Methods and Documentation Used to Identify Outstanding State Water (OSW) and Superior High Quality Water (SHQW) Candidates for Ohio's Water Quality Standards (WQS)

Introduction

Ohio's antidegradation rule[1] (OAC 3745-1-05) incorporates a level of protection between the minimum required under the Clean Water Act and the maximum protection afforded by federal regulations. The most stringent application of antidegradation is to allow absolutely no lowering of water quality in waters listed as Outstanding National Resource Waters. The minimum requirement allows for a lowering of water quality to the established water quality standards applicable to the water body if a determination is made that the lowering of quality is necessary to accommodate important social and economic development. A lowering of water quality below that which is necessary to protect existing uses is prohibited. The Agency has two intermediate levels of protection for certain ecologically important water bodies in the State that permanently reserve a portion of the unused pollutant assimilative capacity, thereby assuring that future generations will enjoy a higher water quality than the minimally acceptable standard in some waters. This document outlines the characteristics that are used to select candidate streams for these two levels: 1) Outstanding State Water (OSW) and 2) Superior High Quality Water (SHQW).

High quality water bodies are valued public resources because of their ecological and human benefits. Intact aquatic ecosystems provide substantial environmental benefits to long-term, sustainable environmental quality. The biological components of these systems act as a warning system that can indicate potential threats to human health, degradation of aesthetic values, reductions in the quality and quantity of recreational opportunities, and other ecosystem benefits or "services." Some of these other services include reliable and safe supplies of water for human consumption and industrial production, assimilation of human and other waste products, sediment transport, and the purification of both ground and surface waters. The ability of streams and rivers to provide these beneficial services and to act as environmental indicators is reduced whenever their integrity is degraded (Ohio EPA 1996). Under the antidegradation rule, a portion of the remaining assimilative capacity is reserved for water bodies categorized as OSW or SHQW in order to preserve the integrity of Ohio's highest quality streams.

Selection Criteria

Table A summarizes some of the characteristics that were used to distinguish between OSW, SHQW, and General High Quality Water (GHQW). The selection of candidate water bodies and delineation of OSW and SHQW segments are based on the following types of information:

1) The presence of threatened and endangered fish, mussel, crayfish, and amphibian species as designated for Ohio by the Ohio DNR (Department of Natural Resources), Division of Wildlife (2010). Ohio's list accounts for all federally listed and candidate species within these groups of aquatic organisms (USFWS 2010). The inclusion of this information helps to focus on those species that: (1) are most at risk from increased point and nonpoint source pollution; (2) may not be adequately protected by water quality criteria; and (3) are associated with those aesthetic properties of water bodies (e.g., high quality habitat) valued by the public. These high quality water indicators have deteriorated throughout the United States; 55 percent of the

[1] Authority under O.R.C. 6111.12

freshwater mussel fauna is considered extinct or imperiled (Williams et al. 1993) and 20 percent of the native fish fauna is considered imperiled (Master 1990). The OSW and SHQW categories are intended to prevent further impoverishment of these components of Ohio's aquatic biodiversity heritage. The data used in this process is from the late 1970s to the present and is either in Ohio EPA, Ohio DNR, or Ohio DOT (Department of Transportation) databases, from universities (e.g., Ohio State University Museum of Biodiversity), or published in reports. Frequency distributions of these species in Ohio EPA databases are illustrated in Figures A-1 (all Ohio sampling stations), A-2 (existing OSW/SHQW streams), and A-3 (candidate OSW/SHQW streams).

2) The presence of viable populations of fish species with a declining distribution across Ohio since 1978 (Ohio EPA 1996). Declining fish species are those fish species that have suffered reductions and increased fragmentation of their distributional range and abundance across Ohio (based on data collected by various state agencies and universities over the past 15 years) compared to historical distributions as documented in the Fishes of Ohio (Trautman 1981). These species have similar properties to the endangered and threatened species and will likely follow suit if conditions continue to decline in Ohio's high quality waters. Added to the endangered and threatened status list (25 percent of Ohio fish fauna), the declining designation brings the proportion of the state fish fauna as potentially imperiled to 33 percent. It is important to protect watersheds from large scale alterations to make recovery of these species possible. Frequency distributions of declining species are illustrated in Figures A-4 (all Ohio streams), A-5 (existing OSW/SHQW streams), and A-6 (candidate OSW/SHQW streams).

3) The attainment of high biological integrity as defined by the Exceptional Warmwater Habitat biologic criteria for fish and macroinvertebrates delineated in the Ohio WQS. Because biological integrity is defined in relation to least impacted reference sites, attainment of the Exceptional Warmwater Habitat (EWH) biological criteria indicates a site has scored within the range of the top 25 percent of the least impacted reference sites in Ohio, or the nearest to "unimpacted" as it exists today. These are the sites that generally harbor the strongest and most viable populations of endangered, threatened, special status, and declining species and are ecologically the most important water bodies in Ohio. Certain water bodies

Table A. General guidelines for nominating OSW, SHQW, and GHQW categories. Attributes are considered singly and in aggregate.

Attribute	OSW	SHQW	GHQW
Endangered & Threatened Species	Multiple species; large populations; include most vulnerable	Present, smaller populations; may be less vulnerable species	Absent or, if present, small populations or low vulnerability
Declining Fish Species	>4 declining fish species/segment; large populations	2-4 declining fish species/segment; moderate populations	<2 declining fish species/segment; typically small populations
Index of Biotic Integrity (IBI) and Invertebrate Community Index (ICI)	High mean scores; very high max scores	Lower mean scores; fewer high max scores or, if more high scores, few other attributes	Lower mean scores; few or no very high max scores
Qualitative Habitat Evaluation Index (QHEI)	High percentage of QHEI scores ≥80	Fewer QHEI scores ≥80, many above 70	Few or no QHEI scores ≥80, fewer above 70
Vulnerability	Little wastewater effluent; high vulnerability	May be more waste water effluent; moderate vulnerability	Lower vulnerability; for vulnerable components, antidegradation application may still be denied
Relative Abundance of Fish Species Sensitive to Pollution and Habitat Destruction	Relative abundance is ≥3 standard deviations compared to statewide collections of similar sized streams	Relative abundance is ≥2 standard deviations compared to statewide collections of similar sized streams	Relative abundance is <2 standard deviations compared to statewide collections of similar sized streams
Multiple Attributes	High co-occurrence of above attributes	Lower co-occurrence of above attributes or individual attributes more marginal	Little co-occurrence of above attributes, individual attributes often marginal if present

may have especially intact, "near-pristine" levels of biotic integrity (e.g., West Fork Little Beaver Creek, Captina Creek, certain small tributaries in the Hocking State Forest and Wayne National Forest) and may qualify for Superior High Quality Water listings without the presence of listed species. The concept of "biological integrity" is a goal of the Clean Water Act and Ohio EPA has incorporated this concept into water quality management. Frequency distributions of IBI (Index of Biotic Integrity) and ICI (Invertebrate Community Index) scores are illustrated in Figures B-1 and B-3 (all Ohio sampling stations) and in Figures B-2 and B-4 (candidate OSW/SHQW streams).

4) Adjustments for Lake Erie drainage tributaries. Streams in the Lake Erie drainage basin pose a special case in assigning antidegradation categories because of the zoogeography of Ohio's fishes and unionids. Because of Ohio's glacial history, the Lake Erie drainage has fewer endemic fish and mussel species than the Ohio River basin, and consequently has fewer endangered species. Because the IBI metrics calibrated for Ohio are based on expectations derived heavily from the Ohio River basin, fewer fish species being present in the Lake Erie basin also has implications for IBI scores. For any given Lake Erie basin stream, IBI scores are likely to be lower because metrics depending on the number of species in a sample, especially the number of darter species and total number of species, are likely to under-perform expectations derived from the Ohio River basin. Taken together in light of points 1-3 above, Lake Erie tributaries are likely to have fewer endangered fish species, fewer endangered mussel species, and lower IBI scores on average than Ohio River tributaries. These biogeographical factors have no reflection on the intrinsic biological integrity of a given stream segment within the Lake Erie drainage, and no reflection on the ecological integrity of a given drainage basin as a whole within the Lake Erie watershed and, therefore, should be accounted for in the determination of antidegradation categorization of water bodies within the Lake Erie drainage basin.

An additional biological attribute that can be used is the relative abundance of pollution intolerant fish species within a given water body compared to statewide collections stratified by stream size (Figure C). Here, unusually high is defined as greater than or equal to two standard deviations. The abundance of pollution intolerant fish species is dependent on both water and habitat quality; therefore, water bodies supporting unusually high relative abundances of these species are likely to have exceptional water and habitat quality and should be protected accordingly.

In addition to consideration of these primary factors, other information is incorporated into this process, especially when determining the boundaries of the SHQW water segments. These types of information may include, but are not limited to:

A) The quality of the habitat available for aquatic life. The Qualitative Habitat Evaluation Index (QHEI) is the primary habitat assessment tool used by Ohio EPA.

High quality habitats are critical because maintenance of biological integrity depends on high quality aquatic habitat as much as or perhaps more than good chemical water quality to maintain robust, healthy, and high value populations of aquatic life. Although many of the endangered, threatened, and declining species are especially sensitive to water quality, many are also habitat specialists and can be extirpated if their habitats are degraded or eliminated. High quality habitat also reflects those aesthetic qualities of natural water bodies that the antidegradation philosophy attempts to protect for future generations. Frequency distributions of QHEI are illustrated in Figures B-5 (all Ohio sampling stations) and B-6 (QHEI $\geq$ 80 by OSW/SHQW stream reach).

B) Biodiversity. A component of the biological criteria, species richness (biodiversity) is of special interest and is often highly correlated with biological integrity. Consideration of the top sites in Ohio, in terms of the total number of species, taxa, or sensitive species groups (e.g., Ephemoptera, Plecoptera, Tricoptera - EPT taxa) captured, provides strong confirmation that water bodies are biologically significant. While the concept of biological integrity certainly includes biodiversity, it additionally encompasses ecosystem processes (i.e., nutrient cycles, trophic interactions, speciation, etc.). It also considers whether the biodiversity is important as repopulation epicenters for currently degraded rivers (e.g., Yellow Creek and Furnace Run for the Cuyahoga River).

C) The existence of institutional designations that have already acknowledged the special characters of a water body. The Scenic River designation in Ohio usually coincides with many of the ecological characteristics outlined above and has the additional advantage of being supported by public policy that identifies each as having significant ecological and aesthetic value to Ohioans. Furthermore, substantial public and private resources are often invested in scenic rivers and attest to their ecological and recreational value. Scenic rivers, that support a high quality biological community are recommended for inclusion into the OSW antidegradation category in recognition of the exceptional ecological and recreational significance of these waters to Ohioans.

D) Geomorphological "boundaries", such as ecoregion boundaries, escarpments, the glacial boundary and associated glacial features, and confluences with tributaries of major subbasins can strongly affect aquatic habitat characteristics and the resulting fauna. Many of the stronger populations of endangered, threatened, and declining species and sites with high biological community performance tend to

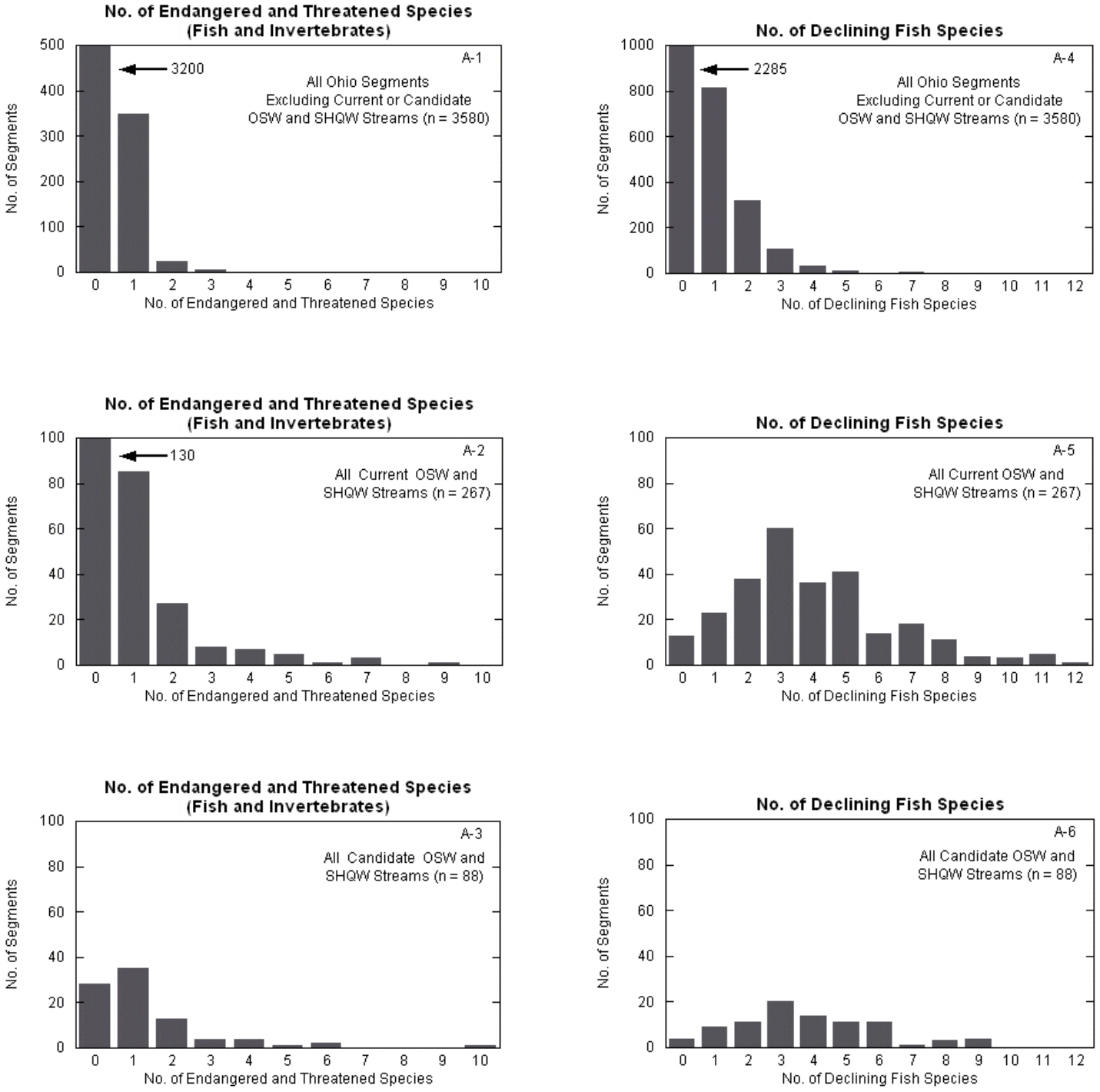
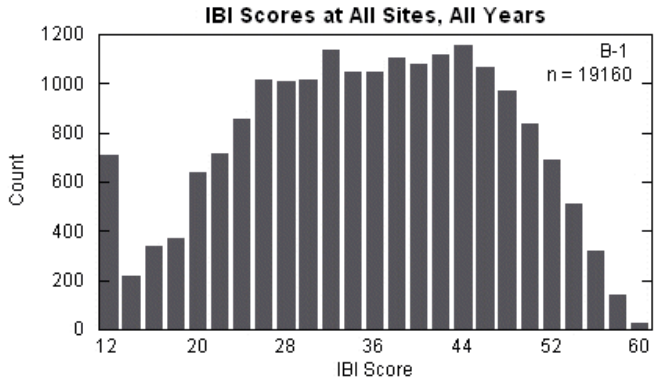
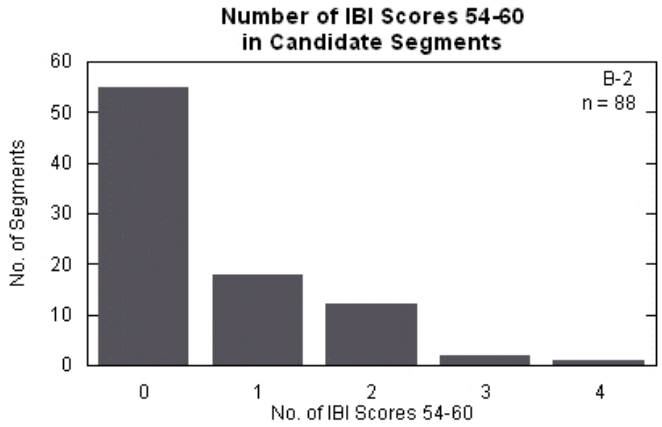
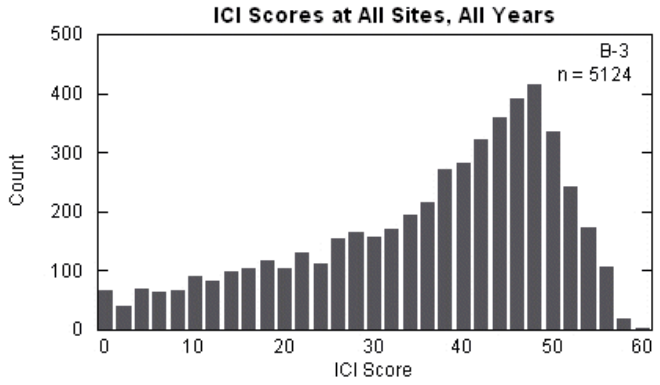
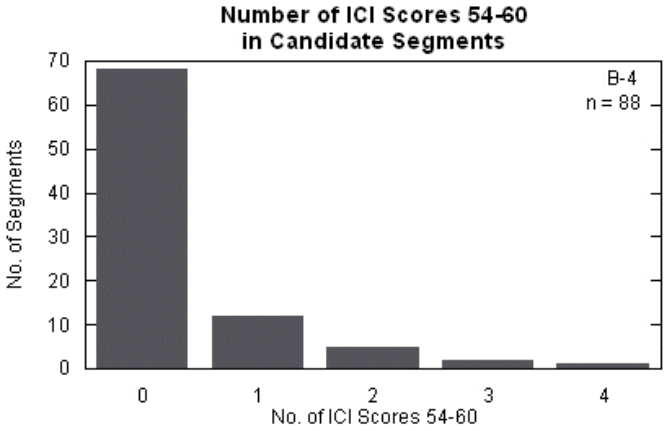


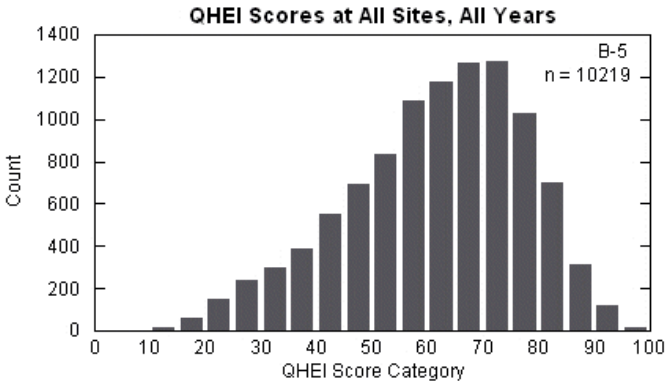
Figure A. Frequency distributions of: 1) state threatened and endangered species at all Ohio sampling stations, 2) state threatened and endangered species in existing OSW and SHQW streams, 3) state threatened and endangered species in candidate OSW and SHQW streams, 4) declining fish species at all Ohio sampling stations, 5) declining fish species in existing OSW and SHQW streams, and 6) declining fish species in candidate OSW and SHQW streams.











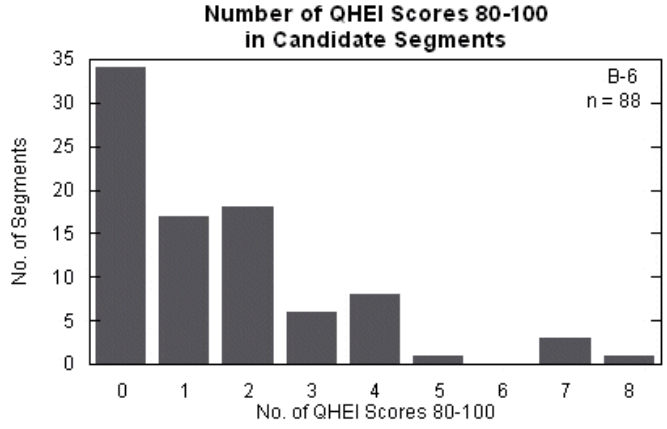


Figure B. Frequency distributions of: 1) IBI scores at all Ohio sampling stations, 2) IBI scores 54-60 by segment for candidate OSW and SHQW streams, 3) ICI scores at all Ohio sampling stations, 4) ICI scores 54-60 by segment for candidate OSW and SHQW streams, 5) QHEI scores at all Ohio sampling locations, and 6) QHEI scores of 80-100 in candidate OSW and SHQW streams.

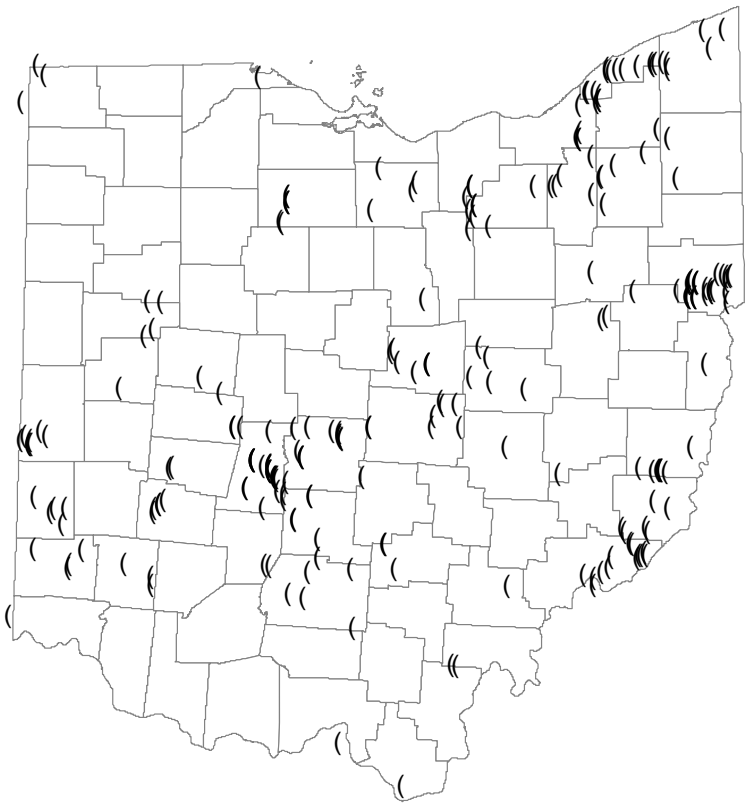


Figure C. Locations of stream fish populations having a relative abundance of pollution intolerant species equaling or exceeding two standard deviations of statewide collections.

occur at or near these boundaries. Stream gradient is another physical feature that has a profound effect on ecological conditions. High stream gradient tends to discourage clayey silts from depositing on and embedding stream substrates and maintains high oxygen levels in streams and rivers (e.g., provides suitable conditions for freshwater mollusks in the tailwaters of Muskingum River locks and dams).

E) Proximity of major urban population centers and existing water quality management plans. Pollution control efforts at some municipal and industrial facilities have been so successful that formerly grossly polluted aquatic environments are now substantially recovered. In a few cases, endangered species and/or very high biological diversity have returned. These recovered systems may merit special protection through listing as SHQWs. In assigning a specific SHQW, the Agency must provide a reasonable approach that recognizes the need to protect the aquatic resource and the need to provide continuity with previous wastewater management plans. These previous plans often used 100 percent of the pollutant assimilative capacity in the stream, in which case the SHQW listing has little effect on discharge related parameters. The SHQW category, however, would provide more protection for nonpoint source and habitat impacts. Nonpoint source degradation can have the effect of decreasing the assimilative capacity of streams and the SHQW category can be used to protect this. The existence of water quality management plans will be factored into the delineation of SHQW segments whenever appropriate.

Selecting Candidate Water Bodies

Candidates for OSW and SHQW listing were generated by examining data in Ohio EPA databases and ecological databases provided by Ohio DNR (Wildlife, Natural Areas and Preserves), and others (e.g., Ohio DOT). Candidate water bodies have some combination of the following attributes that demonstrate both a high biological integrity and the presence of special species:

(1) Viable populations of endangered or threatened species of fish, unionid mollusks, amphibians, or crayfish;

(2) Segments within which attainment of the EWH biological criteria for the IBI and/or the ICI have been documented;

(3) “Near pristine” characteristics of biological integrity, which is defined as consistent, strict attainment of the EWH biological criteria and a significant proportion of locations with IBI or ICI scores greater than or equal to 56 and, in the Lake Erie watershed, having a composition of pollution intolerant species equaling or exceeding two standard deviations compared to statewide collections;

(4) Three or more species of fish that are considered to be declining across Ohio.

To aid in examining candidate streams, a rating was derived to broadly select candidates depending on the strength of each of these attributes and the occurrence of multiple attributes. Summaries of the attributes arranged by water body segment are listed in “Ohio Streams and Rivers Antidegradation Category Justification: OSW & SHQW”.

Outstanding State Waters vs. Superior High Quality Waters: Vulnerability

Biological condition or integrity of Ohio streams occurs along a continuum in Ohio. The top levels of the high quality water hierarchy within the antidegradation rule are

designed to protect high quality waters for future generations. The primary difference between the OSW and SHQW categories is the assimilative capacity set-aside associated with each: 70% for OSW and 35% for SHQW. The characteristics described above and summarized in Table A are the baseline characteristics for OSWs and SHQWs. The distinction between these two groups of waters is somewhat more subjective and is based on the vulnerability of a water body to deleterious human impacts. Often, the waters with good populations of endangered, threatened, and declining species along with high biological integrity are the most vulnerable to change and are also where there is significant uncertainty regarding their ability to withstand reductions in water or habitat quality.

Some waters with extremely high diversity, however, may not be considered highly vulnerable or there may be more certainty of the response of the biota based on their response to existing stressors. The Scioto River downstream from Columbus, for example, was severely impacted by point source impacts. This river has responded tremendously to load reductions from wastewater treatment plants, both in IBI changes and in the return of certain endangered, threatened, and declining species. Because the recovery occurred under current pollutant loadings, the river is not extremely "vulnerable" to this range of loadings. While the stream in certain reaches may merit a SHQW category (slightly elevated anomalies still indicate some effects that would likely be addressed by an EWH designation) it would not be deemed vulnerable enough for listing in the OSW category. In addition, the current assemblages are likely most vulnerable to sediment and habitat effects that would be the focus of the SHQW category. The intact habitat in the Scioto River has permitted its recovery. Streams that have shown recovery despite relatively high pollutant loadings, or streams with species that, on a case-by-case basis are generally less vulnerable, would be less likely candidates for OSW. Water bodies that are the most likely candidates for OSW are those at the upper end of the distribution of sensitive ecological attributes being considered and those that are not already effluent limited.

Defining SHQW and OSW Segments

The delineation of SHQW stream segments is based on an overlay of the types of available data. The presence of an endangered or threatened species is considered significant, but the influence of this characteristic is tempered with caveats. The identity of the species and its regional status are additionally considered (Is it a resident species? Is it a stray from another area? Is the population significant? Are these locations the core of its remaining population in Ohio?). Stream segments where we find two or more declining species per sample (one or more in headwater streams) are considered significant, with many of the same caveats listed for endangered or threatened species. Attainment of the EWH biological criteria for fish or macroinvertebrate communities is also considered a significant factor. Sites with consistent attainment of EWH biological criteria at most sites and with index values that reach 56 or higher at some locations are evidence of "near pristine conditions" and receive proportionately more weighting in the superior segment delineation even when imperiled species are absent. These near pristine communities are related to limited development in large expanses of the floodplain and nearby land areas (e.g., Hocking State and Wayne National Forests).
One of the most important pieces of supporting information is the habitat quality of the water body as measured by the QHEI. Habitat quality reflects many of the other supporting factors (ecoregion characteristics, stream gradient, stream modifications, tributary confluences) also considered to be important. Average QHEI values greater than 70-75 through a stream reach are generally considered sufficient for EWH attainment, given suitable water quality. Thus we consider this level as an additional significant criterion for delineating superior segments. QHEI values greater than 80-90 are extraordinary with only 2-3% of our sites scoring at or above these values. Such high scores are also given heavy weighting in delineating superior reaches.

Although the nomination process includes objective criteria, the incorporation of standardized ecological data, experience and technical judgment is still needed to determine the boundaries of superior segments. The water body specific rationale for individual segment delineations is summarized in a justification document supporting the delineation of antidegradation categories. Streams and rivers are open ecosystems and segments are considered and listed as OSW and SHQW within an ecosystem and watershed framework. Management of aquatic habitats in a watershed framework has been urged if increasing imperilment of more species is to be halted (Warren and Burr 1994). The purpose of the high quality antidegradation categories is to further protect Ohio's best remaining aquatic ecosystems from activities that would result in additional pollution.

Nominated Streams

Streams or stream segments that are nominated for the OSW and SHQW antidegradation categories are depicted in Figure D, and listed alphabetically with rationale and supporting information in "Ohio Streams and Rivers Antidegradation Category Justification: OSW & SHQW" (December 8, 2010). Some streams that anecdotally may be thought of as high quality do not appear on the map in Figure D. This can occur for a number of reasons such as: 1) insufficient data exists

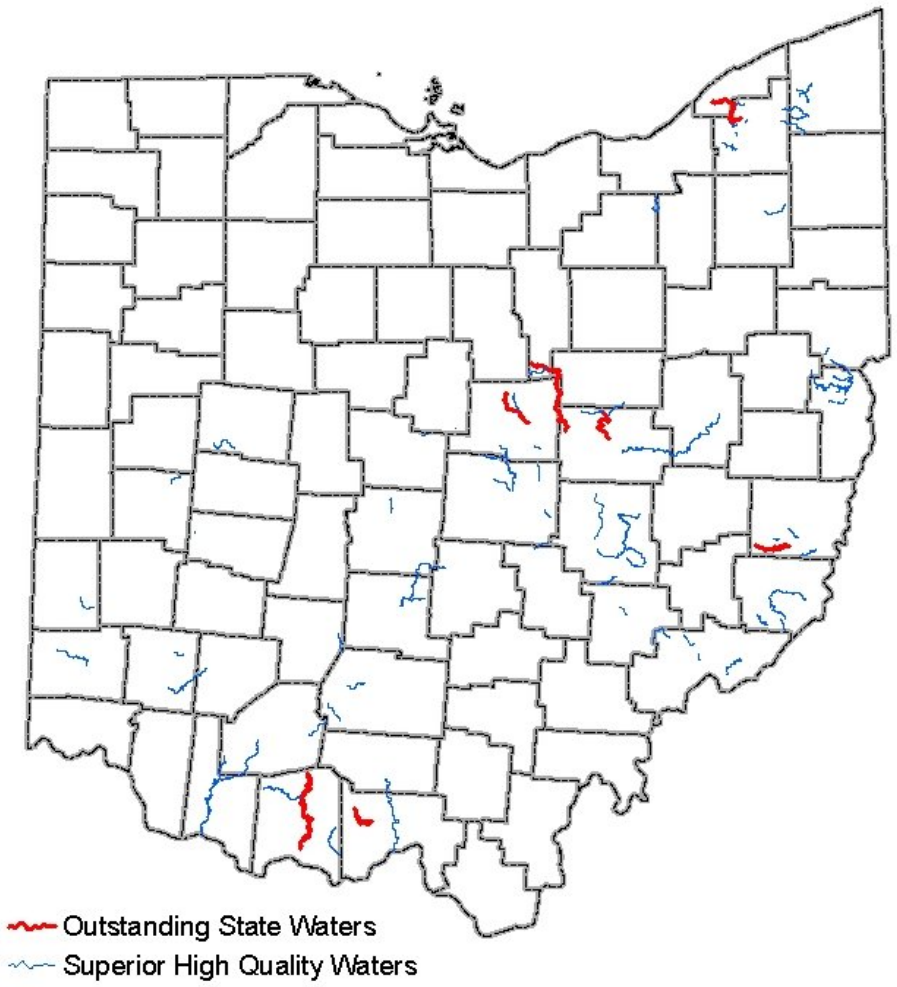


Figure D. Outstanding state water and superior high quality water candidates.

with which to make a high quality water determination (note that this may include water bodies that are currently designated State Resource Water (SRW) in Ohio's WQS use designation rules, OAC 3745-1-08 through -30); or 2) the stream may already be listed in the antidegradation rule as either a SHQW or an OSW (note that Figure D depicts only new candidates).

State Resource Waters

As described in the antidegradation rule, the SRW designation is an old designation of high quality waters that is being phased out and replaced by the categories of high quality waters described within the antidegradation rule (e.g., GHQW, SHQW, OSW). Those water bodies designated SRW as indicated by an asterisk in the SRW column were based on a "desktop" evaluation in 1978 usually without the benefit of much biological and habitat data. As sufficient information becomes available, the data are reviewed to determine which high quality category a water body currently designated SRW should be categorized under the modern antidegradation rule using the approach described within this document. Water bodies designated SRW and documented to possess the characteristics of the SHQW or OSW category will be nominated as such during revisions to the antidegradation rule since this is where the listing of such water bodies is contained within the WQS. Those water bodies designated SRW and for which sufficient data is collected and determined not to possess the characteristics of either a SHQW or OSW will revert to a GHQW category once the SRW designation is replaced as part of the Agency's annual use designation rulemakings. As envisioned in the antidegradation rule, the SRW designation will eventually be phased out of the WQS as the remaining SRW-designated water bodies are placed into one of the new antidegradation categories. Water bodies having an SRW designation will receive a higher priority for future monitoring so that sufficient data is available with which to make antidegradation high quality water determinations.

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