

**Evaluating Beneficial Use:  
Aquatic Life**



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## G1. Background and Rationale

### G1.1 Background

Ohio EPA has been evaluating streams using standardized biological field collection methods for nearly forty years. Stream assessments are based on the experience gained through the collection of well over 25,000 fish population samples, 12,500 macroinvertebrate community samples and close to 200,000 water chemistry samples. Aquatic life use assessments for the 2014 Integrated Report are based on biological and chemical data collected from 2003-2012 at over 4,200 wadeable stream, large river, and Lake Erie shoreline sampling locations. Ohio's Credible Data Law states that all data greater than five years in age will be considered historical, but that it can be used as long as the Director has identified compelling reasons as to why the data are credible. In the case of biological monitoring data, the use of data older than five but ten or fewer years old is necessary. The use of historical data is necessary because not enough biological samples are gathered from enough locations each year to conduct a thorough assessment of aquatic life use status across the state. Owing to limited staff and budget resources, it generally takes over ten years to visit a sufficient number of assessment units and sufficiently monitor them to make aquatic life use assessments. A more complete picture of statewide aquatic life use health is presented when data are utilized based on the ten year timeframe. Since water resource quality in many watersheds in Ohio today is most susceptible to changing land use patterns that are often subtle, slow to evolve, and difficult to monitor and assess, the use of older data is justified.

Ohio's water quality standards (WQS) have seven subcategories of aquatic life uses for streams and rivers (see Ohio Administrative Code 3745-1-07, <http://www.epa.ohio.gov/portals/35/rules/01-07.pdf>). The WQS rule contains a narrative for each aquatic life use and the three most commonly assigned aquatic life uses have quantitative, numeric biological criteria that express the minimum acceptable level of biological performance based on three separate biological indices. These indices are the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb) for fish and the Invertebrate Community Index (ICI) for aquatic macroinvertebrates. A detailed description of Ohio EPA's biological assessment and biocriteria program including specifics on each index and how each was derived is available (see Biological Criteria for the Protection of Aquatic Life, <http://www.epa.ohio.gov/dsw/bioassess/BioCriteriaProtAqLife.aspx>).

Procedures established in a specially designed 1983-1984 U.S. EPA study known as the Stream Regionalization Project (Whittier et al. 1987) were used to select reference, or least impacted sites, in each of Ohio's five Level III ecoregions (Omernik 1987). Biological data from a subset of these sites in addition to supplemental data from other least impacted Ohio reference sites were used to establish the ecoregion-specific biocriteria for each aquatic life use. Note that some criteria vary according to stream size and some indices do not apply in certain circumstances. Ohio's WQS rule stipulates that "biological criteria provide a direct measure of attainment of the warmwater habitat, exceptional warmwater habitat and modified warmwater habitat aquatic life uses" (OAC 3745-1-07(A)(6)). The numeric biological criteria based on IBI, MIwb, and ICI thresholds applicable to exceptional warmwater habitat (EWH), warmwater habitat (WWH), and modified warmwater habitat (MWH) waters are found in Table 7-15 of the WQS rule. Neither coldwater habitat (CWH) nor limited resource water (LRW) streams have numeric biological criteria at this time, so attainment status must be determined on a case-by-case basis. For sites and segments designated with these aquatic life uses, attainment status was determined by using biological data attributes (e.g., presence and abundance of coldwater species in CWH streams)

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and/or interim assessment index targets (e.g., those for LRW streams, Lake Erie lacustraries, Lake Erie nearshore) to assess consistency with the narrative aquatic life use definitions in the WQS.

## **G1.2 General Determination of Attainment Status**

A biological community at an EWH, WWH, or MWH sampling site must achieve the relevant criteria for all three indices, or those available and/or applicable, in order to be in full attainment of the designated aquatic life use criteria. Partial attainment is determined if one criterion is not achieved while non-attainment results when all biological scores are less than the criteria or if poor or very poor index scores are measured in either fish or macroinvertebrate communities.

A carefully conceived ambient monitoring approach, using cost-effective indicators consisting of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach includes a hierarchical continuum from administrative to true environmental indicators. The six “levels” of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health, ecology, or other effects (ecological condition, pathogens). In this process, the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5), which should translate into the environmental “results” (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition.

Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. Stressor indicators generally include activities that have the potential to degrade the aquatic environment, such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. Exposure indicators are those that measure the effects of stressors and can include whole effluent toxicity tests, tissue residues and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. Response indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices that comprise Ohio’s biological criteria. Other response indicators could include target assemblages, i.e., rare, threatened, endangered, special status, and declining species or bacterial levels that serve as surrogates for the recreation uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators within the roles that are most appropriate for each indicator.

Identifying the most probable causes of observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data and biological response signatures within the biological data themselves. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The identified causes of impairment will serve as the target parameters for future total maximum daily load (TMDL) development or regulatory program actions.

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Adequate sampling is necessary to represent the aquatic life use attainment status for large river assessment units (LRAUs, each an average 32 miles in length) or watershed assessment units (WAUs, each an average 28 mi<sup>2</sup> in surface area); these assessment units are defined in Sections D1 and G2 and further detailed in Section J of this report. Despite Ohio EPA's significant commitment to biological sampling efforts, about 40% of Ohio's 1538 WAUs are precluded from this analysis because of no or insufficient data. However, most large Ohio rivers with LRAU reaches have current data with only one major river (one LRAU) falling into historical data status. While some data may be available for some of the assessment units (AUs), many have no water quality monitoring data or the scope of monitoring was judged to be too limited to adequately generate an assessment. Generally, at least two sample sites are minimally considered necessary for a WAU assessment, although under specific circumstances, a WAU may be evaluated with one site. Presently, Ohio EPA prefers that the principal investigators make informed decisions about the data relevance for a particular AU evaluation rather than institute specific guidance on minimum effort.

Recognizing the state's limited resources, one way to increase assessment unit coverage is to utilize all available relevant data. While Ohio EPA uses data from a variety of sources in its work, the data used to determine the aquatic life use status in this report were primarily collected by Ohio EPA. Some additional biological data were provided by the Ohio Department of Natural Resources (ODNR), Northeast Ohio Regional Sewer District (NEORS), U.S. Geological Survey (USGS), the University of Toledo, the Ohio State University, National Center for Water Quality Research (NCWQR) at Heidelberg College, Midwest Biodiversity Institute (MBI), Cleveland Metroparks, and EnviroScience, Inc. Those interested in providing data to Ohio EPA for aquatic life use attainment status determinations must attend appropriate training provided by Ohio EPA or its designee (e.g., through the Ohio Credible Data Program Level 3 Certification) and document and retain competency in Ohio EPA biological sampling protocols. All data used to make attainment determinations are carefully reviewed for consistency with all Ohio EPA methods and guidance.

## **G2. Evaluation Method**

### **G2.1 Rivers and Streams: Large River Assessment Units (LRAUs)**

Decades of monitoring work by Ohio EPA have resulted in an extensive data set that includes recent data for 37 of the 38 large river assessment units in Ohio. The longitudinal sampling pattern (upstream to downstream and bracketing pollution sources and tributaries) used to measure fish community health, macroinvertebrate community condition and water chemistry allows WQS biocriteria attainment status to be fairly precisely estimated based on linear distances. The length of the large river deemed to be in full attainment, as described in the previous section, is divided by the total assessed length of the large river and multiplied by 100 to yield a value between 0 (no miles in attainment) and 100 (all miles in attainment). An LRAU is considered meeting its designated aquatic life use only if a score of 100 is reported. In other words, if all miles are not in full attainment of the designated aquatic life use, the entire LRAU is listed as impaired and placed in Integrated Report Category 4 or 5, depending on whether a TMDL is required.

## G2.2 Rivers and Streams: Watershed Assessment Units (WAUs)

Beginning with the 2010 Integrated Report (IR), the aquatic life use assessment methodology defined the WAU as the U.S. Geological Survey 12-digit hydrologic unit code watershed, or HUC12 (1,538 HUCs averaging 28 mi<sup>2</sup> drainage areas), rather than the 11-digit HUC watershed (331 HUC11s averaging 130 mi<sup>2</sup> drainage areas) used in prior Integrated Reports. Reporting on the HUC12 scale provides information on a finer scale and allows for better reporting of watershed improvements.

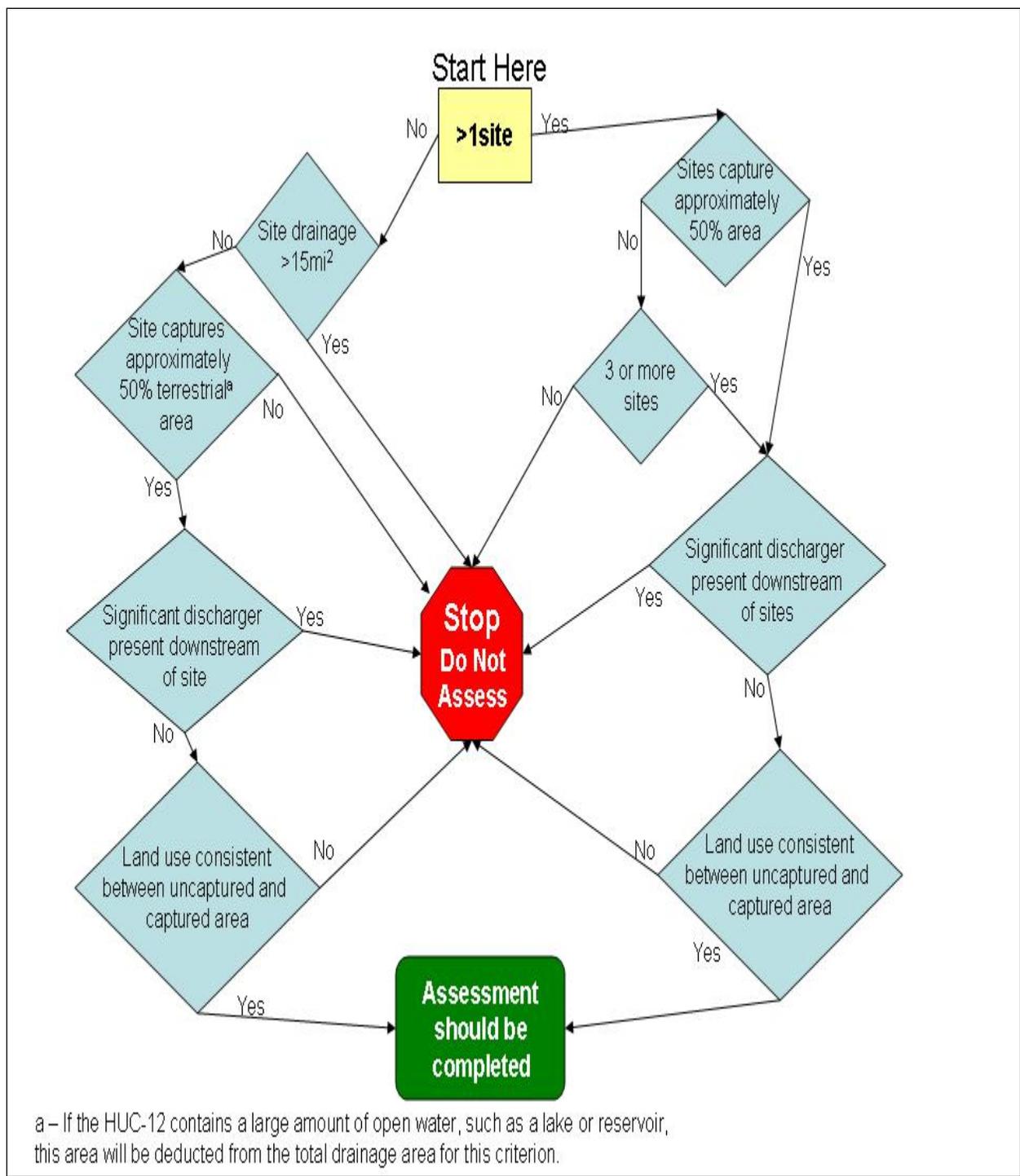
This dramatic reduction in assessment unit size requires consideration of what constitutes adequate sampling within each HUC12 WAU and appropriate evaluation of the sampling results. The relatively small drainage area of the HUC12 WAU requires that the sites evaluated adequately characterize the smaller watershed. For that reason, three scores will be determined for each WAU when sufficient data make this possible. A headwater assessment score that characterizes the aquatic community of the WAU by itself will occur by evaluating all sites with drainage area <20 mi<sup>2</sup> together. A wading stream score will be determined for all sites with drainage area between 20 mi<sup>2</sup> and 50 mi<sup>2</sup> that occur within the WAU. The wading stream score is necessary since a site between 20 mi<sup>2</sup> and 50 mi<sup>2</sup> characterizes the entire watershed upstream from the site, potentially two or more HUC12s, not just to the extent of the WAU boundary where the site resides. A principal stream score for sites >50 mi<sup>2</sup> will also be calculated, as these larger streams reflect a much greater land area than sites at a smaller drainage area. The final assessment unit score will be derived from these three scores. The table below represents this graphically.

WAU (HUC12)	Headwater Assessment-HA (<20 mi <sup>2</sup> )			Wading Assessment- WA (≥ 20 mi <sup>2</sup> <50 mi <sup>2</sup> )			Intermediate Score (IS)	Principal Assessment- PA (≥ 50 mi <sup>2</sup> <500 mi <sup>2</sup> )			WAU Score
	Total Sites	# Sites Full	HA Score	Total Sites	# Sites Full	WA Score	HA+WA 2	Total Sites	# Sites Full	PA Score	IS+PA 2

While the smaller size of the HUC12 WAU greatly reduces the number of sites necessary to be assessed, this creates an emphasis on appropriate sampling locations within the assessment unit. To ensure that decisions regarding adequate coverage are uniformly carried out, a flow chart for the process was created (Figure G-1). The flow chart takes into account the drainage area associated with a minimal number of sites, and incorporates questions as to spatial proximity of the sites within the watershed, land use consistency among sampling locations, and location of significant dischargers within the WAU.

Once it is determined that sampling coverage is adequate to conduct a WAU assessment, the number of headwater sites demonstrating full aquatic life use attainment are divided by the total number of headwater sites within the WAU. The quotient is then multiplied by 100 to provide the headwater score.

Determining the wading stream and principal stream scores involve a similar approach. The wading stream score is based on the number of wading stream sites (sites draining a watershed between 20 mi<sup>2</sup> and 50 mi<sup>2</sup>) demonstrating full attainment of aquatic life use. The total number of wading stream sites in full attainment are divided by the total number of wading stream sites. The quotient is then multiplied by 100 to provide the wading stream score. The same methodology is used to produce the principal stream score, but the scoring is limited to those sites in the WAU draining >50 mi<sup>2</sup>.



**Figure G-1. Flowchart for determining if WAU score can be derived based on available sampling locations.**

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An intermediate WAU score is calculated as the average of the headwater and wading stream scores. The overall WAU score is derived by averaging the intermediate score and the principal stream score. For HUC12s without principal streams, the intermediate stream score will represent the overall WAU score. This procedure provides some weighting to the assessment when principal stream miles are present (i.e., more influence on the final watershed score by principal streams). This weighting is important in that full use or impairment within the principal streams reflects the overall condition of the much larger primary watershed. A manual scoring adjustment is made in those few instances when a WAU score, with many principal stream sites, is unduly affected by the results from one headwater or one wading site. A WAU meets its aquatic life designated use only if a score of 100 is reported. In other words, if all sites are not in full attainment of the designated aquatic life use, the WAU is listed as impaired and placed in Integrated Report Category 4 or 5, depending on whether a TMDL is required.

Additional synthesis of data was used to provide aggregate statewide statistics for Ohio's universe of assessed wading and principal streams and rivers (> 20 mi<sup>2</sup> drainage areas) and large rivers (> 500 mi<sup>2</sup> drainage areas). Baseline IR statistics generated beginning with the 2010 IR were used along with the updated 2014 IR results to track trends of attainment levels across Ohio's watersheds and large rivers in an effort to quantify progress made in point and nonpoint source pollution controls and in meeting Ohio's goals of 80% full aquatic life use attainment by 2020 for assessed WAU wading and principal stream and river sites and 100% full aquatic life use attainment by 2020 for assessed LRAU miles.

### **G2.3 Lake Erie Nearshore and Islands: Lake Erie Assessment Units (LEAUs)**

Aquatic life use determinations are predicated on a narrative description of the aquatic community associated with the relevant use tier. In the absence of numeric criteria, the narrative expectation provides the impairment determination. In 1997, Ohio EPA completed the document *Development of Biological Indices Using Macroinvertebrates in Ohio Nearshore Waters, Harbors, and Lacustuaries of Lake Erie in Order to Evaluate Water Quality* (Lake Erie Protection Fund Grant LEPF-06-94, undated draft). In 1999, the document *Biological Criteria for the Protection of Aquatic Life: Volume IV: Fish and Macroinvertebrate Indices for Ohio's Lake Erie Nearshore Waters, Harbors, and Lacustuaries* was produced (Ohio EPA, undated draft). Also in 1999, the document *Biological Monitoring and an Index of Biotic Integrity for Lake Erie's Nearshore Waters* (Thoma, 1999) was published as a book chapter in *Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities* (Simon, editor, 1999). The data analyses in these documents, including refinement of field sampling protocols and development of assessment indices, provide a foundation to establish numeric biological targets/expectations using IBI and MIwb scores for aquatic life use in Lake Erie along the Ohio shoreline and in lacustuary areas. The term "lacustuary" was coined to specify the zone where Lake Erie water levels have intruded into tributary river channels. The aquatic life use status of a lacustuary is included as part of the assessment of the tributary WAU or LRAU.

Excluding lacustuaries, the status of the Lake Erie nearshore and islands is currently evaluated using fish community assessment targets for the Lake Erie IBI and MIwb based primarily on night electrofishing at sites included in the three LEAUs: Lake Erie Western Basin Shoreline (including Maumee Bay and Sandusky Bay), Lake Erie Central Basin Shoreline, and Lake Erie Islands Shoreline. All available fish data were collected from the nearshore, in this case meaning areas within 100 meters of the mainland, bay, or island shoreline. Status of LEAUs was determined by the percentage of sites in narrative full attainment of biological targets (scaled to prevailing shoreline habitat type) and where sufficient and current biosurvey data were available.

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Ohio EPA was awarded a Great Lakes Restoration Initiative (GLRI) grant in 2010 to develop a comprehensive Lake Erie nearshore monitoring program. This 2011-2013 project includes a strategy to design and implement a monitoring program for the Ohio Lake Erie nearshore zone (including bays, harbors and lacustuaries) that can be maintained on an annual basis. It is anticipated that future Integrated Reports will include revised assessment units and an updated assessment methodology for the LEAUs based on the results of the GLRI study (For a preview of anticipated revisions, see Section 15 of this report).

The GLRI grant is a collaborative effort between state agencies (Ohio EPA and ODNR) and major universities with Lake Erie basin research interests and expertise (the Ohio State University, University of Toledo, John Carroll University, and Heidelberg University). Physical, chemical, and biological parameters monitored from 2011-2013 will provide data to support long-term trend analysis, establish background conditions in selected areas, and conduct sampling related to the impacts of projects implemented in tributaries of the Lake Erie watershed. Data will be used to monitor the progress of implementation projects in Areas of Concern (AOCs) to restore beneficial uses, track implementation of WAPs, develop TMDLs for pollutants impairing beneficial uses, support Balanced Growth Initiative actions on the nearshore, and provide updated information for Integrated Reports, Lake Erie quality index updates, and updates to the Lake Erie Lakewide Management Plan (LAMP). More information about the Great Lakes Restoration Initiative and projects which have been proposed can be found at the Ohio Lake Erie Commission Web site (see Great Lakes Restoration Initiative, <http://www.lakeerie.ohio.gov/GLRI.aspx>).

Of note for future Lake Erie assessments will be the collection of nearshore data for the National Aquatic Resource Survey (NARS) of coastal waters of the United States (the National Coastal Assessment - NCA) which will be conducted during the summer of 2015. Coordinated by U.S. EPA in collaboration with Great Lake states, these one-visit snapshots of lake water quality will be used to provide statistically valid national and regional assessments of Great Lakes resource condition. Additional information and 2010 NCA results, when available, can be found at the U.S. EPA NARS website (see National Aquatic Resource Surveys, <http://www.epa.gov/OWOW/monitoring/nationalsurveys.html>).

### **G3. Results**

For the 2014 Integrated Report, new aquatic life data collected in 2011 and 2012 (some 2013 for LEAUs) were incorporated into the assessment database. During this period, biosurvey data from nearly 870 sampling sites located in 207 HUC12 WAUs, 78 sampling sites located in 13 LRAUs, and 38 sites located in three LEAUs were available to completely or partially update previously assessed AUs or provide new assessments for AUs with unknown aquatic life status. All data were collected by the Ohio EPA or Level 3 Qualified Data Collector external sources. Watersheds intensively monitored during 2011 and 2012 included the Ashtabula River, Ottawa River/Tenmile Creek, lower Scioto River, upper Little Miami River, Deer Creek (Scioto), Mill Creek (Cincinnati), Meander Creek/Yellow Creek (Mahoning), Stillwater Creek, East Fork Little Miami River, Mill Creek (Marysville), lower Muskingum River tributaries, and Black River basins. Large rivers intensively sampled included the lower Scioto River (3 LRAUs), Cuyahoga River (1 LRAU), Maumee River (3 LRAUs), Auglaize River (1 LRAU), and Tiffin River (1 LRAU) with an additional 4 LRAUs (Mahoning River, Raccoon Creek, middle Scioto River, and Stillwater River) revised based on a lesser amount of new data that were used to update portions of each assessment unit. Detailed watershed survey reports for many of the basins mentioned above are or will be available from the Ohio

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EPA Division of Surface Water (see Biological and Water Quality Report Index, [http://www.epa.ohio.gov/dsw/document\\_index/psdindx.aspx](http://www.epa.ohio.gov/dsw/document_index/psdindx.aspx)).

A further examination of individual AUs was made to determine status changes caused by site data collected during 2001 and 2002 that now exceed the 10-year data threshold and have become “historical” since the 2012 Integrated Report. From this examination, it was determined that data from 79 HUC12 WAUs were now insufficient to provide adequate spatial coverage either due to (1) all data being age restricted, or (2) enough of the data are age restricted that the number of sites fell below the minimum needed to assess. These AUs are not being delisted if currently Category 5. Significant basins affected, along with last sampling year, include the upper Sandusky River (2001), Monday Creek-Hocking (2001), Sunday Creek-Hocking (2001), Vermilion River (2002), Huron River (2002), Sevenmile Creek-Great Miami (2002), and upper Raccoon Creek-Ohio (2002).

Summarized 2014 Integrated Report statistics for aquatic life assessments for large river, watershed, and Lake Erie AUs as well as the comparable statistics from the 2002-2012 Integrated Reports are tabulated in Table G-1. More detailed aquatic life use results and statistics for each 2014 AU (watershed, large river and Lake Erie units) are provided at Ohio EPA web pages which can be accessed at <http://wwwapp.epa.ohio.gov/gis/mappointal/IR2014.html>.

Detailed site information for many recent major basin monitoring and assessment projects, including summarized biological monitoring results, habitat quality scores, and raw chemical water quality data, can be accessed via interactive GIS maps linked at the following web site: <http://www.epa.ohio.gov/dsw/gis/index.aspx>.

### **G3.1 Large River Assessment Units**

Large river assessment units (LRAUs) in Ohio (38 LRAUs spanning 23 rivers with watersheds in excess of 500 square miles and totaling 1,248 river miles) reflected essentially no change in percent of monitored miles in full attainment compared to the same statistic reported in the 2012 IR (Table G-1, Figure G-2). Based on monitoring through 2012, the full attainment statistic now stands at 89.2% (1023 of 1147 assessed LRAU miles), up 0.2% from the 2012 IR. Significant large rivers assessed during 2011 and 2012 included the Maumee and Tiffin rivers, which collectively sum nearly 128 large river miles and were considered historical status in the 2012 IR, and the newly delineated Auglaize River assessment unit (33 miles), which now incorporates the entirety of the Defiance Power Dam pool. This pooled Auglaize River reach has been recommended for a Modified Warmwater Habitat-Impounded aquatic life use designation rather than being considered a run-of-river reservoir and assessed as a lake. Attainment statistics for these three rivers (5 LRAUs) are as follows.

- Maumee River, 2012: 81% full attainment over 108 miles (3 LRAUs)
- Auglaize River, 2012: 100% full attainment over 33 miles (1 LRAU)
- Tiffin River, 2012: 100% full attainment over 20 miles (1 LRAU)

Another significant large river assessed for this reporting cycle was the lower Scioto River with updated attainment statistics for three LRAUs from the confluence of Big Darby Creek to the mouth (101 miles).

- Scioto River (lower), 2011: 100% full attainment over 101 miles (3 LRAUs)

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These assessed miles, along with the other large rivers reassessed, in part or whole, for this cycle, significantly expanded the number of assessed miles reported (1147 miles, 92% of the total delineated LRAU miles) when compared to the 2012 IR (984 miles, 80% of total LRAU miles).

If the most recent data from all 38 LRAUs are used (including those from the one remaining historical LRAU covering Wills Creek), irrespective of age of data, the full attainment statistic stands at 86.5% full attainment for over 1,190 monitored miles.

Progress towards the “100% by 2020” aquatic life use goal for Ohio’s large rivers is depicted in Figure G-2. Between the 2002 and 2014 reporting cycles, the percentage of large river miles in full attainment has increased from 62.5% to 89.2% and nearly 92% of total miles have been assessed. Success in approaching the 100% full attainment threshold for 100% of large river miles by 2020 will be dependent on continued resources allocated to monitoring LRAUs with an emphasis on those which are currently listed in the “historical data” category (only the Wills Creek AU which is scheduled for sampling in 2014) and, more importantly, those which will become historical between now and 2018 (the last year of data to be included in the 2020 goal assessment) and which are currently not scheduled to be resampled before then (8 large rivers/10 AUs representing nearly 310 large river miles).

### **G3.2 Watershed Assessment Units**

For the 2014 IR, the average HUC12 watershed assessment unit (WAU) score reflected a positive, but relatively minor, increase from the corresponding score reported in the 2012 IR (Table G-1, Figure G-3). Based on monitoring through 2012, the average HUC12 WAU score stands at 59.2, a 1.5 point increase from the 2012 IR and typical of what has been observed over the last several cycles (a pattern of steady increases of 1-2 points). Included in Table G-1 and depicted in Figure G-3 is the corresponding average score based on the old HUC11 WAUs, which were tracked from 2002 through 2010 and were used to gauge the progress of the “80 by 2010” aquatic life use goal as reported in the 2010 IR.

Table G-2 depicts the breakdown of site full attainment based on the watershed size category used to determine an individual watershed’s score based on available sites in the HUC12 WAU. As in previous reports, the results show that biological impairment is more likely at sites on small streams (nearly 1 in 2 headwater sites are impaired) and that impairment lessens significantly as sites drain larger areas (nearly 7 in 10 principal stream and small river sites are in full attainment). This phenomenon correlates well with the most widespread causes associated with aquatic life impairment in these watersheds.

Table G-3 and Figure G-4 depict the attainment status breakdown of the 3876 WAU sites collected from 2003-2012 by designated or recommended (existing) aquatic life use. As would be expected, most sites (72%) are assigned the base warmwater habitat (WWH) aquatic life use, for which attainment of biocriteria signifies meeting the fishable/swimmable goal of the Clean Water Act (CWA). For this cycle, about 53% of assigned WWH sites are meeting the WWH use. About 20% of the 3876 sites are assigned more protective aquatic life uses (exceptional warmwater habitat-EWH, coldwater habitat-CWH, or a dual use which includes both-EWH/CWH). The remainder of the sites (8%) are assigned “less than goal” CWA uses (modified warmwater habitat-MWH and limited resource water-LRW). Both more protective and “less than goal” uses are only assigned after a use attainability analysis has been conducted based on rigorous field data and this study determines that the assigned aquatic life use is the most appropriate to protect existing high quality/unique biological communities or set reasonable restoration benchmarks for communities challenged by pervasive anthropogenic or natural influences. As might be expected, a high percentage of sites assigned to more protective uses are fully meeting that use (80%)

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while those with assigned “less than goal” uses have low achievement of even the lower expectations of these uses (48% meet).

Table G-4 lists the top five aquatic life use impairment causes for the period 2003 through 2012. For this time period, principal causes for HUC12 WAU impairments were those primarily related to landscape modification issues involving agricultural land use and urban development. These types of impairments would be most manifest in smaller streams, a fact backed up by the numbers presented in Table G-2. It is important to note that between 28% and 54% of impaired HUC12 WAUs had at least one monitored site impaired by one of these individual causes and many WAUs had several sites affected by three or more of the five causes listed as responsible for the aquatic life use impairment. This would not be an unusual situation given the frequently close association between these impairment causes (e.g., nutrients, sedimentation/siltation, habitat modifications, and hydromodifications in rural/agricultural landscapes relying on channelization and field tiles for drainage). Also of note is the prevalence of HUC12 WAUs and LRAUs which are impaired by the generic organic enrichment/dissolved oxygen (DO) cause category; 38% of impaired WAUs show “sewage” related impairments such as high biochemical oxygen demand, elevated ammonia concentrations, and/or in-stream sewage solids deposition. Ten of 19 impaired LRAUs also note sewage related causes. While the WAU percentage is not as high as reported in the 2012 IR, it is still comparable to those percentages reported in past IRs that tracked these cause statistics, which suggests that adequate treatment and disposal of human and animal wastes via wastewater treatment plants, home sewage treatment systems, and land applications of septage and animal manure continue to be critical water quality issues in many Ohio watersheds.

Progress towards the “80% by 2020” aquatic life use goal for Ohio’s wading and principal stream and river sites (those monitored sites draining watersheds between 20 and 500 square miles) is depicted in Figure G-5. Contrasted with the 2010 IR statistic, when the 2020 goal benchmark was established, the percentage of qualifying sites in full attainment has increased nearly three percentage points with an increase from 61.4% to 64.4%. If this rate of change remains consistent over the next six years (*i.e.*, with new data collected through 2018), the statistic will not reach the goal by the time the 2020 IR is produced. It is readily apparent that more proactive implementation of watershed recommendations in TMDL reports and watershed action plans (WAPs) will be needed to recover impaired aquatic communities and protect those currently meeting aquatic life expectations in order to approach the 80% goal. It will also be critical that resources be directed to follow-up monitoring in areas with implemented restoration and protection projects so that success of efforts can be documented and reflected in future goal statistics. This latter effort is just beginning in survey areas with TMDLs approved and implemented beginning in the late 1990s and is an ongoing activity in support of the Ohio EPA Nonpoint Source Program (see <http://epa.ohio.gov/dsw/nps/index.aspx> for more program information).

### **G3.3 Lake Erie Assessment Units**

For previous IRs, assessments were based on past data collected in the mid-1990s through the early 2000s. Significant changes appear to be ongoing in Lake Erie, and, as a result, these older data are no longer being used to determine aquatic life use attainment status in the three LEAUs. However, these data are used in the following discussion to highlight key trends in fish community condition over two time periods of sampling.

From 2011-2013, 91 fish community collections using night electrofishing methods (daytime electrofishing in Sandusky Bay) were taken from 38 sites spread over the three LEAUs and these data

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serve as the core data set for assessment of Lake Erie nearshore status. For this cycle, and despite the rather limited amount of data, the assessment methodology as used in past IRs was once again used to determine aquatic life use status in the LEAUs.

All three AUs remain Category 5 with significant impairment of sites due primarily to tributary loadings of nutrients and sediment, exacerbated by continued trophic disruptions caused by the proliferation of exotic species, algal blooms, and shoreline habitat modifications. In the aggregate, only five fish community collections were assessed as fully attaining the designated EWH aquatic life use; 13 were assessed as partially attaining and the remaining 20 were in non-attainment (Table G-1). With the exception of attainment results reported for the 2012 IR, when the size of the database was severely restricted, the percentages of sites in full attainment of the EWH aquatic life use have not changed significantly through the IR cycles. One positive may be the increased percentage of sites in partial attainment, at the expense of non-attainment, for the current cycle when compared to previous cycles. All partial attainment sites were due to MIwb scores meeting expectations which may reflect better aggregated numerical abundance of fish, increased biomass, and structural evenness, the latter being a product of species richness and the distribution of numbers and biomass among the various species.

A breakdown of results reflects the following site attainment status for each of the three AUs.

	# Sites	# Full	# Partial	# Non
Western Basin Shoreline (incl. Maumee and Sandusky bays)	19	5	6	8
Central Basin Shoreline	15	0	6	9
Lake Erie Islands Shoreline	4	0	1	3

Three of the five sites with fish communities meeting aquatic life use expectations were collected from Sandusky Bay with the remaining two sites collected from the western basin shoreline along the eastern extent of Maumee Bay (between Immergrun and Cedar Point).

While more robust and thorough data assessment and analyses are ongoing as part of the GLRI project activities, an attempt was made to compare the recent data set collected 2011-2013 to similar electrofishing results collected from co-located sites sampled in the 1990s and early 2000s. Resulting comparisons of Lake Erie IBI and MIwb scores by individual sampling passes at 38 sites and matching historical sites are presented in Figures G-6 and G-7. For the most part, there seemed to be little change in medians and ranges of these two indices at the sites spanning the two timeframes. The biggest changes appeared linked to Islands Shoreline sites but that may be more an artifact of the small sample sizes. One Lake Erie IBI component metric which did seem to reflect a significant change across the two timespans was the proportion of exotic species by numerical abundance in each sampling pass (Figure G-8). For Lake Erie, typical common exotic species which can be collected using the electrofishing sampling method include round and tube nose goby, white perch, ghost shiner, gizzard shad, common carp, and goldfish. Initial assessment of 2011-2013 results implicates large populations of white perch and gizzard shad as the culprits causing the proportional increases in exotic species collected when compared to earlier collections.

**Table G-1. Summary of aquatic life use assessment for Ohio's watershed<sup>1</sup>, large river, and Lake Erie assessment units: 2002-2014 Integrated Report cycles.**

IR Cycle	2002 (1991-2000)	2004 (1993-2002)	2006 (1995-2004)	2008 (1997-2006)	2010 (1999-2008)	2012 (2001-2010)	2014 (2003-2012)
<b>HUC11 Watershed AUs (331)</b>							
No. AUs Assessed (% of total)	224 (68%)	225 (68%)	212 (64%)	218 (66%)	221 (67%)	-	
No. Sites Assessed	3272	3620	3785	4030	4200	-	
Average AU Scores							
Full Attainment	<b>46.6</b>	<b>48.3</b>	<b>52.5</b>	<b>54.7</b>	<b>58.5</b>	-	
Partial Attainment	25.2	23.6	22.6	22.4	21.2	-	
Non-Attainment	28.2	28.1	24.9	22.9	20.3	-	
<b>HUC12 Watershed AUs (1538)</b>							
No. AUs Assessed (% of total) <sup>2</sup>	-	-	-	-	999 (65%)	908 (59%)	933 (61%)
No. Sites Assessed	-	-	-	-	4200	3867	3876
Average AU Score <sup>3</sup>	-	-	-	-	<b>56.7</b>	<b>57.7</b>	<b>59.2</b>
% Sites Full Attainment	-	-	-	-	55.1	57.0	57.8
% Sites Partial Attainment	-	-	-	-	20.0	21.6	22.3
% Sites Non-Attainment	-	-	-	-	24.9	21.4	19.9
<b>Large River AUs (23 rivers/38 AUs totaling 1247.54 Miles)</b>							
No. Rivers/AUs Assessed	22	21	17	16	18/30	18/31	22/37
No. Sites Assessed	422	425	374	278	265	312	332
No. Miles Assessed (% of total)	905 (70%)	918 (71%)	873 (68%)	850 (66%)	852 (69%)	984 (80%)	1147 (92%)
% Miles Full Attainment	<b>62.5</b>	<b>64.0</b>	<b>76.8</b>	<b>78.7</b>	<b>93.1</b>	<b>89.0</b>	<b>89.2</b>
% Miles Partial Attainment	23.0	21.4	15.1	13.9	5.5	7.5	6.3
% Miles Non-Attainment	14.5	14.6	8.1	7.4	1.4	3.5	4.5
<b>Lake Erie AUs (3)</b>							
No. AUs Assessed	3	3	3	3	3	3	3
No. Sites Assessed <sup>4</sup>	92	111	93	49	34	23	38
% Sites Full Attainment	<b>12.0</b>	<b>18.0</b>	<b>19.4</b>	<b>10.2</b>	<b>14.7</b>	<b>30.4</b>	<b>13.2</b>
% Sites Partial Attainment	13.0	14.4	16.1	22.4	17.7	30.4	34.2
% Sites Non-Attainment	75.0	67.6	64.5	67.4	67.6	39.2	52.6

<sup>1</sup> WAUs for the IR 2002-2010 cycles were based on HUC11s; WAUs transitioned to HUC12s for cycles beginning with 2010.

<sup>2</sup> 2010 statistics based on direct assessment of HUC12 AUs with data collected between 2005 and 2008 (n=545) and HUC11 extrapolated assessment of HUC12 AUs with data collected between 1998 and 2004 (n=454). 2012 and 2014 assessments based on direct assessment of HUC12 AUs with data collected between 2001 and 2010 (n=908) and 2003 and 2012 (n=933), respectively.

<sup>3</sup> Statistic based on the average of available AU scores with current data, derived as explained in Section G2.2.

<sup>4</sup> Data for sites used in the 2002-2012 IR cycles were generally collected between 1993 and 2002; for the 2014 IR, data were collected 2011-2013.

**Table G-2. Breakdown by watershed size category of sites in full, partial, and non-attainment in monitored watershed assessment units (933 HUC12s) based on data collected from 2003-2012.**

<b>Watershed Size Category (mi<sup>2</sup>)</b>	<b># of Sites (% of total)</b>	<b>Number of Sites in Full Attainment (%)</b>	<b>Number of Sites in Partial Attainment (%)</b>	<b>Number of Sites in Non-Attainment (%)</b>
0-20 (headwater)	2331 (60)	1247 (53.5)	519 (22.3)	565 (24.2)
20-50 (wading)	618 (16)	370 (59.9)	146 (23.6)	102 (16.5)
50-500 (principal)	927 (24)	625 (67.4)	200 (21.6)	102 (11.0)
<b>Total</b>	<b>3876</b>	<b>2242 (57.8)</b>	<b>865 (22.3)</b>	<b>769 (19.9)</b>

**Table G-3. Breakdown by designated or recommended aquatic life use of sites in full, partial, and non-attainment in monitored watershed assessment units (933 HUC12s) based on data collected from 2003-2012.**

<b>Aquatic Life Use<sup>1</sup></b>	<b># of Sites (% of total)</b>	<b>Number of Sites in Full Attainment (%)</b>	<b>Number of Sites in Partial Attainment (%)</b>	<b>Number of Sites in Non-Attainment (%)</b>
<b><i>EWH</i></b>	465 (12)	351 (75.5)	107 (23.0)	7 (1.5)
<b><i>EWH/CWH</i></b>	85 (2)	71 (83.5)	10 (11.8)	4 (4.7)
<b><i>CWH</i></b>	246 (6)	212 (86.2)	22 (8.9)	12 (4.9)
<b><i>WWH</i></b>	2778 (72)	1462 (52.6)	674 (24.3)	642 (23.1)
<b><i>WWH/CWH</i></b>	7 (<1)	5 (71.4)	2 (28.6)	0 (0.0)
MWH	217 (6)	111 (51.2)	50 (23.0)	56 (25.8)
LRW	78 (2)	30 (38.5)	-	48 (61.5)
<b>Total</b>	<b>3876</b>	<b>2242 (57.8)</b>	<b>865 (22.3)</b>	<b>769 (19.9)</b>

EWH: exceptional warmwater habitat, CWH: coldwater habitat, WWH: warmwater habitat

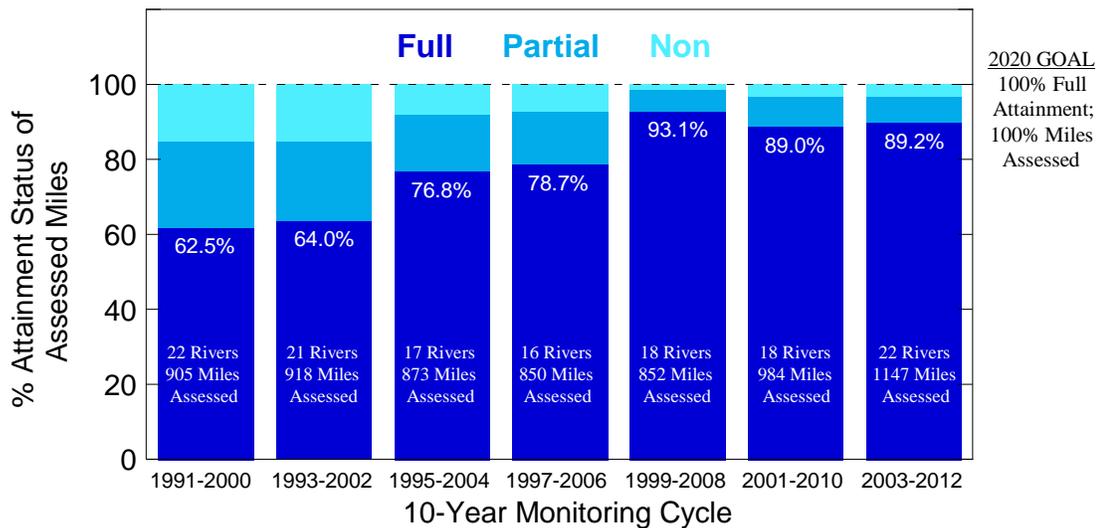
MWH: modified warmwater habitat, LRW: limited resource water

<sup>1</sup> Bold text indicates use that meets the minimum fishable/swimmable goal of the Clean Water Act.  
 Bold/italics text indicates use that exceeds the minimum fishable/swimmable goal of the Clean Water Act.  
 Plain text indicates "less than goal" use that does not meet the minimum fishable/swimmable goal of the Clean Water Act.

**Table G-4. Prevalence of the top five causes of aquatic life use impairment in watershed and large river assessment units based on biological and water quality survey data collected from 2003-2012.**

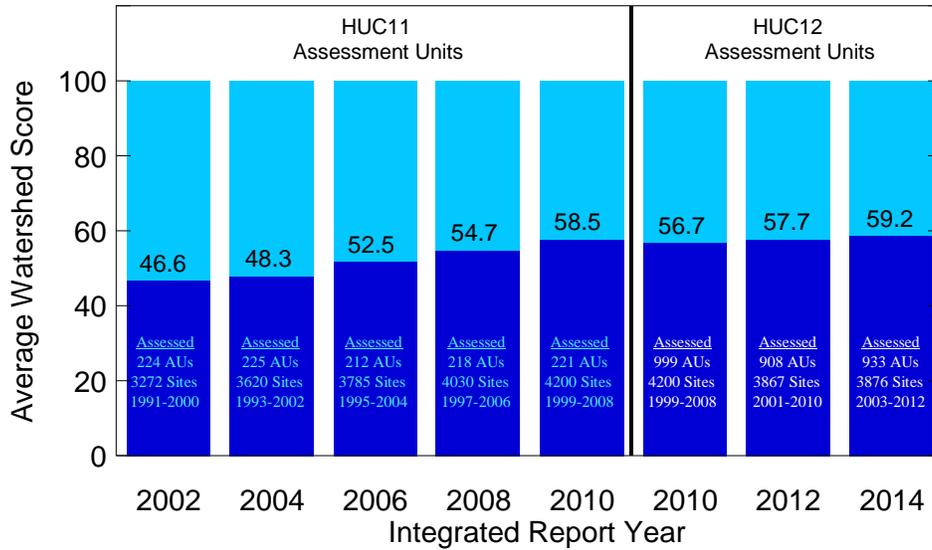
Assessment Unit (AU)	#	Number & Percentage of Monitored AUs with Impaired Aquatic Life Use Listed with a Top Five Cause of Impairment <sup>1</sup>				
		Siltation/ Sedimentation	Nutrients	Habitat Modification	Organic Enrichment/ Dissolved Oxygen	Hydromodification
<b>Watershed</b>	<b>1,538</b>					
Monitored 2003-2012	933					
Impaired aquatic life use	637	344 (54%)	286 (45%)	272 (43%)	245 (38%)	176 (28%)
No impairment	296					
<b>Large River</b>	<b>38</b>					
Monitored 2003-2012	37					
Impaired aquatic life use	19	5 (26%)	9 (47%)	10 (53%)	10 (53%)	6 (32%)
No impairment	18					

<sup>1</sup> Listed as an aquatic life use impairment cause for at least one stream within the watershed AU or one reach within the large river AU.



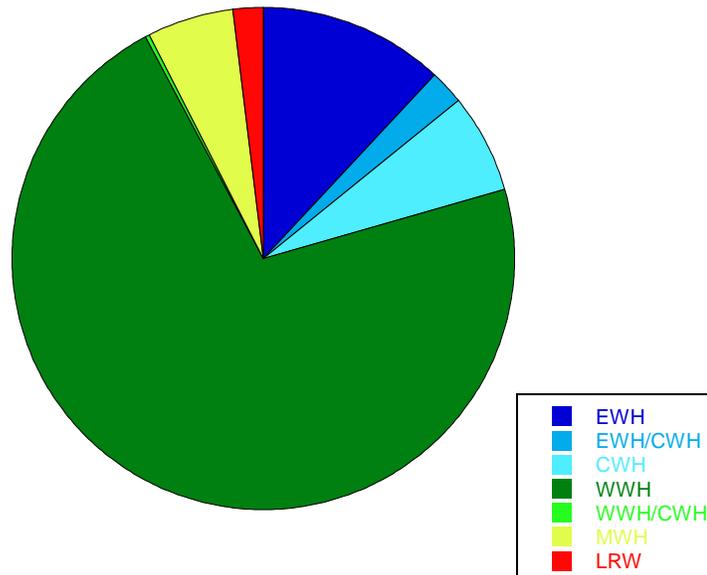
**Figure G-2. Percent attainment status and goal progress (“100% by 2020”) for assessed miles of Ohio’s large river assessment units (23 rivers/38 AUs/1247.54 miles total).**

*Note:* Data compiled over the last seven 10-year Integrated Report cycles with the current 2014 cycle including data collected from 2003-2012.



**Figure G-3. Average full attainment watershed score for Ohio’s HUC11 watershed assessment units (IR cycles 2002-2010) and HUC12 watershed assessment units (IR cycles 2010-2014).**

*Note:* Data compiled over the last seven 10-year Integrated Report cycles with the current 2014 cycle including data collected from 2003-2012.



**Figure G-4. Breakdown by designated or recommended aquatic life use of sites in monitored watershed assessment units (933 HUC12s) based on data collected from 2003-2012 (n= 3876 sites).**

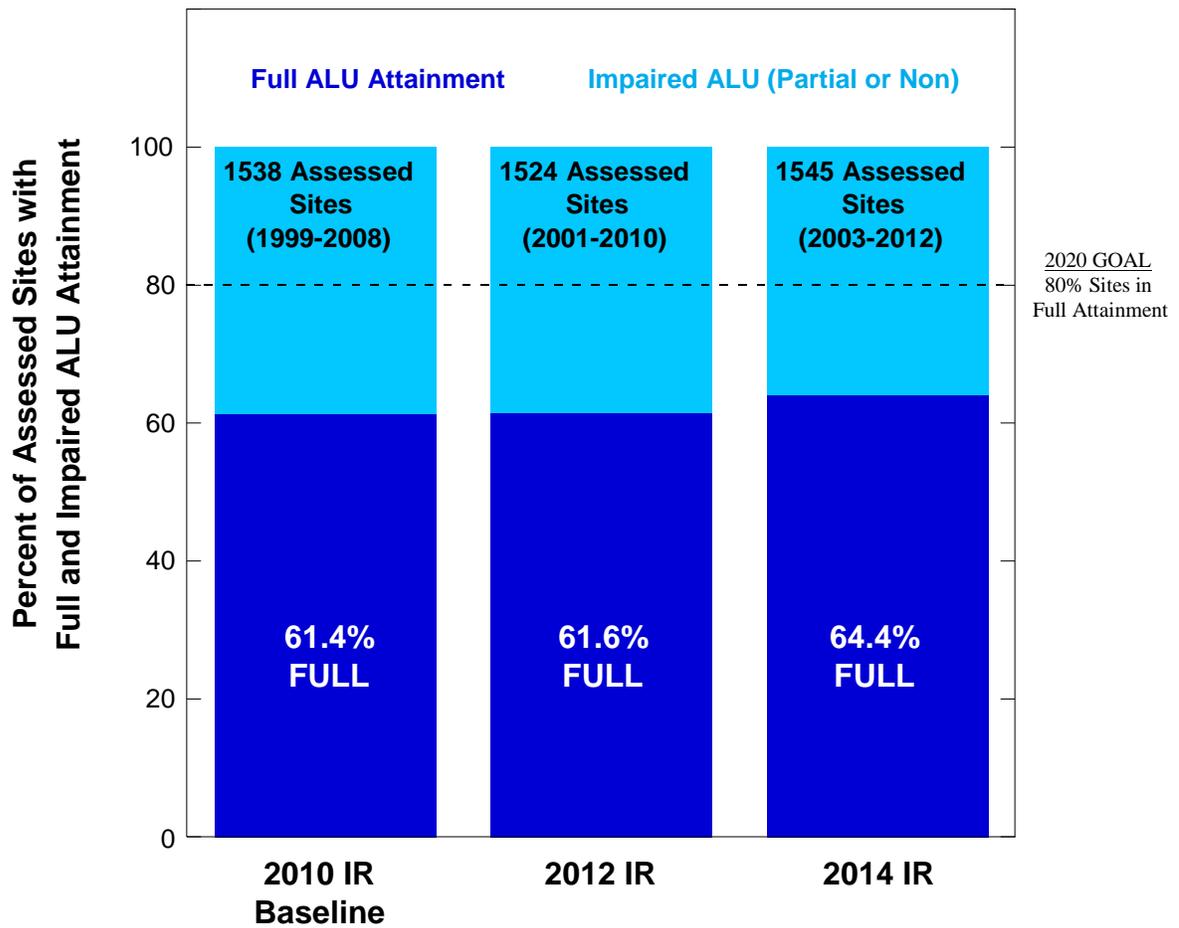


Figure G-5. Status and trend of aquatic life use “80% by 2020” goal for wading and principal stream and river sites in Ohio based on the last three Integrated Report cycles.

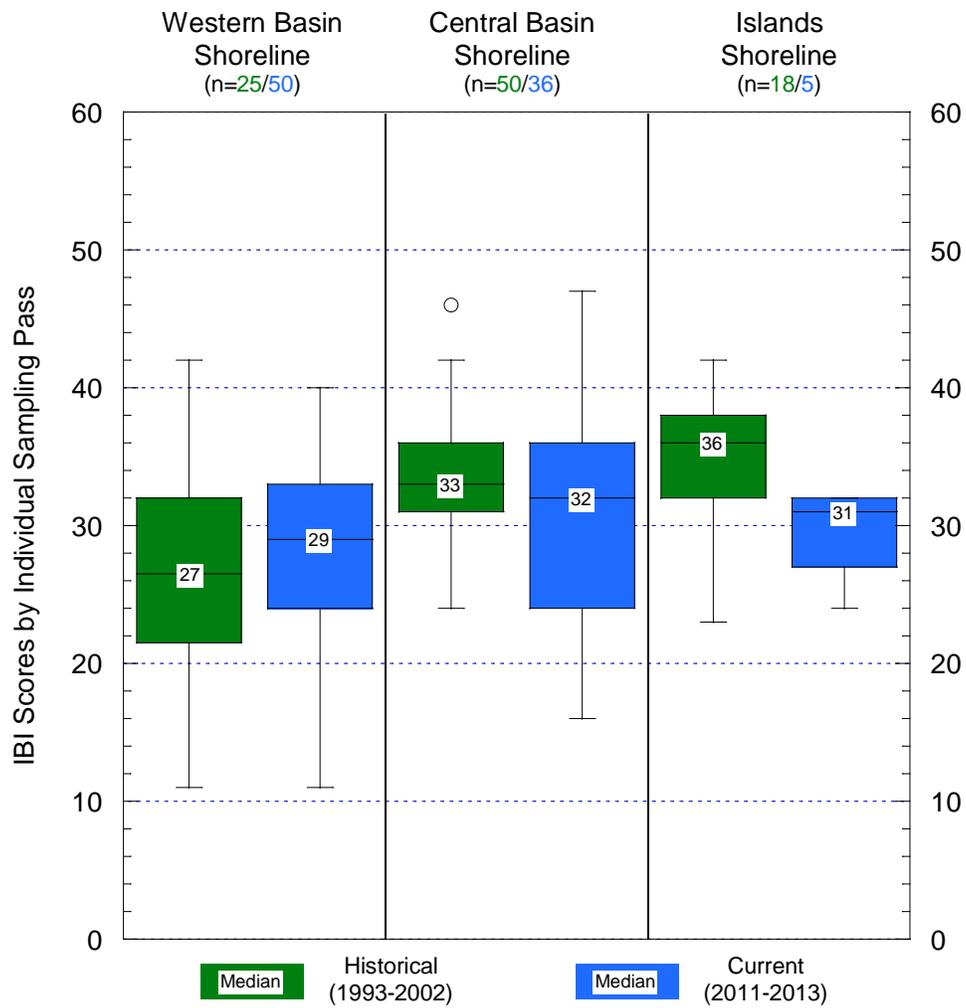


Figure G-6. Comparison of IBI scores for individual electrofishing sampling passes at 38 shoreline sampling locations collected 2011-2013 and 1993-2002.

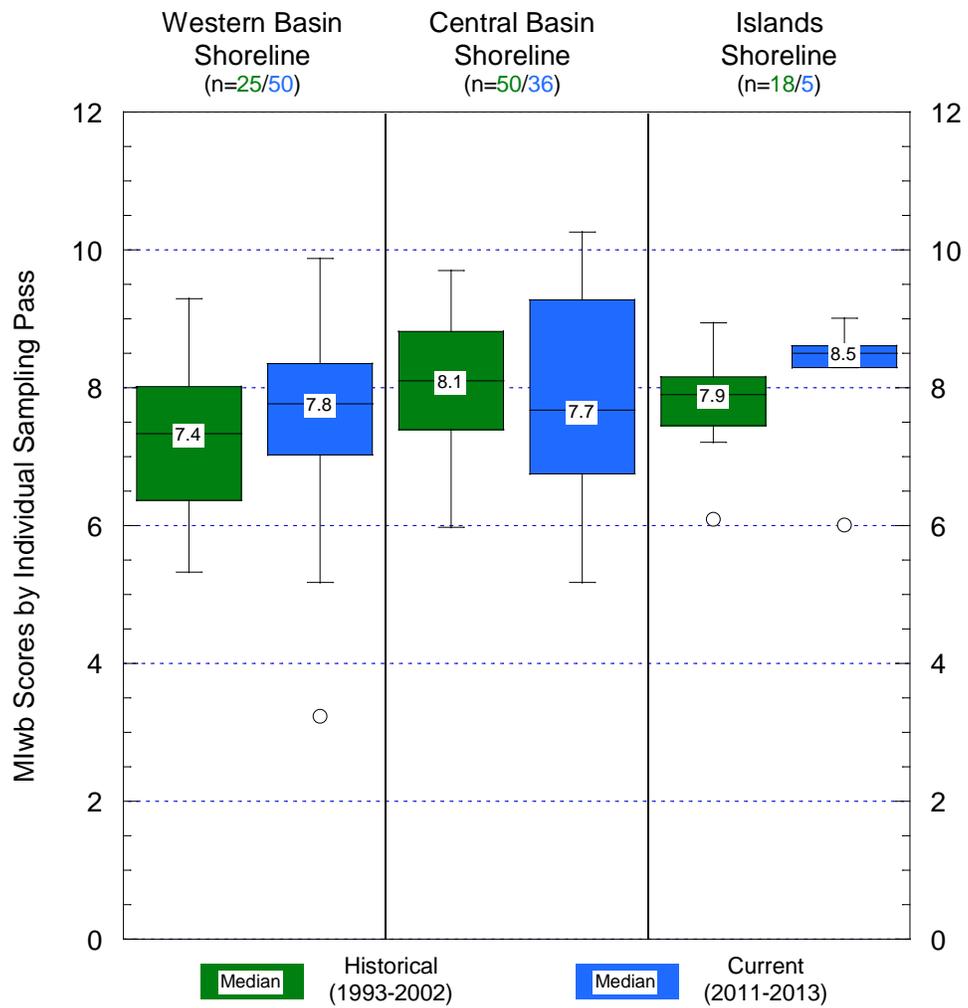


Figure G-7. Comparison of MIwb scores for individual electrofishing sampling passes at 38 shoreline sampling locations collected 2011-2013 and 1993-2002.

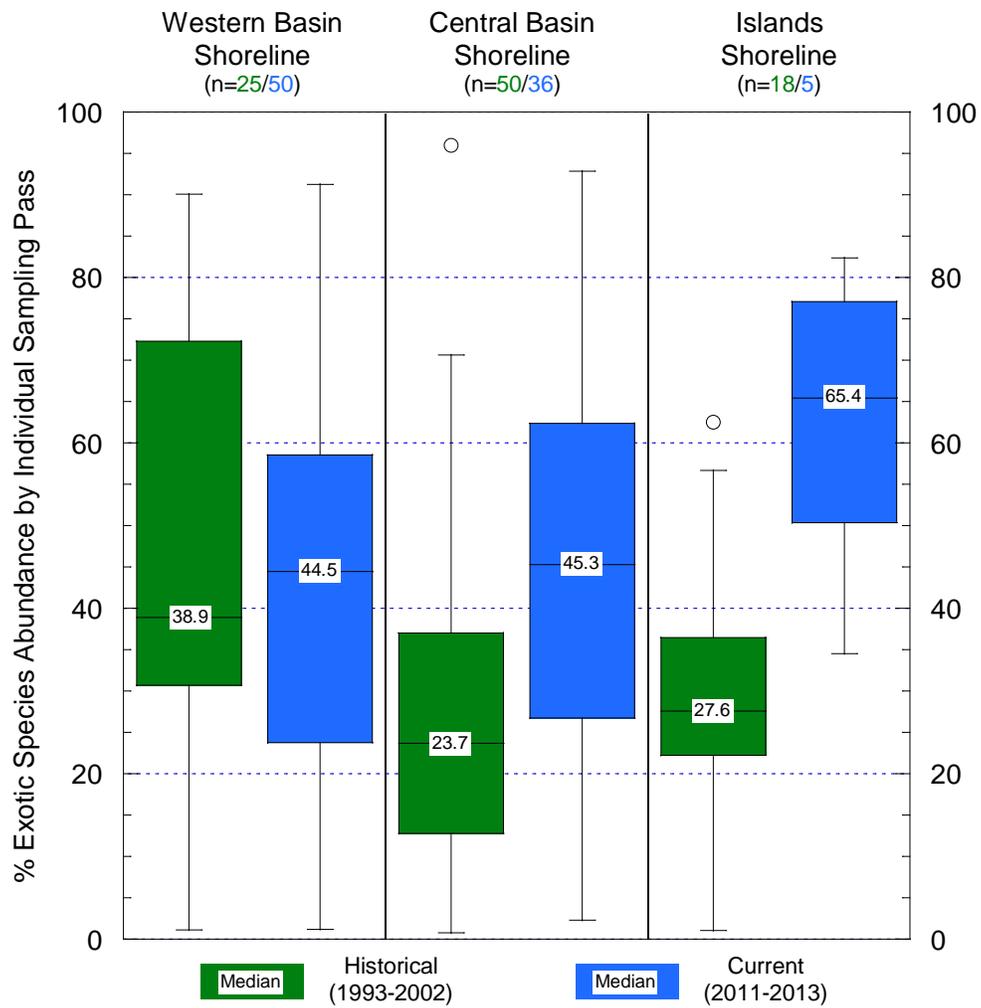


Figure G-8. Comparison of exotic species abundance as a proportion of total catch for individual electrofishing sampling passes at 38 shoreline sampling locations collected 2011-2013 and 1993-2002.