*	Warmwater	Large	Intolerant
BULLHEAD CATFISHES	ICTALURIDAE			
Black Bullhead	*Ameiurus melas*	Warmwater	Medium	Tolerant
Yellow Bullhead	*Ameiurus natalis*	Warmwater	Medium	Tolerant
Brown Bullhead	*Ameiurus nebulosus*	Warmwater	Large	Intermediate
Channel Catfish	*Ictalurus punctatus*	Warmwater	Large	Intermediate
Slender Madtom	*Noturus exilis*	Warmwater	Medium	Intolerant
Stonecat	*Noturus flavus*	Warmwater	Medium	Intermediate
Tadpole Madtom	*Noturus gyrinus*	Warmwater	Large	Intermediate
Flathead Catfish	*Pylodictis olivaris*	Warmwater	Large	Intermediate
PIKES	ESOCIDAE			
Grass Pickerel	*Esox americanus vermiculatus*	Warmwater	Medium	Intermediate
Northern Pike	*Esox lucius*	Transitional	Small	Intermediate
Muskellunge	*Esox masquinongy*	Transitional	Large	Intolerant

MUDMINNOWS	UMBRIDAE			
Central Mudminnow	*Umbra limi*	Transitional	Small	Tolerant
SMELTS	OSMERIDAE			
Rainbow Smelt	*Osmerus mordax*	Coldwater	Lake	Intermediate
TROUTS	SALMONIDAE			
Cisco/Lake Herring	*Coregonus artedi*	Coldwater	Lake	Intolerant
Lake Whitefish	*Coregonus clupeaformis*	Coldwater	Lake	Unclassified
Bloater	*Coregonus hoyi*	Coldwater	Lake	Unclassified
Deepwater Cisco	*Coregonus johannae*	Coldwater	Lake	Unclassified
Kiyi	*Coregonus kiyi*	Coldwater	Lake	Unclassified
Blackfin Cisco	*Coregonus nigripinnis*	Coldwater	Lake	Unclassified
Shortnose Cisco	*Coregonus reighardi*	Coldwater	Lake	Unclassified
Shortjaw Cisco	*Coregonus zenithicus*	Coldwater	Lake	Intolerant
Pink Salmon	*Oncorhynchus gorbuscha*	Coldwater	Medium	Intermediate
Coho Salmon	*Oncorhynchus kisutch*	Coldwater	Medium	Intermediate
Rainbow Trout	*Oncorhynchus mykiss*	Coldwater	Medium	Intermediate
Kokanee/Sockeye Salmon	*Oncorhynchus nerka*	Coldwater	Lake	Unclassified
Chinook Salmon	*Oncorhynchus tshawytscha*	Coldwater	Medium	Intermediate
Pygmy Whitefish	*Prosopium coulteri*	Coldwater	Lake	Unclassified
Round Whitefish	*Prosopium cylindraceum*	Coldwater	Lake	Unclassified
Brown Trout	*Salmo trutta*	Coldwater	Medium	Intermediate
Brook Trout	*Salvelinus fontinalis*	Coldwater	Small	Intolerant
Lake Trout	*Salvelinus namaycush*	Coldwater	Lake	Intolerant
TROUT-PERCHES	PERCOPSIDAE			
Trout-perch	*Percopsis omiscomaycus*	Transitional	Large	Intermediate
PIRATE PERCHES	APHREDODERIDAE			
Pirate Perch	*Aphredoderus sayanus*	Warmwater	Medium	Intermediate
CODFISHES	GADIDAE			
Burbot	*Lota lota*	Transitional	Large	Intermediate
TOPMINNOWS	FUNDULIDAE			
Banded Killifish	*Fundulus diaphanus*	Warmwater	Medium	Intermediate
Starhead Topminnow	*Fundulus dispar*	Warmwater	Large	Intermediate
Blackstripe Topminnow	*Fundulus notatus*	Warmwater	Large	Intermediate
LIVEBEARERS	POECILIIDAE			
Western mosquitofish	*Gambusia affinis*	Warmwater	Medium	Tolerant
NEW WORLD SILVERSIDES	ATHERINOPSIDAE			
Brook Silverside	*Labidesthes sicculus*	Warmwater	Large	Intermediate
STICKLEBACKS	GASTEROSTEIDAE			
Brook Stickleback	*Culaea inconstans*	Transitional	Small	Tolerant
Threespine Stickleback	*Gasterosteus aculeatus*	Transitional	Lake	Unclassified
Ninespine Stickleback	*Pungitius pungitius*	Coldwater	Lake	Unclassified
SCULPINS	COTTIDAE			
Mottled Sculpin	*Cottus bairdii*	Coldwater	Small	Intolerant
Slimy Sculpin	*Cottus cognatus*	Coldwater	Small	Intolerant
Spoonhead Sculpin	*Cottus ricei*	Coldwater	Lake	Intolerant
Deepwater Sculpin	*Myoxocephalus thompsonii*	Coldwater	Lake	Intolerant
TEMPERATE BASSES	MORONIDAE			
White Perch	*Morone americana*	Warmwater	Large	Intermediate
White Bass	*Morone chrysops*	Warmwater	Large	Intermediate
Yellow Bass	*Morone mississippiensis*	Warmwater	Large	Intermediate
SUNFISHES	CENTRARCHIDAE			
Rock Bass	*Ambloplites rupestris*	Warmwater	Large	Intolerant
Green Sunfish	*Lepomis cyanellus*	Warmwater	Small	Tolerant

Pumpkinseed	*Lepomis gibbosus*	Warmwater	Medium	Intermediate
Warmouth	*Lepomis gulosus*	Warmwater	Large	Intermediate
Orangespotted Sunfish	*Lepomis humilis*	Warmwater	Large	Intermediate
Bluegill	*Lepomis macrochirus*	Warmwater	Large	Intermediate
Longear Sunfish	*Lepomis megalotis*	Warmwater	Medium	Intolerant
Smallmouth Bass	*Micropterus dolomieu*	Warmwater	Large	Intolerant
Largemouth Bass	*Micropterus salmoides*	Warmwater	Large	Intermediate
White Crappie	*Pomoxis annularis*	Warmwater	Large	Intermediate
Black Crappie	*Pomoxis nigromaculatus*	Warmwater	Large	Intermediate
PERCHES	PERCIDAE			
Western Sand Darter	*Ammocrypta clara*	Warmwater	Large	Intolerant
Crystal Darter	*Crystallaria asprella*	Warmwater	Large	Intolerant
Mud Darter	*Etheostoma asprigene*	Warmwater	Large	Intermediate
Rainbow Darter	*Etheostoma caeruleum*	Warmwater	Medium	Intolerant
Bluntnose Darter	*Etheostoma chlorosoma*	Warmwater	Large	Intolerant
Iowa Darter	*Etheostoma exile*	Warmwater	Small	Intolerant
Fantail Darter	*Etheostoma flabellare*	Warmwater	Small	Intermediate
Least Darter	*Etheostoma microperca*	Warmwater	Medium	Intolerant
Johnny Darter	*Etheostoma nigrum*	Transitional	Medium	Intermediate
Banded Darter	*Etheostoma zonale*	Warmwater	Large	Intolerant
Ruffe	*Gymnocephalus cernuus*	Transitional	Medium	Intermediate
Yellow Perch	*Perca flavescens*	Transitional	Large	Intermediate
Logperch	*Percina caprodes*	Warmwater	Large	Intermediate
Gilt Darter	*Percina evides*	Warmwater	Large	Intolerant
Blackside Darter	*Percina maculata*	Warmwater	Large	Intermediate
Slenderhead Darter	*Percina phoxocephala*	Warmwater	Large	Intolerant
River Darter	*Percina shumardi*	Warmwater	Large	Intermediate
Sauger	*Sander canadensis*	Warmwater	Large	Intermediate
Walleye	*Sander vitreus*	Transitional	Large	Intermediate
DRUMS	SCIAENIDAE			
Freshwater Drum	*Aplodinotus grunniens*	Warmwater	Large	Intermediate
GOBIES	GOBIIDAE			
Round Goby	*Neogobius melanostomus*	Warmwater	Large	Intermediate
Tubenose Goby	*Proterorhinus marmoratus*	Warmwater	Lake	Intermediate

Appendix: Worksheet to Document Natural Community Verification Process

Stream Name: ____

WBIC: _______________ *County:* _________________ *Sample Date:* __________

Sample Location: ____

____

SWIMS Station ID: _________________ *SWIMS Sample ID:* __________________

Predicted Natural Community (NC): ____

FINAL NATURAL COMMUNITY: ____

Question 1: Do observed and expected percentages for fish thermal and stream-size guilds agree?

Thermal Guild Percentages:

Expected: Coldwater: ________ Transitional: ________ Warmwater: ________

Observed: Coldwater: ________ Transitional: ________ Warmwater: ________

If Observed Percentages all within Expected Ranges, retain Predicted Thermal NC as Final Thermal NC.

If Observed Percentage NOT all within Expected Ranges, go to *Question 2*.

Stream-Size Guild Percentages:

Expected: Small: ________ Medium: ________ Large: ________

Observed: Small: ________ Medium: ________ Large: ________

If Observed Percentages all within Expected Ranges, retain Predicted Stream-Size NC as Final Stream-Size NC.

If Observed Percentage NOT all within Expected Ranges, go to *Question 2*.

Question 2: Is Segment degraded?

Tolerance Guild Percentages:

Expected: Intolerant: ___> 0%___ Tolerant: ________

Observed: Intolerant: ________ Tolerant: ________

If EITHER of the Observed Percentages is within Expected Ranges, segment is unlikely to be degraded. Go to *Question 3*.

If BOTH of the Observed Percentages are NOT within Expected Ranges, segment is likely to be degraded. Retain Predicted NC as Final NC.

Question 3: Could weather extremes have affected fish guild percentages?

Nearest Weather Station (ID Number): ____

Month Before Fish Sample: _______ 12 Months Before Fish Sample: _____________

Mean Monthly Air Temperature:

Start Year: ________ End Year: ________ Years of Data: _______

Minimum Monthly Mean: _________ Maximum Monthly Mean: _________

Mean for Month before Sample: _______ Rank: _____ Warmest _____ Coldest

10th Percentile Monthly Mean: _______ 90th Percentile Monthly Mean: _______

If Mean Air Temperature for the Month before is in top or bottom 10% of Long-Term Monthly Mean Air Temperature, and the temperature extreme prior to sampling is consistent with the direction of the difference between observed and expected fish thermal guilds, then EXTREME WEATHER may confound the Natural Community Verification. Collect a new fish sample when extreme weather is not a factor and redo the analysis beginning with *Question 1*.

If Air Temperature was NOT EXTREME before sampling or if the extreme was NOT CONSISTENT with the fish community differences, go to analysis of whether Total Annual Precipitation before sampling was extreme.

Total Annual (12months before sample) Precipitation**:**

Start Year: _______ End Year: _______ Years of Data: _____

Minimum 12-Month Total: _________ Maximum 12-Month Total: _________

Total for Year before Sample: _______ Rank: _____ Wettest _____ Driest

10th Percentile 12-Month Total: _______ 90th Percentile 12-Month Total: _______

If Total Precipitation for the year before the sample is in top or bottom 10% of Long-Term Total Annual Precipitation, and the precipitation extreme prior to sampling is consistent with the direction of the difference between observed and expected fish stream-size guilds, then EXTREME WEATHER may confound the Natural Community verification. <u>Collect a new fish sample when extreme weather is not a factor and redo the analysis beginning with *Question 1*</u>.

If Precipitation was NOT EXTREME before sampling, or if the extreme was NOT CONSISTENT with fish community differences, <u>go to *Question 4*</u>.

Question 4: Based on Best Professional Judgment, can other factors account for the differences between observed and expected fish thermal and stream-size guild percentages?

Do other factors support either retaining the Predicted Natural Community or collecting new fish data and repeating the analysis? Yes: ____ No: ____

If "Yes", describe why: ____

____

____

____

If "Yes", <u>retain Predicted NC as the Final NC or collect a new fish sample and repeat analysis beginning with *Question 1*</u>, as appropriate.

If "No", <u>designate a new Final NC based on observed percentages of fish thermal and stream-size guilds</u>.