SCDRS INITIATIVE INDICATOR DESCRIPTIONS

This document contains descriptions and further information for each of the indicators listed in the St. Clair-Detroit River System (SCDRS) Initiative Science and Monitoring Database Google Form. These descriptions were taken from the viability analysis write-up and not all indicators have specific metrics determined. The numbers correspond to the numbers in the Google Form for easier navigation to specific indicators. If you have any further questions, clarifications, or suggestions regarding metrics to use, please contact Robin DeBruyne (rdebruyne@usgs.gov).

1) Fish species richness: larval or spawning adults

Larval: There is evidence of increasing spawning activity by native species that historically spawned in large numbers in the Detroit River but that have been absent or very rare for many decades (Roseman et al. 2007). As such, tracking the richness of larval species can be an effective indicator of the recovery of the St. Clair and Detroit rivers.

Spawning adults: There is evidence of increasing spawning activity in the SCDRS by species, such as lake whitefish, that historically spawned in large numbers in the Detroit River but that have been absent or very rare for many decades (Roseman et al. 2007). Other species including lake sturgeon, walleye, and muskellunge are known to spawn in the SCDRS (Thomas and Haas 2002; Kapuscinski et al. 2010; Manny et al. 2010). As such, tracking the richness of spawning species can be an effective indicator of the recovery of these connecting channels.

2) Peak density of whitefish larvae (5 year mean)

This indicator reflects the recently discovered presence of spawning lake whitefish and ongoing survey efforts in the SCDRS (Roseman et al. 2007). The presence of spawning lake whitefish is an indicator of improving water quality since the adoption of the GLWQA in 1972, and can serve as a positive and motivational symbol of system recovery.

3) Total native intolerant fish species in annual bottom trawl surveys (3 year mean)

The survival or presence of many intolerant fish species depends on response to differing levels of eutrophication, which results in stressful conditions such as low oxygen and turbidity. Tracking the richness of intolerant species can provide an indication of ecosystem condition with regards to stress on the fish community from low oxygen or high turbidity conditions. Native intolerant species include emerald shiners, lake sturgeon, rock bass, sand shiners, shorthead redhorse, silver redhorse, smallmouth bass, spottail shiner, and trout-perch. Intolerant species were taken from Ludsin et al. (2001) and references therein.

4) Smallmouth bass population/relative abundance

Smallmouth bass are a native species with high recreational value in Lake St. Clair. Lake St. Clair has a premier smallmouth bass fishery which accounted for 39% of trophy entries into the Michigan DNR Master Angler program in 2012 (Thomas and Wills 2013). The specific metric to assess the smallmouth bass population or relative abundance in the SCDRS has not been determined; however information regarding catch-per-effort or population estimates at locations within the corridor would be helpful in determining a suitable metric and tracking the population trends.

5) Walleye population/relative abundance

Walleye are very important ecologically and economically in Lake St. Clair (MacLennan et al. 2003), with 28% of open water anglers identifying walleye as their target species (Thomas and Towns 2011). As a top predator in the lake, they are important in maintaining the fish community structure of Lake St. Clair. Walleye from Lake St. Clair are also exploited by commercial fisheries in southern Lake Huron (MacLennan et al. 2003). Walleye caught and tagged in Lake St. Clair are known to have wide-ranging movements (Thomas and Hass 2012); indicating some of the walleye in Lake St. Clair may be part of a larger meta-population of walleye in the region. The specific metric to assess the walleye population or relative abundance in the SCDRS has not been determined; however information regarding catch-per-effort or population estimates at locations within the corridor would be helpful in determining a suitable metric and tracking the population trends.

6) Yellow perch population/relative abundance

Yellow perch are very important ecologically and economically in Lake St. Clair, accounting for a majority of the fish harvested from Lake St. Clair (Thomas and Towns 2011). The specific metric to assess the yellow perch population or relative abundance in the SCDRS has not been determined; however information regarding catch-per-effort or population estimates at locations within the corridor would be helpful in determining a suitable metric and tracking the population trends.

7) Muskellunge population/relative abundance

Lake St. Clair is home to one of the last self-sustaining muskellunge populations in the Great Lakes with the management objective of providing a trophy muskellunge fishery (MacLennan et al. 2003). In 2012, 60% of the entries into the Michigan DNR Master Angler Program were from Lake St. Clair (Thomas and Wills 2013). The specific metric to assess the muskellunge population or relative abundance in the SCDRS has not been determined; however information regarding catch-per-effort or population estimates at locations within the corridor would be helpful in determining a suitable metric and tracking the population trends.

8) Mature lake sturgeon population abundance

Lake sturgeon have been steadily increasing across the Great Lakes, with only a few populations considered large (Hayes and Caroffino 2012), and their numbers provide a useful and recognizable sign of water quality and habitat improvements.

9) Lake sturgeon status across tributaries

Lake sturgeon are dependent upon tributaries and connecting channels for spawning habitat (Lane et al. 1996; Zollweg et al. 2003). Historically, they were an important ecological and economic component of the SCDRS and Lake Erie fish communities (Leach and Nepszy 1976; Ryan et al. 2003; Zollweg et al. 2003; Davies et al. 2005). However, their populations were decimated by overfishing, dam construction, and habitat degradation (Ryan et al. 2003; Davies et al. 2005), and their numbers provide a useful and recognizable sign of water quality and habitat improvements.

10) Status of shorthead redhorse across tributaries

Shorthead redhorse are one of several Lake Erie redhorse species that migrate into tributary rivers, including the Detroit and St. Clair rivers to spawn (Goodyear et al. 1982; Eakins 2013). Shorthead redhorse appear to be among the most susceptible of the redhorse species to habitat fragmentation (Reid et al. 2008a) and their population size increases with decreasing fragmentation (Reid et al. 2008b).

11) Status of walleye across tributaries

Walleye are very important ecologically and economically in the SCDRS (Thomas and Towns 2011; Thomas and Wills 2013) and tributary spawning populations provide a major component of walleye populations across the Great Lakes and within the SCDRS (Lane et al. 1996; Mion et al. 1998; Davies et al. 2005).

12) Status of white suckers across tributaries

Spawning runs of white suckers in the Great Lakes are widespread (Klingler et al. 2003; Burtner 2009; Childress 2010) and represent the highest biomass of tributary-spawning migratory fish species across the Great Lakes in contemporary times. Recent research on white suckers is beginning to provide an understanding of the functional role of native migratory fish in the Great Lakes (Burtner 2009; Childress 2010; Flecker et al. 2010) and given the abundance and biomass of their runs, white suckers likely play particularly important functional roles.

13) Spawning/recruitment success of representative coastal wetland spawners

This indicator would complement the wetland fish IBI indicator, and is more reflective of the role of coastal wetlands as critical spawning habitat for many Great Lakes fish species.

14) Wetland Fish Index (WFI) of wetland quality

As used in the Lake Huron Biodiversity Conservation Strategy (Franks Taylor et al. 2010), the WFI is a measurable indicator of fish species composition in coastal wetlands but also considers ecosystem function because environmental variables (water quality) are incorporated into the index. Fish assemblages have been used as land use or water quality indicators of environmental conditions at the Great Lakes coastal margins (Uzarski et al. 2005; Seilheimer and Chow-Fraser 2006). The WFI is essentially an earlier version of the SOLEC indicator of Coastal Wetland Fish Community Health (Sass et al. 2009), being developed for use across the Great Lakes basin.

15) Wetland area (acres)

This indicator represents the total area of wetlands in each assessment unit. Wetlands provide multiple critical ecosystem functions and habitat for numerous plant and wildlife species, and the total area of wetlands is a valuable and direct indicator of coastal wetland viability for a particular area. Wetlands have been mostly destroyed by human activities across the Great Lakes including shoreline alteration, dredging, construction of jetties and marinas, and others (e.g., Manny 2007), but there are few references that cite the amount of coastal wetland loss relative to what would be expected for a particular area.

16) Percent of accessible tributary wetland habitat

Some Great Lakes migratory fish, such as northern pike and muskellunge, use tributary systems to access wetland systems located upstream (Trautman 1981). Understanding the extent of tributary wetland habitat accessible from the SCDRS would help target wetland preservation and restoration efforts.

17) Area of suitable habitat for lithophilic spawners

Since many Great Lakes fish species migrate to the SCDRS (Trautman 1981; Goodyear et al. 1982), connectivity to a wide variety of habitats is necessary to maintain populations of all of these species. Lithophilic spawners, in particular, generally broadcast spawn on gravel and cobble substrates and respond greatly to urbanization and habitat alteration (Helms and Feminella 2005). The construction and maintenance of commercial shipping channels during the 20th century removed most of the historic lithophilic spawning habitat in the St. Clair and Detroit Rivers. The geographic area considered for this metric will only be the St. Clair and Detroit rivers.

18) Native mussel density (#/m^2)
Freshwater mussels are of significant interest in North America given the high diversity of this taxa in North America and the high level imperilment of this group (Master 1990), as well as the ecological functions they provide (Vaughn et al. 2008). Among these ecological functions is their ability to filter large volumes of water, which helps to temper algal populations in productive areas and helps to reduce turbidity. Historically much more abundant and rich in diversity, the Detroit River and Lake St. Clair’s native mussels have experienced a major decline over the decades, most likely due to the dreissenid invasion (zebra and quagga) mussels (Gillis and Mackie 1994; Nalepa 1996; Schloesser et al. 1996). However, studies have indicated coastal areas can provide native mussels refuge from dreissenids (McGoldrick et al. 2009; Crail et al. 2011; Bryan et al. 2013)

19) Mean native mussel richness per site
This indicator is indicative of the number of species collected at each site through freshwater mussel (Unionidae) surveys in the nearshore habitats of the SCDRS.

20) Mean *Dreissena* density (#/m^2)
The two *Dreissena* species that have invaded the Great Lakes, zebra mussels and quagga mussels, have caused massive changes in the Great Lakes. In the nearshore zone (<15m), these have included changes in nearshore nutrient dynamics (Hecky et al. 2004), large outbreaks of nuisance *Cladophora* (Auer et al. 2010), degradation of spawning reefs (Marsden and Chotkowski 2001), and eradication of native freshwater mussels from many Great Lakes habitats (Schloesser et al. 1996).

21) Emergent and submergent vegetation distribution in protected embayments and soft sediment areas in Lake St. Clair
To support phytophilic fish, submerged aquatic macrophytes are needed in the system. This vegetation is affected by pollutants (Hartig et al. 2007) and exotic species (Knapton and Petrie 1999). The Michigan DNR mapped macrophytes in Lake St. Clair from 2003-2007 with regards to their species composition and abundance (Thomas and Haas 2012). Macrophytes are important to fish in the nearshore lake margin, and the Great Lakes Fishery Commission (2012) includes a goal of “Restore submerged aquatic macrophyte communities in estuaries, embayments, and protected nearshore areas.”

22) Wetland macrophyte index
Wetland macrophytes are directly influenced by water quality, and impairment in wetland quality can be reflected by taxonomic composition of the aquatic plant community. Croft and Chow-Fraser (2007) developed the wetland macrophyte index from the statistical relationships of

biotic communities along a gradient of deteriorating water quality and using plant presence/absence data for 127 coastal wetlands from all five Great Lakes.

23) Mean densities of rotifers, copepods, and cladocerans in early summer (ind./L)
Zooplankton are a critical food source to larval fish during the early summer.

24) Wetland Zooplankton Index (WZI)
This indicator is based on the work of Lougheed and Chow-Fraser (2002), in which they demonstrated that the WZI could effectively detect water quality improvements.

25) Amphibian community-based coastal wetland Index of Biotic Integrity (IBI)
This indicator captures the status of amphibians, specifically, frogs and toads (anurans) in coastal wetlands. It is essentially the same as SOLEC draft indicator for Wetland Anurans (Timmermans et al. 2008; Archer et al. 2009b), and is part of a Great Lakes basin-wide monitoring project funded through the U.S. EPA Great Lakes Restoration Initiative.

26) Marsh Bird IBI
This indicator captures the status of birds in coastal wetlands. It is the same as SOLEC draft indicator for Wetland Birds (Grabas et al. 2008; Archer et al. 2009a), and is part of a Great Lakes basin-wide monitoring project funded through the U.S. EPA Great Lakes Restoration Initiative.

27) (Macro) Invertebrate IBI
A basin-wide coastal wetland survey project funded by the Great Lakes Restoration Initiative is collecting extensive invertebrate data on all 5 Great Lakes, using methods from Uzarski et al. (2004). This indicator is being developed for SOLEC as the Coastal Wetland Invertebrate Communities indicator (Uzarski and Burton 2011 *cited in* Pearsall et al. 2012). Details on field methods and calculation of the IBI are available in Uzarski et al. (2004).

28) Mean *Hexagenia* density (#/m^2)
Hexagenia, a dominant benthic organism in the nearshore zone of lakes, are important indicators of nearshore health in more productive areas of the Great Lakes that are dominated by soft substrates (Edsall et al. 2005). In addition, *Hexagenia* can be a very important food source to many benthic feeding fishes, including lake sturgeon (Choudhury et al. 1996; Beamish et al. 1998), yellow perch (Price 1963; Clady and Hutchinson 1976), and walleye (Ritchie and Colby 1988).

29) Percent coverage of *Phragmites* in coastal wetlands
Non-native, invasive plants occupy space that otherwise would be occupied by native species, and can fundamentally change the structure, composition, and processes of a coastal wetland. Common reed (*Phragmites australis*) is a non-native species which is particularly harmful because it grows in dense monocultures, spreads quickly and widely, and is eaten by virtually no insects or herbivores.

30) Mean distance between suitable shorebird or waterfowl habitat and disturbance factor

This indicator is based on response of shorebirds and/or waterfowl to anthropogenic disturbance factors such as hiking, running, walking, and response to dogs accompanied by people, as well as response to boats.

31) Percentage of 2 km shoreline area suitable for shorebirds, landbirds or waterfowl
Studies outside the Great Lakes region indicate that the number and/or species richness of shorebirds is positively associated with the amount of wetland cover at a scale of 3-10 km (Farmer and Parent 1997). Increased densities of migrants occur in habitat patches located in landscapes <40% in natural cover (Williams 2002), and migrant body condition may be reduced in landscapes with <10% cover (Ktitorov et al. 2008).

32) Percentage of high priority habitat across all bird groups in conservation management
This is a conservative approach to ensure there is sufficient habitat at all times during any given and between migration seasons.

33) Fish tissue contaminant load: mercury and/or PCBs
Mercury: This indicator has been tracked in the Great Lakes for over 35 years by federal, tribal, and state agencies, primarily in recognition of the human health implications of eating fish with high concentrations of mercury (Monson et al. 2011).
PCBs: As with the above indicator, this one has been established primarily for human health concerns. It can serve well as an indicator of water quality, along with measures of other contaminants.

34) Soil erosion and deposition rates (from tributaries)
This indicator reflects the rates of erosion and deposition of SCDRS tributaries. Erosion from tributaries contributes sediment loads in the system, and sediment discharge from tributaries has been tightly linked to phosphorus in Lake Erie. The Thames River is prone to discharging large sediment plumes into eastern Lake St. Clair.

35) Mean/median total dissolved solids (mg/L)
Description: This indicator reflects the combined amount of all inorganic and organic substances contained in a liquid in suspended form. It is commonly used as an indicator of water quality and was included in the Lake Erie Biodiversity Conservation Strategy (Pearsall et al. 2012).

36) Nitrogen
Whereas phosphorus is the key limiting nutrient and the focus of management efforts, nitrogen can occasionally limit productivity and should be the focus of ongoing research (Lake Erie LaMP 2011). As stated in the Binational Nutrient Management Strategy (Lake Erie LaMP 2011): "…it is important to continue to research and monitor the effects of nitrogen and other nutrients so that management decisions and actions can be adapted to appropriate concerns." The specific metric to assess nitrogen has not been determined.

37) Dissolved phosphorus loads
To reduce and/or prevent harmful algal blooms and nuisance algae, measurement and reduction of phosphorus loads to Lake St. Clair may be necessary. The specific metric to assess dissolved phosphorus loads has not been determined.

38) Total phosphorus concentrations in rivers, Lake St. Clair, and wetlands (µg/L)
Total phosphorus is an important measure of trophic state and keeping phosphorus below target levels is important to maintain or achieve desired trophic conditions (mesotrophic) and avoid nuisance and harmful algal blooms (IJC 2012). Total phosphorus has been measured for decades in the Great Lakes and has been a predominant measure of phosphorus as an indicator of eutrophication.

39) Water Quality Index for wetland quality
Description: The Water Quality Index score provides a snapshot of coastal wetland condition according to the degree of anthropogenic disturbance and is reflected by enrichment of nutrients and suspended solids in the water column, as well as conductivity and temperature (Chow-Fraser 2006). Over 200 Great Lakes Coastal Wetlands have been surveyed between 1998 and 2008 using this method; mostly in lakes Erie and Huron.

40) *Cladophora* standing crop (gDW/m^2) during late summer (Aug-Sept)
Cladophora is a nuisance alga that grows on rocks and other structures at the bottom of lakes and other water-bodies. The substantial physical and chemical changes in habitat conditions cause by *Cladophora* can substantially alter native species populations (Ward and Ricciardi 2010).

41) Extent of harmful algal blooms (e.g., *Microcystis, Lyngbya*)
This indicator would measure how far algal blooms (with specific attention to harmful algal blooms [HABs]) extend across Lake St. Clair. In the recent past, Lake Erie has incurred blooms extending through much of the Western Basin. Loadings of phosphorus are correlated with the extent of blooms. This measure would determine the aerial extent of HABs, such as measured by NOAA satellite tracking.

42) Artificial shoreline hardening index
This indicator reflects the percent of shoreline protected with artificial structures (e.g., seawalls, rip rap) to prevent erosion. Shoreline hardening disrupts natural nearshore coastal processes that drive erosion and sediment transport, and therefore the nature and extent of nearshore zone habitats and community structure of Great Lakes shorelines (Meadows et al. 2005; Morang et al. 2011; Morang et al. 2012). In the SCDRS, hardened shorelines have destroyed wetlands and wildlife habitat and alter the flow regime of these rivers by preventing high waters from flooding inland, redirecting energy downstream. Despite knowledge that the impacts of shoreline hardening have been profound, the impacts of shoreline hardening have been understudied in the Great Lakes (Mackey and Liebenthall 2005) and have received little attention in efforts to protect or restore coastal systems.

43) Percent river flow through Chenal Ecarte
Herdendorf et al. (1986) reports that approximately 5% of water from the main stem of the St. Clair River enters the Chenal Ecarte distributary. The Chenal Ecarte, and the distributaries from the Chenal Ecarte, are the source of river flow for much of the eastern portion of the St. Clair Delta, including Walpole and St. Anne islands. Adequate flow through the Chenal Ecarte is needed to maintain the current biodiversity and hydrology of the eastern half of the St. Clair Delta.

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