Cuyahoga AOC GLRI Project – Executive Summary Findings

Complete sampling of abiotic and biotic conditions; habitat, food web, fishes; 2011-2015.

- **Flow rates are poor (lack thereof, or exacerbating pulses from ship traffic and reverberation from narrow channel with sheetpile/armoring)**
- **High turbidity/low light transmission**
- **Thermal (discharge) issues locally**
- **Very few low dissolved oxygen events (mainly down river and in old channel)**
- **Nutrient loads and P are a concern, but less so that Maumee, Sandusky rivers**
- **Blue green (Microcystis) algae is being produced, potentially a concern**
- **Diverse plankton and fish populations (better above ship channel, in harbor, and in shallows), but are impaired compared to other rivers (e.g. Grand R.); larval fish found in ship channel annually (mostly gizzard shad & shiners)**
- **Quality habitat zones in ship channel are rare; rehabbed areas are helping: need more shallow water & vegetation.**

Comparisons to BUIs

1. Restrictions on fish and wildlife consumption;

2. Tainting of fish and wildlife flavor;

3. Degradation of fish and wildlife populations*;

Study results support the current status quo that fish and wildlife populations (BUI 3 above) in this portion of the Cuyahoga/Cleveland Harbor Area of Concern are still regionally impaired by the old USEPA and IJC standards, but the lower river and harbor fish population metrics now meet or exceed those criteria recently established by Ohio EPA for Limited Resource Waters (LRWs; OEPA 2014). Adult and juvenile fish composition, diversity, and densities; larval sampling success/composition/densities; and fish metrics like IBI (Karr 1981) and MIwb continue to exhibit lower scores in the ship channel and old channel than those observed in neighboring systems that do not have extensive channelized, armored, and slack water conditions. Our (Boat) IBI readings in the 20s and 30s are acceptable for fair to good conditions and actually have similar ranges to IBI metrics offshore in the central basin of Lake Erie. These study area IBI mean scores meet or exceed the new (OEPA 2014) target thresholds for Limited Resource Waters and Modified Warmwater Habitat for the Erie-Ontario Lake Plain. OEPA (2014) has accounted for the ship channel effects by designating these areas as LRWs, and localized attainment of these new standards for IBI and MIwb is evident.

4. Fish tumors or other deformities*;

Observed percentage of DELTs, at 3.1% across all years of sampling for all fish measured (Appendix 4), is essentially at the target level of 3% (IJC 1991, 2012, OEPA 2014). Annual estimates of DELTs ranged from 2.5-3.6%. Our DELT estimating procedure is somewhat conservative (giving higher percentages than actual) in that

not all fish that we observed in electrofishing were brought to the boat tank and measured. Most of the small fish that were field counted were juvenile emerald shiners and gizzard shad, two species with a low occurrence of DELTs. At no sites across our four study years did the incidence of DELTs exceed twice the target rate of 3% - which is the applicable value to determine the whole assessment unit is in non-attainment.

5. Bird or animal deformities or reproductive problems(*);

not recorded - but a diversity of tolerant, intolerant and sensitive wildlife species were observed throughout the study area.

6. Degradation of benthos*;

Our data collected in this study will not have a direct impact on attainment of this BUI, as OEPA ICI data is used solely to inform progress in this metric. We sampled relatively few areas in a more qualitative manner to complement NEORSD annual benthic sampling procedures - and not duplicate or possibly affect their areal results for their regulatory sampling. Many of their benthic sampling stations were adjacent to our water quality and plankton sampling stations (LR0/River Mile [RM] 7.0; LR1/RM 5.9; LR2/RM 2.75; LR3/RM 0.2), so their results can be viewed as applicable for the study area and for 2011-2014 timeframe. These results show that the NEORSD L-ICI scores meet or exceed the OEPA criteria for benthic community standards. The lowest value recorded across the four years was 18, which was sufficient for attainment in riverine Modified Warmwater Habitats, but not in Lacustuary habitat. This is in spite of the OEPA (2014) caution that this BUI standard will not be evaluated in waters that are routinely dredged as "it is unrealistic for a healthy benthos community to be restored under these conditions."

7. Restrictions on dredging;

8. Eutrophication or undesirable algae*;

Study data support the notion that the Cuyahoga River watershed is a contributor to highly eutrophic conditions in the lower river, Cleveland harbor, and nearshore Lake Erie, based on our total phosphorus (TP), soluble reactive phosphorus (SRP), and chlorophyll a (chl a) results. Also supporting this finding are the nuisance algae densities recorded in our plankton samples in the lower river and harbor. Our TP, SRP and chl a values recorded a great deal of variation between the areas above the ship channel (LR0) and outside the breakwall (OB1 and OB2) compared to the ship channel and old channel stations (LR1, LR2, OC1 and OC2). The lake stations and naturalized river channel station above the ship channel do have episodes or pulses of nutrients that push readings into more eutrophic conditions, but they are transitory in nature as nutrients move through the system or are used by algae. The harbor, lower river, and old channel sections frequently had values of TP and chl a that were well above the defined hyper-eutrophic thresholds. The dredged channels may be acting as a nutrient sink reservoir that can then release high-level pulses of nutrients when

extreme high water events occur. Mixing and agitation vertically in the water column and horizontally through the system can also occur from ship traffic in the river.

These levels of nutrient-rich water can give rise to nuisance harmful algae blooms (HAB) like Microcystis, as observed in our plankton samples (see previous results and discussion of BUI 13, below). These harmful algal blooms were found in lower river, harbor, and nearshore Lake Erie. The one mitigating factor that may keep the lower river and harbor from having perpetual HAB issues is the persistent high turbidity that exists in these areas. The resulting low water clarity may keep local HAB blooms in check as light transmission is quickly filtered out in the top of the water column, thereby limiting the productivity zone.

Impairments from reduced dissolved oxygen levels in the Cuyahoga AOC have long been documented. Early studies in the Cuyahoga RAP and AOC remediation process pointed to low DO and anoxic conditions that began at many sample sites as early as May and persisted until the fall (OEPA 1999). It has long been stated that the stagnant conditions of the reservoir-like nature of the dredged ship channel act like a nutrient sink and give rise to increased oxygen demand, making these poor DO conditions persist.

The newer OEPA guidelines (2014) establish DO targets in ship channels, LRWs and other designated use categories. Those DO criteria of interest for comparison in the study area include: minima of 1.5 mg/l in the designated ship channel, 2.0 mg/l in Limited Resource Waters, and 2.5* mg/l in modified warmwater habitat (*as established in Ohio Administrative Code). Dissolved oxygen 24-hour averages are also established for LRWs at 3.0 mg/l (OEPA 2014). In review of our DO data collected at sample stations during 2011-2014, there was only one occurrence on the Cuyahoga where surface water DO readings were below 1.5 mg/l – and that was in the Old Channel (OC2) in 2013. Bottom DO readings at sample stations did go below 1.5 mg/l more frequently during that time period; 8 times in the lower Cuyahoga stations, LR1 & LR2; 6 times in the Old Channel stations, OC1 & OC2; and 4 times in the Cleveland Harbor stations, H1 & H2. There were no occurrences of very low DO at stations OB1, OB2 or LR0.

Also of note was the relatively good readings of dissolved oxygen and % DO saturation recorded from the data sondes during 2014. For the most part, DO values observed during this study meet or exceed those minima values set for the designated ship channel and the limited resource waters. DO values above the ship channel at station LR0 never were lower than 6.0 mg/l, by station or data sonde readings, far exceeding the minima set for modified warm water habitat. The data sonde readings at the other stations (LR1-LR3) would meet the 24-hr averages set for LRWs; LR1 and LR2 may even meet modified warmwater habitat, by DO minima values recorded, but more data is required to be sure that 2014 is a "typical" river year. It was noted that DO values did sag (sequentially) from the data sonde location above the ship channel at LR0 to stations in the ship channel; LR1, LR2, and LR3. Again, the stagnant reservoir effect of the ship channel, coupled with oxygen demand in the ship channel, affect DO

quality as you go downstream in the ship channel and into the harbor. Data sonde DO readings confirm that progress has been made to meet or exceed the BUI metric standards, but more years of data are needed to confirm these improvements. The DO improvements are becoming evident throughout the channel, but the effects are most noteworthy farther upstream from the mouth.

Pursuant to the current BUI in the Cuyahoga ship channel and OAC (Ohio Administrative Code) 3745-1-26, the OEPA (2014) document states:

"Specifically for the Cuyahoga River, exceptions for the dissolved oxygen criteria are included in OAC 3745-1-26 for the LRW waters identified as the Cuyahoga river ship channel (river mile 5.6 @ the Newburgh and South Shore RR Bridge to the Cleveland harbor portion of Lake Erie). According to the rule, "the physical habitat of the channel and the prevailing background dissolved oxygen regime are insufficient to support any resemblance of the warmwater habitat aquatic life use designation. A use attainability analysis has been conducted and indicated the extant fauna is substantially degraded and the potential for recovery of the fauna to the level characteristic of other Lake Erie river mouth is precluded by irretrievable human induced conditions. However, the ship channel is used by fish as a migratory route in the spring months. This seasonal and stream flow related uses shall be recognized and protected through this rule." The section E(3)(a) of the rule describes the following exception related to dissolved oxygen, "The limited resource water dissolved oxygen criterion shall be 1.5 mg/L minimum. No dissolved oxygen average criteria apply." Section E(5) states "These standards reflect the desire for restoring and maintaining multiple uses of the ship channel expressed by the Cuyahoga River Remedial Action Plan Coordinating Committee. All parties, private and public, who contribute to the dissolved oxygen problem may share a responsibility in the study and attainment of these standards. The dissolved oxygen criteria established in paragraph (E)(3) of this rule are intended to be the minimum planning targets for the remedial action planning process to use in evaluating beneficial use restoration."

"Based on the Cuyahoga rule, we believe it is appropriate to utilize the Cuyahoga shipping channel dissolved oxygen criteria as the BUI restoration target for the federally designated shipping channels in the Black, Maumee and Ashtabula AOCs. It should be noted that if waters have more than one designated use then the lowest target applies and for lacustuary waters with no other use designation, dissolved oxygen will not be evaluated."

According to the data presented in this report, substantial gains have been made in DO in the Cuyahoga AOC including the lower river, ship channel and harbor. Corroborating data in the near future would allow the revisiting and removal of this impairment and change in the administrative code (OAC) to reflect and insure improvements can persist in the future.

9. Restrictions on drinking water or taste and odor problems;

10. Beach closings/access(*);

It was noted that public river access to the lower and middle river reaches downstream of the National Park is limited.

11. Degradation of aesthetics(*);

not recorded, but observations of trash, plastics, oily sheens, airborne particulates were noted. Woody debris and logs were also an episodic problem.

12. Added costs to agriculture and industry;

13. Degradation of phytoplankton and zooplankton populations*;

Study sample data and the analyses presented by Culver et al. (2015) highlight the great diversity in the phytoplankton and zooplankton samples. Taxonomic diversity of zooplankton was very high (27 cladoceran species, 22 copepod species, and 18 rotifer genera, plus dreissenid veligers; Culver et al. 2015). Copepod and cladoceran crustaceans were generally dominant in the zooplankton densities and biomass, with occasional large seasonal contributions from rotifers and veligers. Cyanophytes (blue green algae), including Microcystis, were seasonally predominant in the late summer and early fall, although Microcystis did persist or predominate at other times of the year as well.

In comparisons between the Cuyahoga River stations and Grand River stations for the two years where we have common data (2013 and 2014), there were mixed results. There was not a significant trend in Microcystis between the two water areas: the mean densities of Microcystis measured at Cuyahoga stations was 74 individuals per ml in 2013 (range: 0-564) and 55 per ml in 2014 (range: 0-211), while at Grand River stations it was 33 individuals per ml in 2013 (range: 0-173) and 72 per ml in 2014 (range: 0-303). During high discharge years like 2011, cyanobacteria biomass (mainly as Microcystis) was higher at Cuyahoga stations than nearshore Lake Erie stations, and often cyanobacteria densities exceeded densities of beneficial diatoms, green algae, and flagellates. Densities of the beneficial plankton in the Grand River usually exceeded those observed in the Cuyahoga River, while overall Cyanophyte (blue green algae) densities were higher in the Cuyahoga compared to the Grand. These two observations allow a relative comparison of performance and impairment between the two systems; i.e., the Cuyahoga is more impaired than the Grand, but without more data in these and other systems, we cannot say if that impairment is significant and if there is any trending performance in these systems.

14. Loss of fish and wildlife habitat*

For this BUI metric, the State of Ohio delisting criteria only use the QHEI and/or L-QHEI scores to determine if the habitat is impaired (OEPA 1989, 2014). Recent reviews and the re-worked BUI definitions have removed a QHEI threshold score for Limited Resource Waters (LRWs), like those areas defined for the Cuyahoga Ship Channel, Old Channel and Cleveland Harbor (the lower area of the defined AOC). OEPA (2014) states that the LRW designation and lack of QHEI targets are not applicable because:

"(The) LRW designations are waters that have been found to lack the potential for any resemblance of any other aquatic life habitat as determined by the biological criteria through a use attainability analysis such that the extant fauna is substantially degraded and that the potential for recovery of the fauna to the level characteristic of any other aquatic life habitat is realistically precluded to natural background conditions or irretrievable human-induced conditions."

OEPA (2014) also states that for Modified Warmwater Habitat attainment, QHEI/L-QHEI scores of 50 or above should be maintained and represents a level of aquatic habitat required to meet fish community quality and health. Yet in the next sentence, it is stated (OEPA 2014): "that if the MWH cannot attain the target due to degradation or

physical modifications that cannot be reasonably and cost effectively rectified, then these waters should not preclude the BUI from being removed in the AOC."

It appears that accommodations are in place for both LRWs and MWHs to allow removal of the BUI if ship channel depth maintenance and shore hardening are expected to be perpetuated in the future.

QHEI scores from the study area illustrate the magnitude of the impairment: Our QHEI scores and NEORSD QHEI scores were consistently in the 20s and 30s in the ship channel and old channel locations; river miles (RM) 0-5.9. In NEORSD sites upstream of the ship channel at RMs 7-16, QHEI scores rebounded to the 60s-70s, reflecting more natural riverine conditions. The impairments in the ship channel were reflected in reduced scores for Substrate, Cover, Riffle/Run, and Current/Gradient components. This reduction in habitat scores is to be expected when the ship channel is typically a dredged, 23-foot (7m) deep, "U" shaped channel throughout its 5.5 mile course from Arcelor-Mittal to the river mouth and out through the harbor. The transition areas along the land-water interface in the ship channel old channel and most of the harbor remain clay-silt-muck and drop-offs to the dredge channel are steep (or vertical). The lack of vegetated, littoral or coarse-grained habitat is pervasive.

Lack of gradient and current diversity (even inner and outer river bends are uniform in stream depth and velocity) impair the natural river function of the ship channel, making it appear more like a stagnant reservoir. Ubiquitous shore armoring, in the form of steel sheetpile or poured or placed concrete, harnesses the river channel and the lake shoreline in most places. Energy in the river, stays in the river, and does not dissipate up the shoreline; it just reverberates. Large stone or concrete blocks armor breakwalls or revetments along the lakeshore and in marinas. These armored structures provide little to no transition zones of shallow water to the uniform dredged depths. The vertical hardening does not provide substantial dissipation or release of water energy in the narrow channels or the land/water interface. Large ships provide periodic episodes of destructive energy forces through bow waves and lateral forces from thrusters and prop wash as they maneuver upstream, downstream, and alongside mooring areas.

On the other hand, our cursory review of the habitat of the "middle section" of the Cuyahoga River, from the State Route 82 dam in Brecksville down to the first riffle below the Harvard-Dennison bridge, confirmed what was presented in the NEORSD QHEI values. This stretch of the Cuyahoga River habitat is largely reverted to riffle-pool-run development with natural meanders, albeit within a narrow corridor dropped in a variety of upland habitats that range from urban to suburban to rural (within the confines of the Cuyahoga Valley National Park). Habitat quality is as good as attainable for Modified Warmwater Habitat in a developed urban and suburban watershed. Urban, suburban and agricultural inputs all affect the AOC watershed in these locations, yet habitat diversity is flourishing and MWH index thresholds are exceeded. Conditions in this river reach are exemplifying habitat and aquatic community recovery beyond past impairments. All is not perfect, though, as critical

issues such as flooding episodes, and silt, nutrient and bacterial inputs still remain and need to be addressed.

Holistic improvements to water quality and quantity parameters, and prescribed habitat refugia placement, implemented throughout the watershed, will go a long way to promoting healthy aquatic communities and removal of this BUI.

The dredged ship channel lacks habitat diversity, bottom and shore complexity, any appreciable areas of shallow water habitat, and substantial cover habitat. Sediments are mostly clay and silt based. Sands and gravels are some of the first materials to rain out and settle in the upper ship channel, and they are likely the first materials to be removed through the annual dredging process. Cover habitat, in the form of logs, root wads, shore brush and submersed or emergent vegetation are scarce in the dredged channel. Many logs that enter the ship channel are removed to ensure safe navigation conditions. A few backwater marina, small stream entrances, and abandoned areas or neglected properties provide some shallow water refuge and woody or vegetated cover. Reversion to natural conditions is a healing part of the restoration process.

Opportunities for restoration and management implications

- **Watershed management**
- **Flow and hydraulic engineering; bank adjustments**
- **Actions that promote abiotic and biotic improvements**
- **Habitat improvements**

Table 12. Benchmarks on the Cuyahoga AOC health/documented reproduction of tentative Indicator Species.

Achievement	Lake Transient Species:	Resident Species:	Forage fishes:
Level 1 "Easy"	White Sucker Shorthead Redhorse	Channel Catfish Common Carp	Gizzard Shad Freshwater Drum
Level 2 "Intermediate"	White Perch / White Bass Smallmouth Bass	Largemouth Bass Sunfish species	Emerald Shiner Brook Silverside
Level 3 "Advanced"	Walleye Muskellunge Lake Sturgeon	Smallmouth Bass Northern Pike	Rosyface Shiner Blacknose Dace