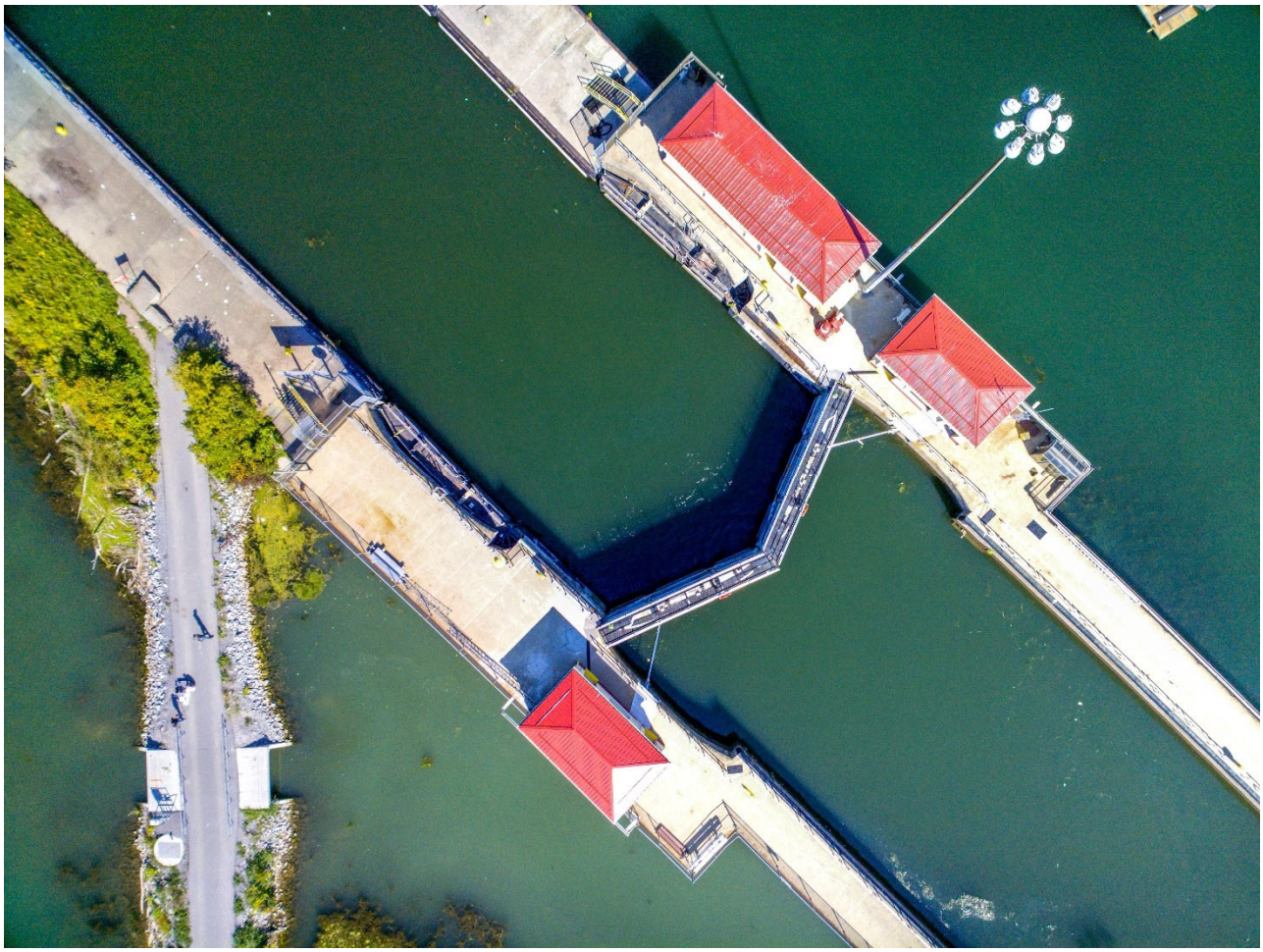
Sustainable Rivers Program

Black Rock Lock Ecological Analysis

Appendix 1: Niagara River Hydrology and Hydraulics
Appendix 2: Fish Inventory Matrix



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Above: Black Rock Lock in Buffalo District (USACE photo)

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1. Niagara River Hydrology and Hydraulics (Appendix 1)

The U.S. Army Corps of Engineers (USACE) previously developed a 2-dimensional Hydrologic Engineering Center River Analysis System (HEC-RAS) model of the Upper Niagara River to evaluate the cumulative impacts of various projects on water surface elevation (WSE) within the river and Lake Erie.

The model was run using typical high flow, low flow, and long-term average (LTA) flow hydrographs. The selected events for the high, low and LTA hydrographs were 10-28 June 2019, 11-17 February 2003, and 9-23 September 2011, respectively. Each flow hydrograph (Figures 1, 2 and 3) was generated using Lake Erie water surface elevations (WSEs) from National Oceanic and Atmospheric Administration (NOAA) gage 9063020 that were converted to flow using the equation below. The equation uses stage in International Great Lakes Datum (IGLD) meters, therefore those units were used in the calculation to compute flow rates in cubic meters per second (cms), which were then converted to flow rates in cubic feet per second (cfs) for use in this analysis and report.

$$Q\ (cms) = 699.4 \times (Stage\ at\ NOAA\ Gage\ 9063020 - 170.043)^{1.5}$$

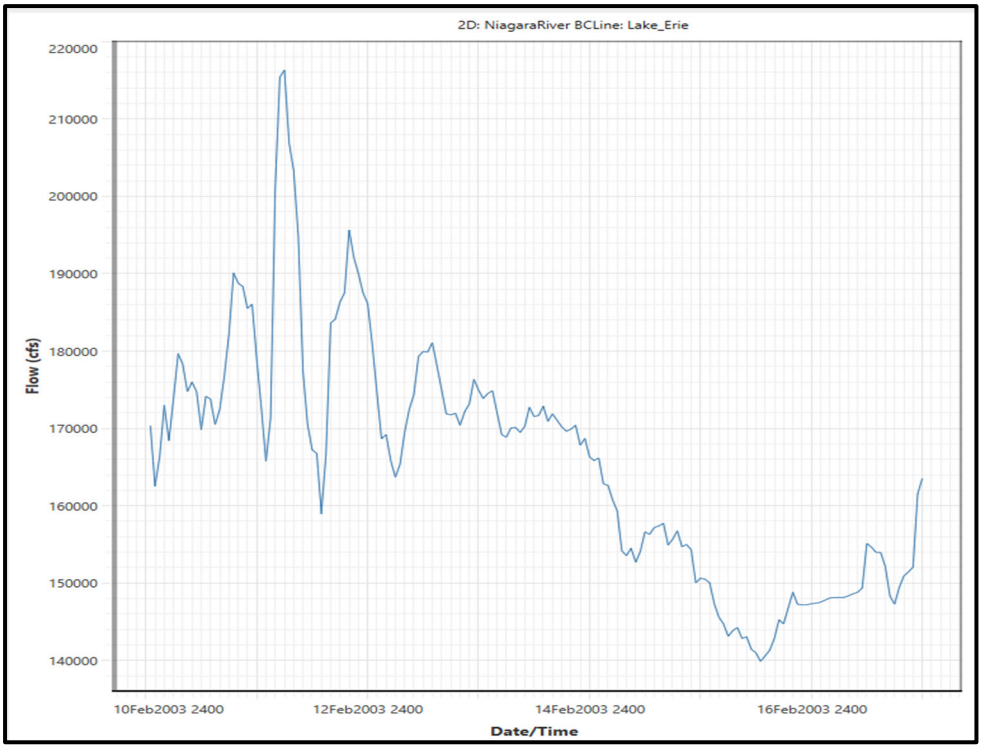

Figure 1. Low flow hydrograph.

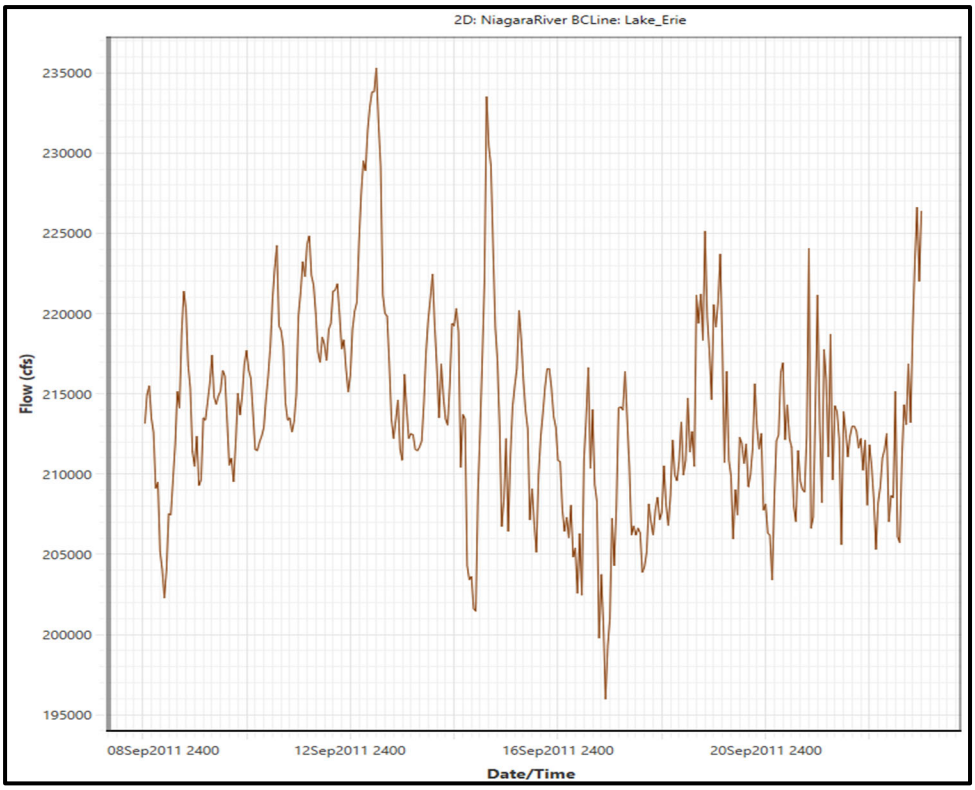

Figure 2. Long-term Average (LTA) flow hydrograph.

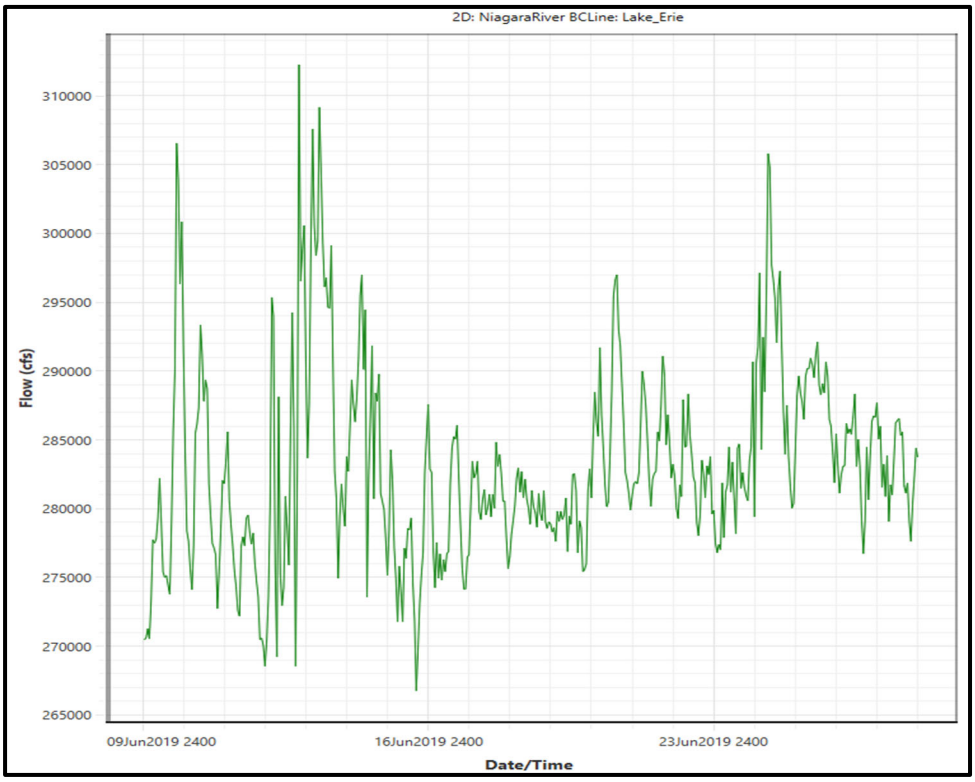

Figure 3. High flow hydrograph.

2. Existing Conditions Results (Appendix 1)

The model results from the previous study were used to identify existing conditions, particularly flow velocities, depths and shear stress, throughout four regions within the Niagara River in the vicinity of Black Rock Lock (Figure 4). These results are summarized in Tables 1 to 3 and Figures 5 to 13.

For the flow velocities figures, areas with flow velocity greater than 0.81 m/s (2.66 ft/s) are displayed in red, while areas with lower velocities are marked in green. This velocity threshold corresponds to swimming speeds for Emerald shiner, which are a particular species of interest for upstream passage within the Niagara River. Additional swim speeds and velocity thresholds can be considered for other species of fish as well.

Results for regions 1, 2, and 3 indicate no barriers to fish passage concerning flow velocity, depth, and shear stress are present under existing conditions. The lock itself is a physical barrier, which likely prevents most passage under current operations. Velocities in region 4 indicate that upstream passage may be limited within the main channel of the Niagara River for certain species, further supporting the consideration for conservation lockage of the Black Rock lock for upstream fish migration. Velocities within the River downstream of region 3 could impede fish movement upstream into the canal and towards the lock, which can be further investigated.

Figure 4. Site regions.

Table 1. Flow velocities (ft/s).

		Region 1	Region 2	Region 3	Region 4
Low Flow	Min	0.03	0.16	0.21	1.72
	Max	1.44	1.35	2.00	6.53
	Mean	0.72	0.61	0.77	4.80
LTA Flow	Min	0.04	0.18	0.19	1.97
	Max	1.46	1.45	2.39	6.88
	Mean	0.74	0.67	0.84	5.40
High Flow	Min	0.05	0.17	0.35	2.14
	Max	2.21	2.14	2.72	7.77
	Mean	0.89	0.98	1.17	6.03

Table 2. Flow depth (ft).

		Region 1	Region 2	Region 3	Region 4
Low Flow	Min	0.02	12.47	15.80	3.00
	Max	31.81	28.42	28.33	31.31
	Mean	21.93	22.45	23.68	21.53
LTA Flow	Min	0.91	13.11	16.45	3.64
	Max	32.88	29.08	28.98	31.95
	Mean	22.92	23.08	24.33	22.17
High Flow	Min	3.36	0.60	18.75	6.03
	Max	35.23	31.38	31.28	34.39
	Mean	25.31	24.49	26.63	24.54

Table 3. Flow shear stress (lb/ft^2).

		Region 1	Region 2	Region 3	Region 4
Low Flow	Min	0.00	0.00	0.00	0.05
	Max	0.00	0.01	0.10	0.56
	Mean	0.00	0.00	0.01	0.26
LTA Flow	Min	0.00	0.00	0.00	0.01
	Max	0.00	0.01	0.06	0.34
	Mean	0.00	0.00	0.00	0.19
High Flow	Min	0.00	0.00	0.00	0.08
	Max	0.00	0.34	0.21	0.91
	Mean	0.00	0.01	0.03	0.44

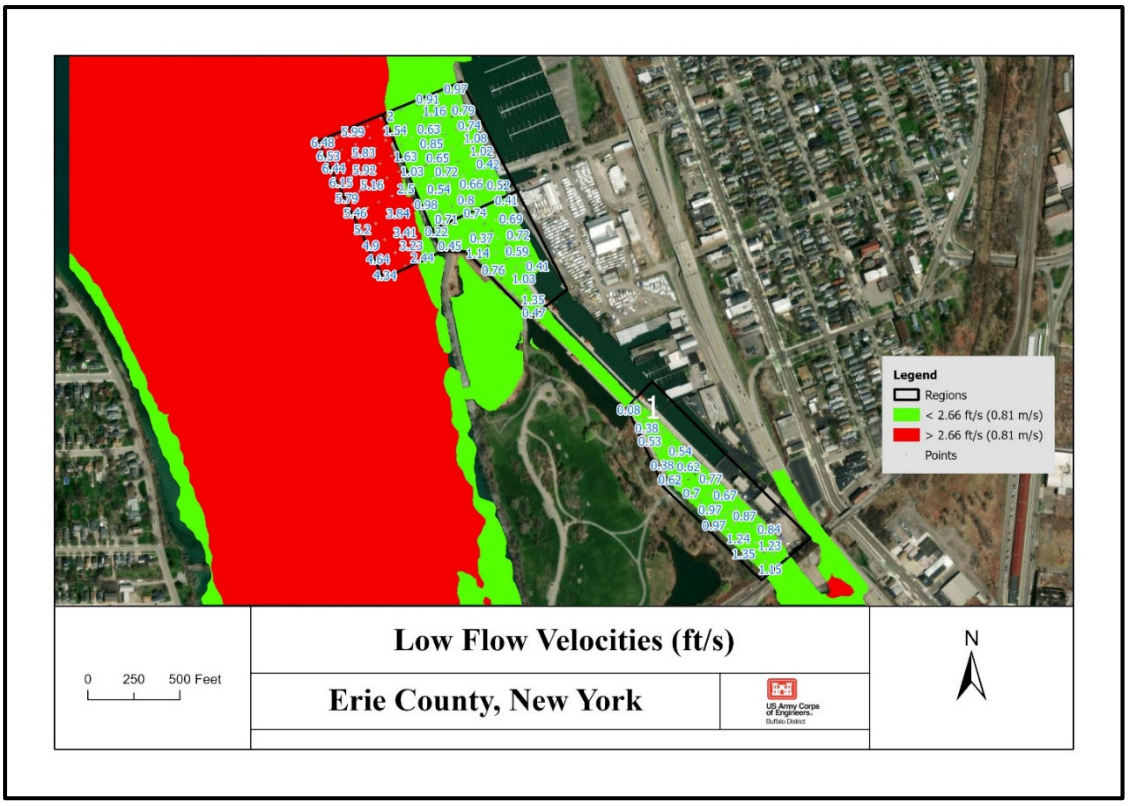

Figure 5. Low flow velocities (ft/sec). Threshold of 2.66 ft/s corresponds to emerald shiner swim speed limits.

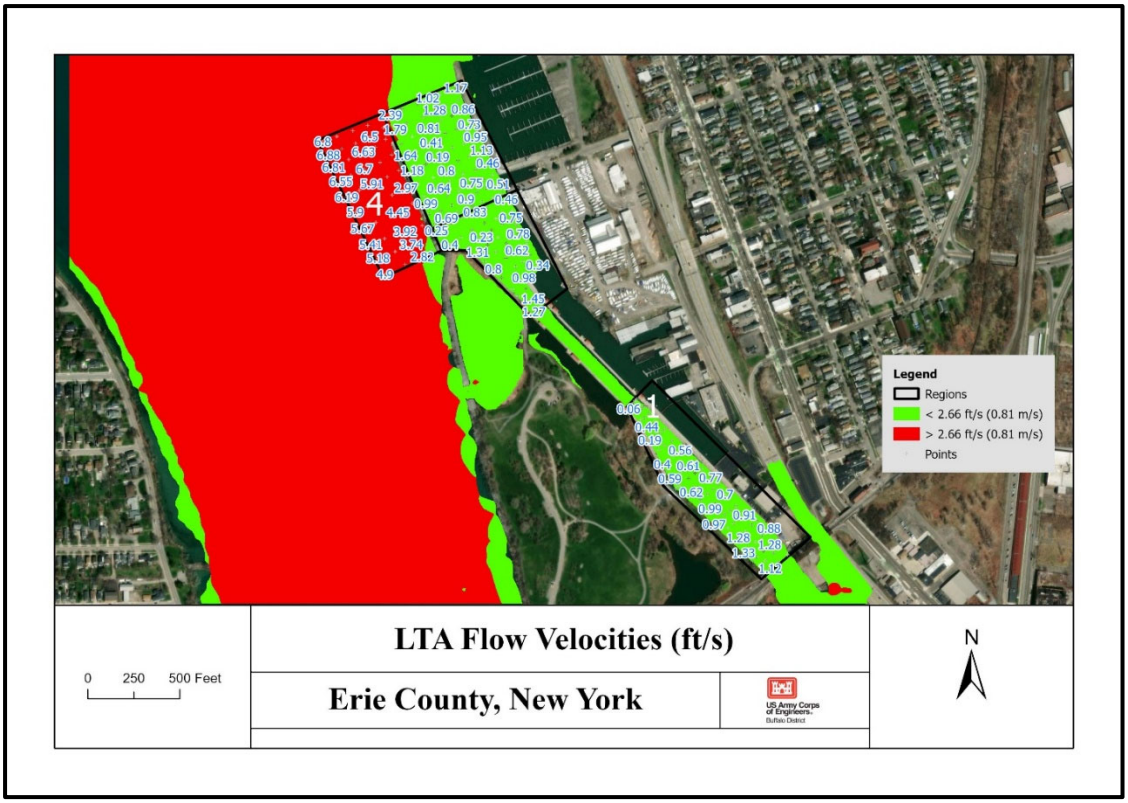

Figure 6. LTA flow velocities (ft/sec). Threshold of 2.66 ft/s corresponds to emerald shiner swim speed limits.

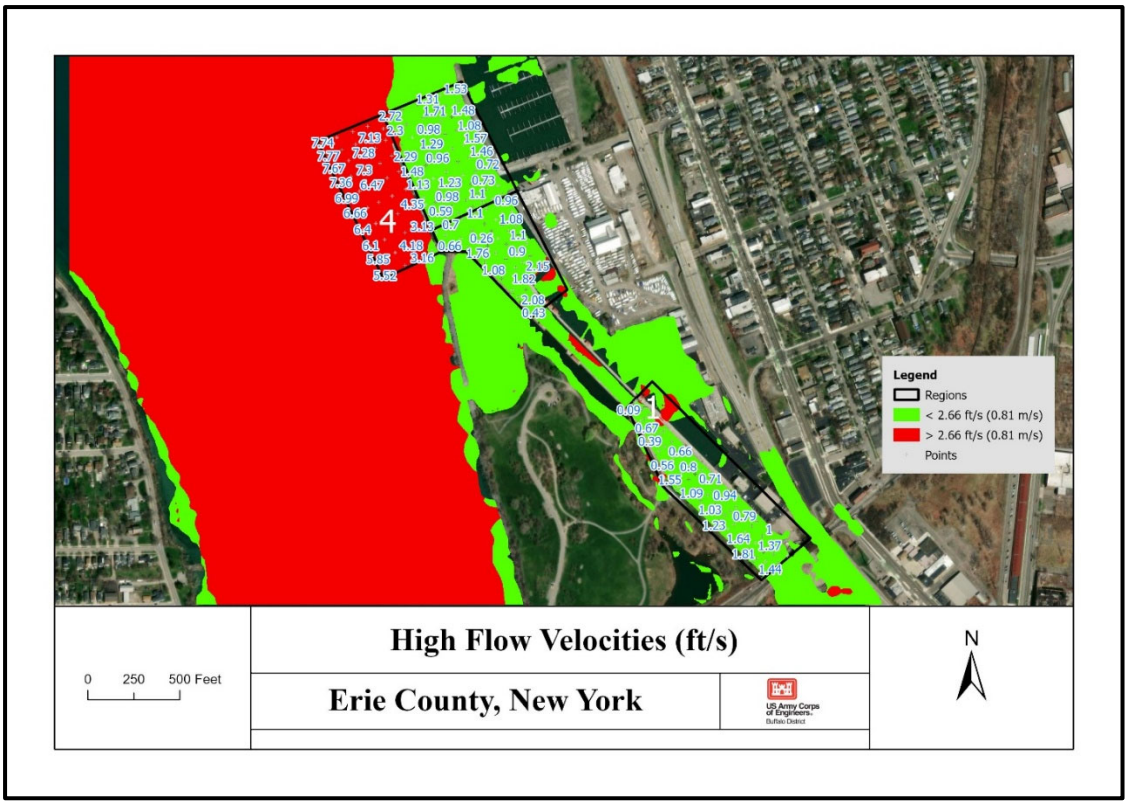

Figure 7. High flow velocities (ft/sec). Threshold of 2.66 ft/s corresponds to emerald shiner swim speed limits.

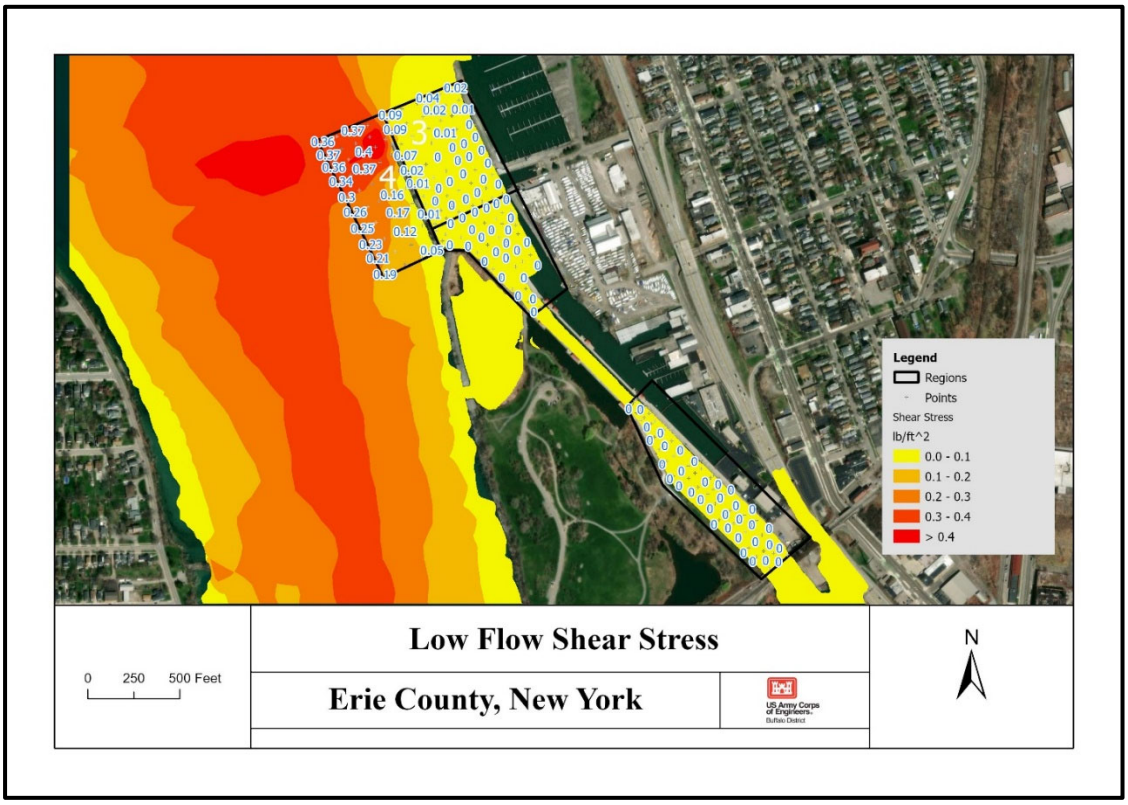

Figure 8. Low flow shear stress (lb/ft^2).

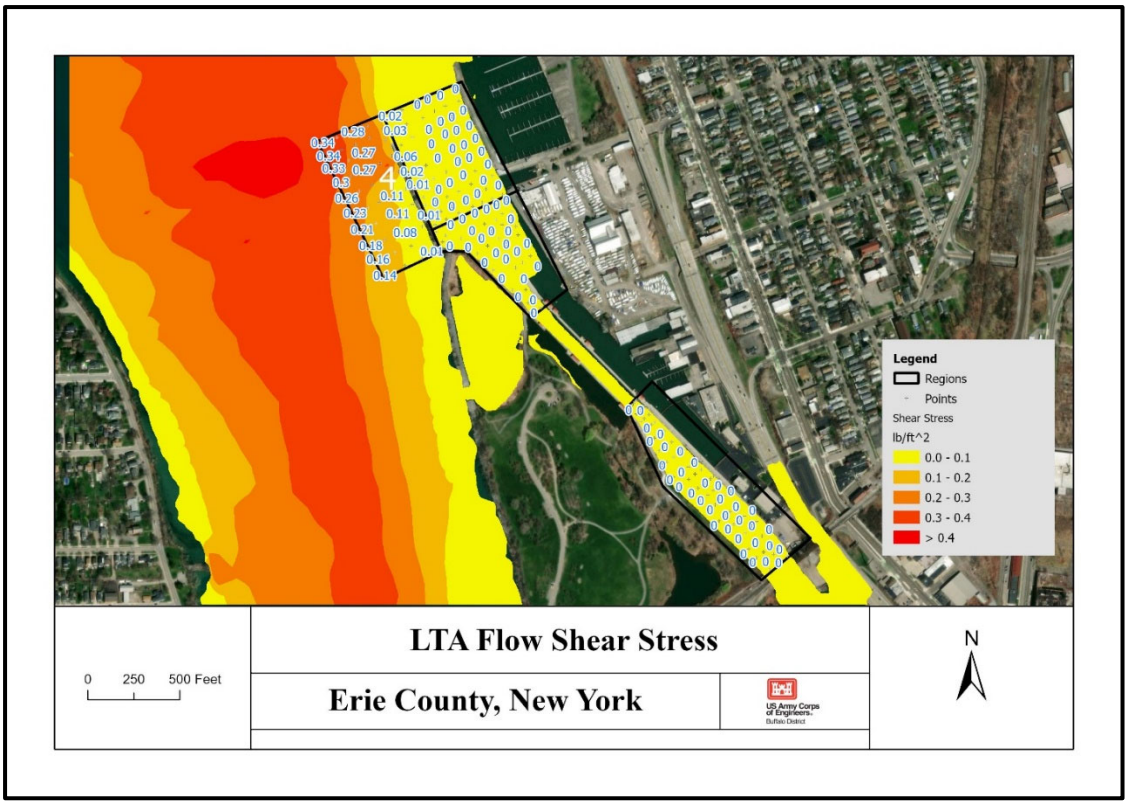

Figure 9. LTA flow shear stress (lb/ft^2).

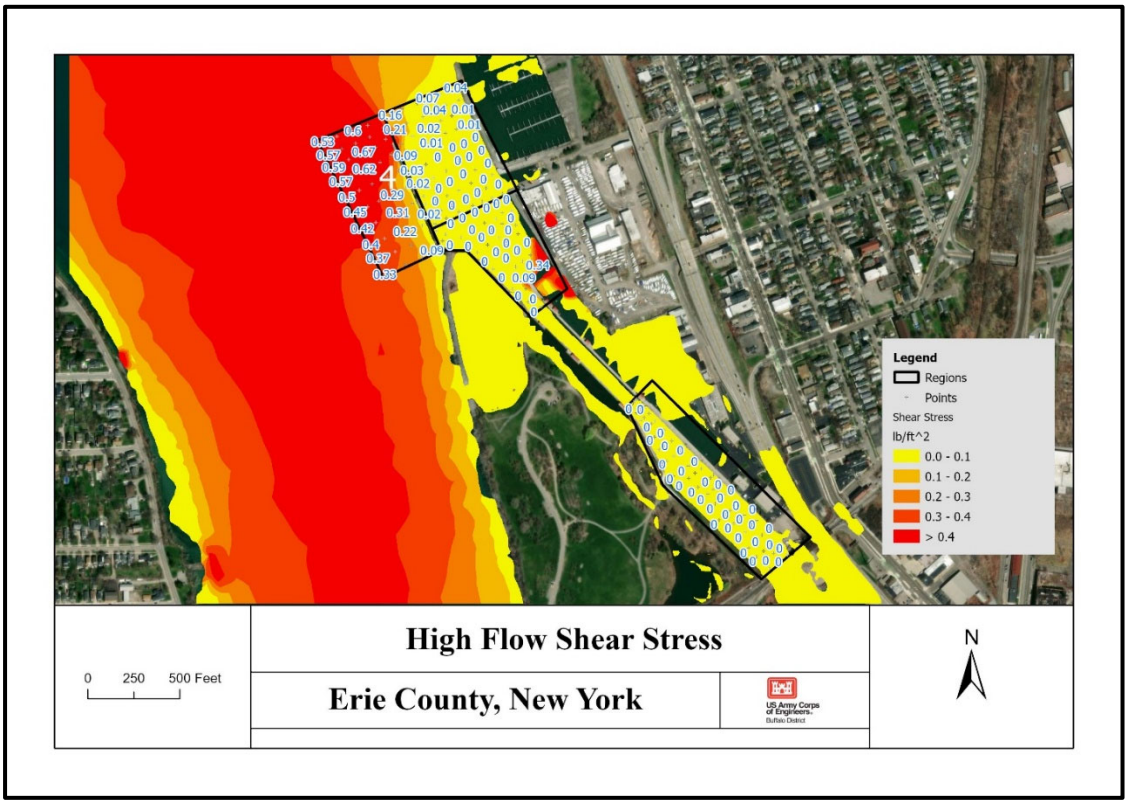

Figure 10. High flow shear stress (lb/ft^2).

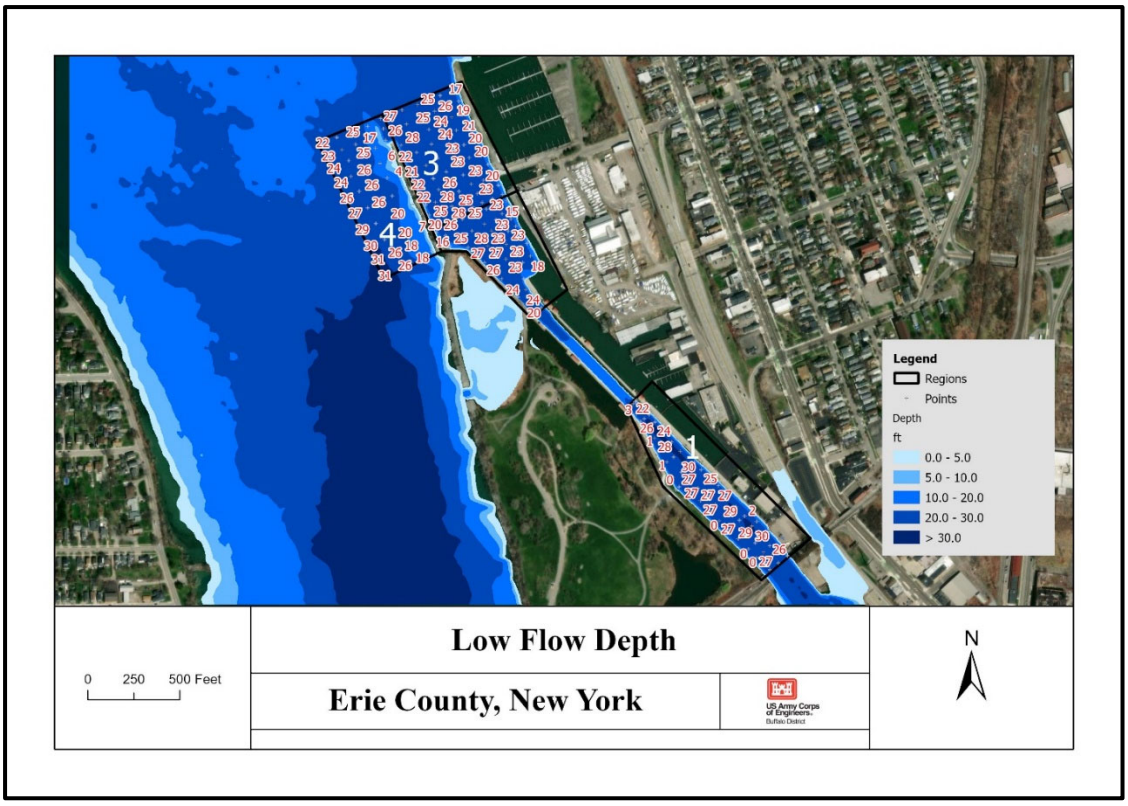

Figure 11. Low flow depth (ft).

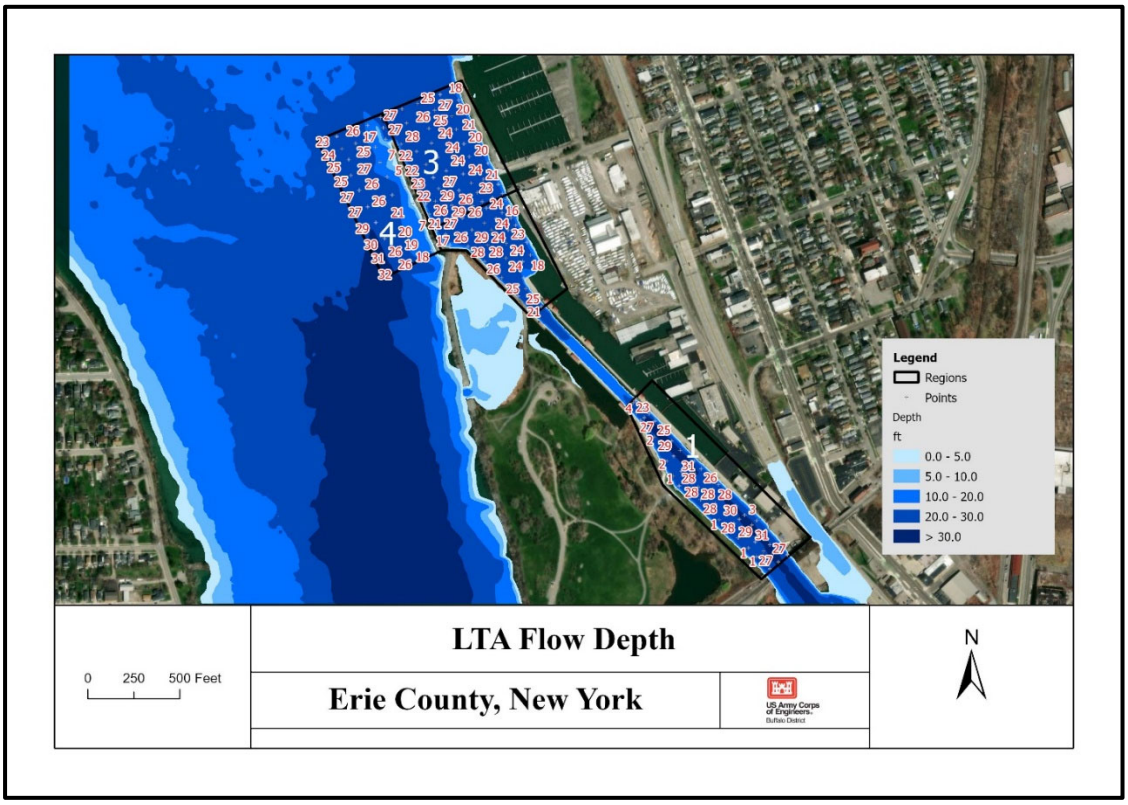

Figure 12. LTA flow depth (ft).

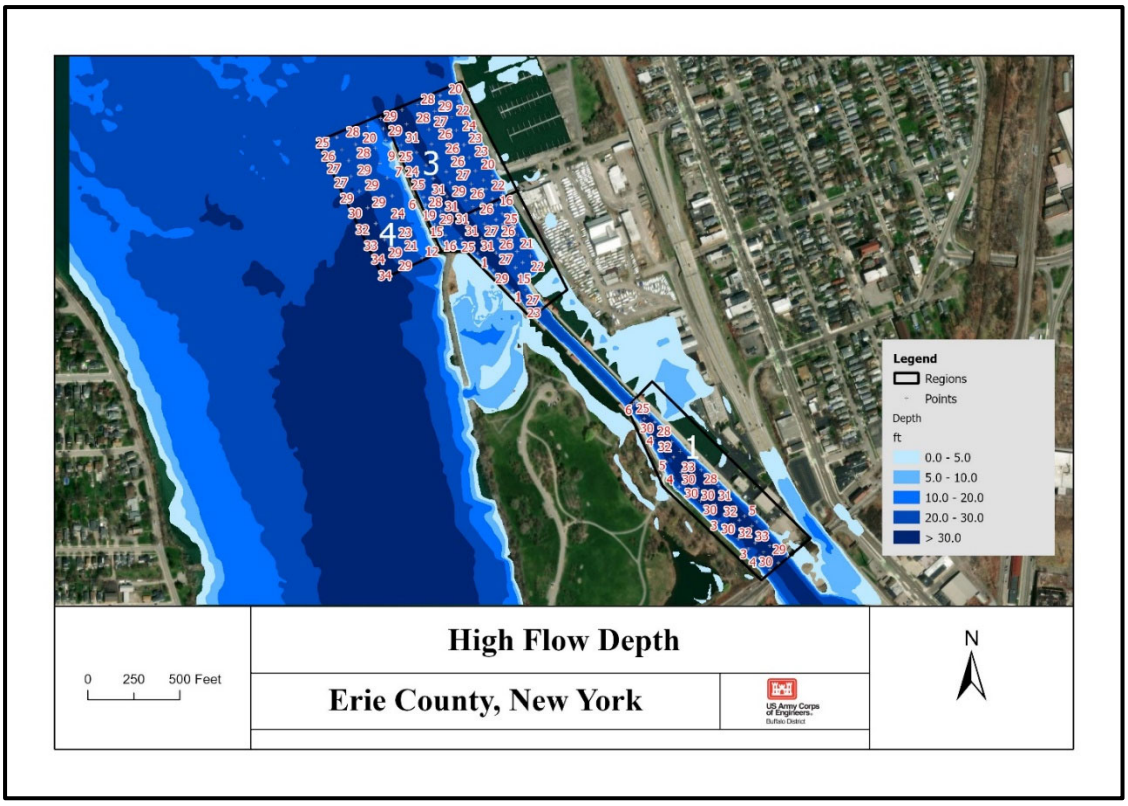

Figure 13. High flow depth (ft).

3. Recommended Measures Analysis (Appendix 1)

The recommendation of measures to be implemented at the BRL includes pre- and post-maintenance operations to increase fish passage and provide ecological uplift for the Black Rock Canal and adjacent waterbodies. The major maintenance project that temporally defines the recommended measures into pre and post time frames involves upper and lower guard gate removal, installation of new miter guard gates, and installation of new maintenance bulkheads. This work is set to begin in FY28 and conclude in FY31. As part of this maintenance, the new miter guard gates have butterfly valves which could allow for operation to provide benefits to fish passage. The invert of the butterfly valves on the existing miter gates poses concerns for erosion of the sill, causing additional O&M concerns. However, as the new butterfly valves are designed with a higher invert, the risk of erosion along the sill should be mitigated.

The recommended measures to be implemented pre-maintenance project are conservation lockages in the early spring and conduit (culvert) opening overnight. The recommended measures to be implemented post-maintenance project are conservation lockages in early spring and butterfly valve opening overnight. Using the existing conditions HEC-RAS model, the outflow from the proposed opening measures was determined. Section 4 below calculates the volume exchange and canal turnover provided via conservation lockages.

Due to limitations of the HEC-RAS, the pre-maintenance conduit operation alternative was not modeled. However, given the operation of these conduits and the calculated water surface elevations in the Niagara River and Black Rock Canal, the outflow from these conduits can be considered similar to the outflow from the post-maintenance butterfly valve measure. For the purposes of this study, the outflows from

both the pre-construction conduits and post-construction butterfly valve are considered equal. Additional analysis should be conducted to quantify pre-maintenance conduit outflows, should that be required.

It is important to note that these outflow values calculated in this section are based on the long-term average scenario for the system. The outflow through the lock is dependent on head differential and will vary based on conditions within the Niagara River and Black Rock Canal. A range of anticipated outflows and velocities should be provided based on the range of high, low, and average water surface elevations within the Niagara River. Also, the model was run assuming both butterfly valves on each of the upper and lower gates are open, for a total of 4 gates. If only one butterfly valve is anticipated to be open on each gate, the outflow should be calculated for that scenario.

The scenario modeled assumed a starting WSE in the lock chamber to be equalized with WSE downstream of the lock. With the downstream miter gate closed, the upstream miter gate was opened to simulate filling the lock chamber. Figure 14 shows the time series results of the upstream gate, with the outflow represented by the dashed green line while headwater stage and tailwater stage are the blue and pink lines, respectively. The first spike in the green outflow line represents the opening of the upstream miter gate to fill the lock chamber. As a result, the tailwater WSE rises to match the headwater WSE. Several hours later, the butterfly valves on both the upstream and downstream lock gates were opened, resulting in a decrease in the WSE within the lock chamber (drop in the upstream gate tailwater represented by the pink line).

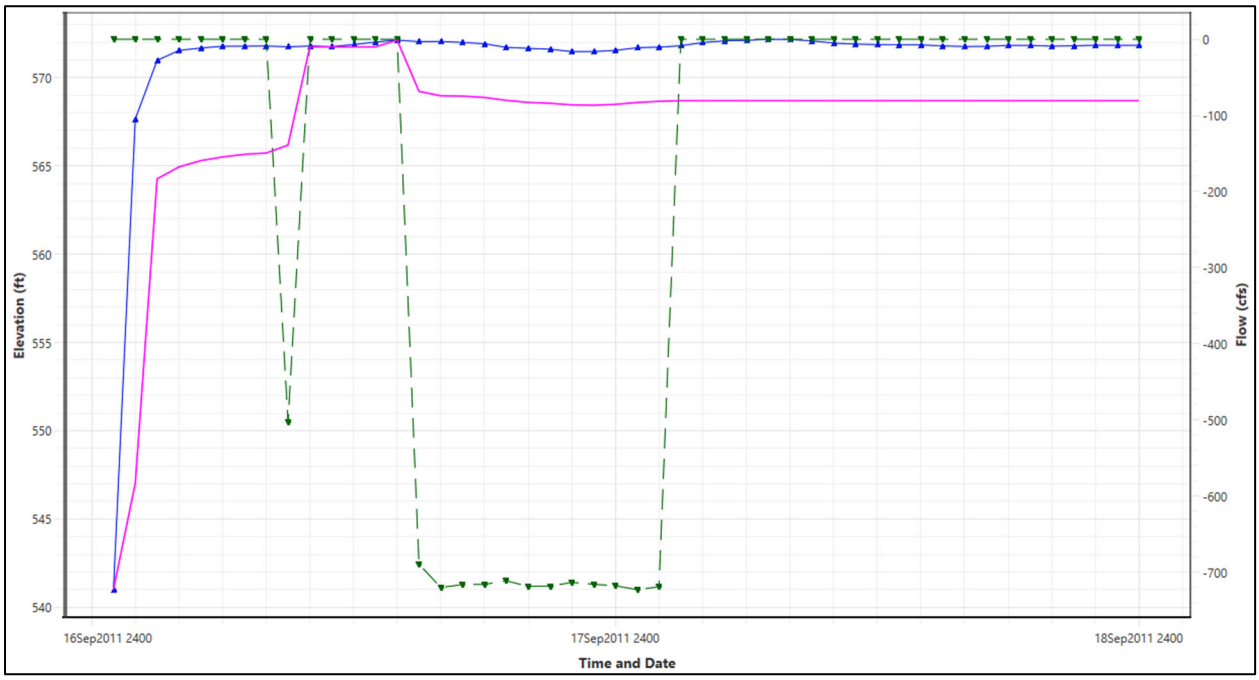

Figure 14. Modeled outflow (green), headwater WSE (blue), and tailwater WSE (pink) for the upstream lock gate.

The resulting outflow from this scenario is approximately 725 cfs. Velocities through the butterfly valves exceed 10 ft/s. Velocities immediately upstream and downstream of the lock gates increase and decrease rapidly with increasing distance from the gate. Velocities approximately 25 ft from the gate on either side are roughly 2 ft/s. Velocities approximately 150 ft and 300-ft downstream of the lock reach maxima of 0.5 ft/s and 0.25 ft/s, respectively. Compared to existing conditions, where velocities were 0 ft/s in the reach downstream of the lock, there is a measurable increase in velocity.

4. Black Rock Canal Elevation-Volume Analysis (Appendix 1)

Figure 15 below shows elevation–volume curves for the Black Rock Canal, with the section between the Black Rock Lock and the Peace Bridge shown in blue, and the entire canal shown in orange. As the water surface elevation (WSE) rises, the total volume contained within the canal increases accordingly. Delineation of the canal volume at the Peace Bridge was selected to more closely analyze volumes as this section of the canal is most likely to be affected.

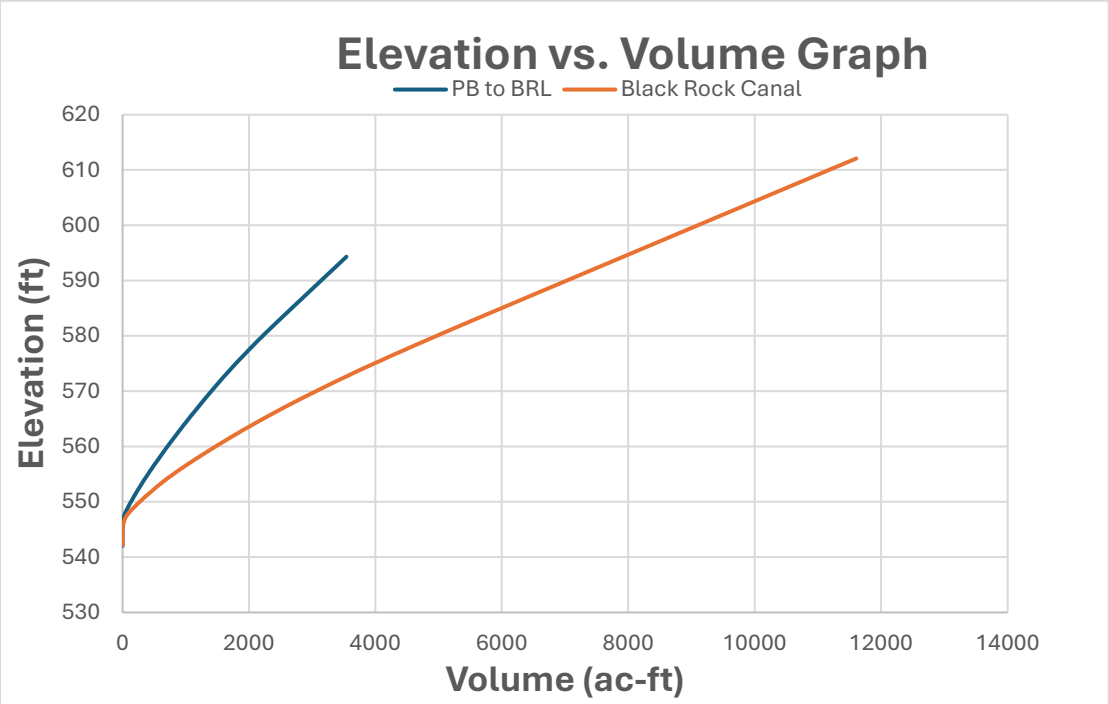

Figure 15. Elevation-volume curve for Black Rock Canal.

Table 4 presents interpolated volume estimates of the canal for the three different flow conditions analyzed. Each condition, including LTA (long term average), Low, and High, has a corresponding volume estimate representing the total control volume within the canal for that flow scenario.

Table 4. Black Rock Canal volume calculation per flow scenario.

BlackRockCanal: Volume Elevation Table		
	Volume (ac-ft)	Elevation(ft)
LTA:	3751.44	573.80
Low:	3564.09	572.80
High:	4271.00	576.50

PBtoBRL: Volume Elevation Table		
	Volume (ac-ft)	Elevation(ft)
LTA:	1695.32	573.80
Low:	1616.57	572.80
High:	1915.99	576.50

Table 5 presents the Black Rock lock chamber volume calculation based on as-built dimensions. The volume of water the chamber holds relative to the total volume of the Black Rock Canal, as well as relative to the canal section between the Black Rock lock and the Peace Bridge was also calculated. The elevation difference, used to determine the depth within the lock per lockage, was estimated using the

HEC-RAS water surface elevation results for the LTA scenario on either side of the lock. The Black Rock lock chamber holds 0.2% of the total volume of the Black Rock Canal and 0.5% of the canal volume between the Peace Bridge and the upstream lock gate. Each lockage can pass about 362,000 cubic feet of water.

Table 5. BRL lockage volume as a percent of total lock volume.

BRL Chamber Volume:	
Length (ft):	650.00
Width (ft):	70.00
Elev. Diff. (ft):	7.95
Volume (ft^3):	361725.00
Volume (ac-ft):	8.30
% of BlackRockCanal (using LTA):	0.2214%
% of PBtoBRL (using LTA):	0.4898%

Table 6 and Table 7 show how many lock changes correspond to a given percentage of canal volume. That is, n number of lock changes would pass a volume of water equal to X% of the entire Black Rock Canal. The LTA flow condition was used for both these tables. To pass the equivalent of 20%, 50%, and 100% of the entire Black Rock Canal, it would require approximately 91, 226, and 452 lockages, respectively. For the canal section between the Peace Bridge and the first lock gate, passing 20%, 50%, and 100% of its volume would require about 41, 103, and 205 lockages, respectively.

Table 6. Number of lockages as a percent of total Black Rock Canal volume.

Number of lockages as percent of the entire Black Rock Canal volume		
Percent of Canal	**Number of lock Changes**	**(Rounded up)**
0%	0.00	0
10%	45.18	46
20%	90.35	91
30%	135.53	136
40%	180.70	181
50%	225.88	226
60%	271.06	272
70%	316.23	317
80%	361.41	362
90%	406.58	407
100%	451.76	452

Table 7. Number of lockages as a percent of Black Rock Canal volume from BRL to the Peace Bridge.

Number of lockages as percent of the canal section from BRL to Peace Bridge's volume		
Percent of Canal	**Number of lock Changes**	**(Rounded up)**
0%	0.00	0
10%	20.42	21
20%	40.83	41
30%	61.25	62
40%	81.66	82
50%	102.08	103
60%	122.49	123
70%	142.91	143
80%	163.32	164
90%	183.74	184
100%	204.16	205

5. Fish Inventory Matrix (Appendix 2)

A list of species likely to be present in the Black Rock Lock canal was developed to guide identification of ecological opportunities. Species of interest included those with specific habitat requirements and species that have significant recreational value (i.e., game fish, bait fish, waterfowl). Other species, including those that prefer the swift waters of the Niagara River (i.e., lake sturgeon), were also identified to refine ecological opportunities and identify potential considerations. The list of species was generated from data collected by USACE, NYSDEC, and USFWS.

The main report for the Black Rock Lock ecological analysis has more context and information about aquatic species, including fish. This appendix includes a summary of fish species and associated habitat use, ecological roles, and considerations related to the operation of Black Rock Lock (Table 8).

Table 8. Fish inventory matrix for the Black Rock Lock ecological analysis.

Family	Scientific Name	Common Name	Upper Niagara River Use	Black Rock Canal Use	Ecosystem Role	Recreational Role	Swimming Power	Habitat Requirements	Potential Barriers to Fish Passage Present	Pollution Tolerance	Turbidity Tolerance	Notes
Acipenseridae	*Acipenser fulvescens*	Lake sturgeon	Sturgeon have been observed to both inhabit the Upper Niagara River as well as spawn within the river near the Bird Island reef.	Sturgeon have been observed within the Black Rock Canal, but have not yet been documented spawning witin the canal. However, spawning has occurred near the entrance of the canal and at the Bird Island reef, potentially allowing for young sturgeon to mature in slower waters.	Lake sturgeon are bottom feeders. They eat leeches, snails, clams, other invertebrates, small fish, and even algae that they forage from the river/lake bottoms.	Historically overexploited as an edible fish, the species was previously extremely abundant prior to a decline in the 1800's. It is currently illegal to fish for lake sturgeon in NY.	Adults are extremely powerful swimmers, and are known to spawn and swim in rivers with swift currents or on rocky shoals of lakes with high wave action.	Found in large lakes and rivers with mud, sand, hard clay, or gravel substrates. Lake sturgeon requires clear waters with large rubble (cobble, boulders, trees) substrate for spawning. The preferred spawning depth is between 2-15ft in rivers with swift currents, rapids or waterfalls. Larval sturgeon prefer slower moving water (0.1-0.7 m/s), and finer sediments such as silt and sand, than the faster moving waters that they will hatch from. When spawning in lakes, lake sturgeon prefer to spawn on rocky shoals with consistent wave action.	Altered flow regimes caused by the lock, physical barrier created by the lock, pollution from Scajaquada Creek and roadway runoff.	Low Tolerance	Not Intolerant (Little Data)	Listed as threatened within the state of New York.
Catostomidae	*Carpoides cyprinus*	Quillback	This species observed by NYSDEC and USFWS within the Upper Niagara. This species are likely inhabiting the river during periods outside of spawning, and begin to migrate to tributaries when spawning behavior begins. It would likely be found schooling near the bottom of the Niagara River where it forages as the school meandered along the riverbed.	Quillback were observed by NYSDEC and USFWS within Black Rock canal. However, it is unlikely that this species is spawning within the canal. It is possible that they are inhabiting Black Rock canal, but it is more likely that their apperance is incidental as they maneuver the Niagara River.	A bottom-feeder, it feeds on microcrustaceans, aquatic insects, detritus, algae, and small mollusks. As this species has a tendency to school, schools of young quillback can often provide easy forage for large gamefish as well as waterbirds.	Not often seen as a target for recreation, the members of catostomidae are usually considered "trash fish" or bycatch. However, young of this species can be used as baitfish for catching larger predators.	Fairly strong swimmer that swims upstream through swift moving streams/creeks/rivers with ease.	Preferred habitat ranges greatly for the species. Ranging from moderately clear, highly productive streams and rivers having large, permanent pools and stable bottoms composed of gravel and other coarse material; to backwaters and large rivers and lakes with bottoms of sand to silt. Preferred water temperature range 22-26°C. Spawning occurs from April to June and begins when water temperatures reach above 7°C and ends when water temps get higher than 18°C.	Lock may present a physical barrier, but it is likely that these species pass through the canal accidentally and will move through the lock when open.	Moderate	Tolerant	Most DO data for catostomids is limited other than for white suckers.
	Catostomus commersonii	White sucker	These species observed by NYSDEC within the Upper Niagara. Species are likely inhabiting river during periods outside of spawn, and begin to migrate to tributaries when spawning behavior begins. However, it is possible that the individuals observed were incidentally in these areas, as white suckers have been reported to struggle maintaining equilibrium in fast or turbulent waters.	Both northern hog suckers and white suckers were observed by NYSDEC and USFWS within Black Rock canal. However, it is unlikely that either species is spawning within the canal. It is possible that both sucker species are inhabiting Black Rock canal, but it is more likely that their apperance is incidental as they maneuver the Niagara River.	A bottom-feeder, it feeds on microcrustaceans, aquatic insects, detritus, algae, and small mollusks. As smaller suckers these species are often used as forage fish for smallmouth bass and other predatory gamefish.	Not often seen as a target for recreation, the members of catostomidae are usually considered "trash fish" or bycatch. However, these are often used as baitfish for catching larger predators.	Fairly strong swimmer that swims upstream through swift moving streams/creeks/rivers with ease.	Prefered habitat for suckers include pools and riffles of creeks and rivers, preferred water temperature range 17-29°C with a maximum temperature range of 30.8°C. Spawning occurs between April and June when temperatures reach 10°C and end when water temperature reaches 20°C. With the white suckers spawning normally takes place at night, starting at dusk. Spawning occurs in gravelly areas of creeks and rivers, where males create a "trough" like nest that is cleared of the gravel and allows for the female to place her eggs. Once spawning has occured the eggs are then disperced by the movement of the spawning adults. Optimal DO levels for white suckers is >4.3ppm, with adult white suckers actively avoiding areas with DO < 2.4ppm.	Low DO conditions of the canal may potentially lead to barriers for these species as the lack of water movement during periods after lock passages have stopped. Lock may present a physical barrier, but it is likely that these species pass through the canal accidentally and will move through the lock when open.	Moderately Intolerant	Moderately Tolerant	Most DO data for catostomids is limited other than for white suckers. The DO used was taken from data collected on white suckers.
	Hypentelium nigricans	Northern hog sucker										
	Minytrema melanops	Spotted sucker										
	Moxostoma anisurum	Silver redhorse	Most *Moxostoma* species observed by NYSDEC were observed within the Upper Niagara. These species are likely inhabiting the river during periods outside of spawning, and begin to migrate to tributaries when spawning behavior begins.	The listed species of redhorse have been found within the Black Rock canal, though it is not likely that any of the species are using the canal as an area for spawning as redhorse often require riverine habitat with moderate to swift current, riffle-run habitat, and clean coarse substrates that will be beneficial in conducting nest. Most spawning for redhorses is likely occuring within tributaries of the Niagara River.	A bottom-feeder, it feeds on microcrustaceans, aquatic insects, detritus, algae, and small mollusks.	Not often seen as a target for recreation, the members of catostomidae are usually considered "trash fish" or bycatch. Some redhorses, such as the silver redhorse, are targeted by bow fishermen for sport as opposed to using as food.	Fairly strong swimmer that swims upstream through swift moving streams/creeks/rivers with ease.	Redhorse live in creeks and small to large rivers with a rock or gravel bottom. This fish lives in large schools on the bottom. They spawn within tributaries of the Niagara River April through May over rubble with gravel and sand. The species is dependent on suitable riverine habitat for spawning, moderate to swift current, riffle-run habitat and clean coarse substrates. Most spawning habitat is always adjacent or downsteam of deep pools that serve as refuge during spawning. Greater redhorses will not begin spawning until mid-day water temperatures reach above 13°C in April or May, and will not usually end the spawn when temperature reach over 19°C. All *Moxostoma* species listed by NYSDEC within the area are listed as either sensitive or mesotolerant in regards to dissolved oxygen levels.	Pollutants coming from Scajaquada Creek during rain/high flow events may pose as a barrier to the passage of these species as well as the physical barrier of the lock. May have issues with rapid siltation caused by intial opening of the lock during spring, notes on the species specifically state an intolerance to rapid siltation (depending on the short-term increase of turbidity).	Intolerant-Moderate Tolerance	Tolerant-Moderate Intolerance	Most DO data for catostomids is limited other than for white suckers.
	Moxostoma duquesnei	Black redhorse										
	Moxostoma erythrurum	Golden redhorse										
	Moxostoma macrolepidotum	Shorthead redhorse										
	Moxostoma valenciennesi	Greater redhorse										
Centrarchidae	*Ambloplites rupestris*	Rock bass	All species, except for the green sunfish, were observed recently by NYSDEC within the Upper Niagara, it is very likely that all of the panfish species do use the river for passage and potentially spawning within some areas such as harbors, backwaters, and marinas. While it is unlikely the panfish are using the main stem/channel of the Upper Niagara for spawning, they will likely use the areas previously mentioned.	NYSDEC observed all of these species in Black Rock Canal. It can be assumed, due to the slower flow as compared to the Upper Niagara, that these fish are regularly using the area for both passage and spawning. All *Lepomis* as well as rockbass have been recorded within Scajaquada Creek, which may be where the fish prefer to inhabit, but the canal does offer ideal nesting habitat for these panfish with abundant forage species year-round. There is also anecdotal evidence of the species being angled near the train bridge year-round.	Seen as a mid-tier predator, panfish are known to predate smaller fish and almost anything that can fit in their mouths. Panfish are primarily insectivores, focusing on invertebrates, zooplankton, and sometimes small fish and amphibians. Panfish are also seen as a common food source for larger predators such as walleye, northern pike, muskellunge, largemouth bass, turtles, osprey/eagles, and herons.	Often seen as an ideal fish for recreation, panfish are sought out as an ideal fish for eating. These fish are often fished for year-round with the fish being caught commonly while ice fishing. Panfish are extremely easy to catch, and are often considered a beginner fish or one of the first fish most anglers catch.	Favors slow moving water and tends to swim just below the surface to mid water column. Non-migratory species, that mostly uses burst swimming for catching prey.	Most panfish prefer a very similar habitat vegetated small lakes, ponds, shallow weedy bays of larger lakes and pools of creeks and small to large rivers. All species are associated with weedy areas that have a high cover diversity/availability for the fish at all life stages. All species spawn in similar situations, begining in May-June and ending in June-August between water temperatures of 16-28°C. When spawning, panfish prefer low/slower flowing waterways, but will spawn in a variety of substrates and waterways. However, panfish will mostly always construct nest near vegetation or other cover types in shallow water. When nest are constructed and spawning has begun, the nest will be guarded by the parents. Panfish have been found in water with DO as low as 1.0ppm, but prefer a DO >5.0ppm for optimal growth and survival. The limiting factor for most species appears to be the flow rate of the waterway the inhabit, prefering lower currents.	Lock may present a physical barrier, but it is likely that these species pass through the canal accidentally and will move through the lock when open. DO may be a limiting factor, if summer conditions create anoxic conditons, but panfish can handle lower DO conditions. Faster currents created by the lock may inhibit the species' ability to inhabit the area directly near the lock, but would likely not prevent them from staying there.	Moderate-Tolerant	Moderately Tolerant-Tolerant	Commonly referred to as panfish, *Lepomis* spp. and rockbass have been grouped together due to their similar habitat requirements. Most species within this selection can hybridize with the other species.
	Lepomis cyanellus	Green sunfish										
	Lepomis gibbosus	Pumpkinseed										
	Lepomis macrochirus	Bluegill										
	Micropterus dolomieu	Smallmouth bass	Smallmouth bass have been observed by NYSDEC within the Upper Niagara River. It is not likely that the species is spawning within the mainstem of the Niagara river, but it is likely that the species is using its tributaries and/or its backwater areas. The Niagara River is likely mostly used by smallmouth as habitat outside of spawning times and when the populations are spending time in Lake Erie.	Smallmouth bass were observed by NYSDEC within Black Rock Canal. However, it is unlikely that this species is spawning within the canal due this species' preferences which include spawning in tributaries and spawning over clean substrate such as stone, rock, or gravel. It is possible that they are inhabiting Black Rock canal, but more likely that their apperance is incidental as they maneuver the Niagara River and pass through the lock. There is also anecdotal evidence of the species being angled near the train bridge and lock.	Seen as a higher-tier predator, this species is known to eat smaller fish and almost anything that can fit in their mouths. Each age class focuses on different foods: fry-microcrustaceans, juveniles-insects/crawfish/small fish, adults-primarily fish and crawfish. Smaller smallmouth bass are also seen as a common food source for larger predators such as walleye, northern pike, muskellunge, largemouth bass, turtles, osprey/eagles, and herons; once they've reached adulthood smallmouth bass do not face much predation.	Seen as a highly sought-after gamefish in the region, smallmouth bass are used frequently as a food source for people in the Great Lakes region as well as a purely recreationally fished species. This species brings economic benefit to the region through charter fishing and fishing targeting this species.	Fairly strong swimmer that swims upstream through swift moving streams/creeks/rivers with ease. Species commonly migrates upstream for spawning. Species is adapted for short burst of speed to ambush prey.	Smallmouth bass prefer clear, gravel-bottomed runs and flowing pools of small to large rivers and shallow, rocky, and sandy areas of lakes. Smallmouth bass, at all life stages, seek cover from sunlight and prefer protection from light. Bass will use all forms of submerged cover to avoid sunlight or seek deep dark water when light penetration is high. Smallmouth bass require >6.0ppm of dissolved oxygen for optimal growth, but growth/success will reduce if DO drops to <4.0ppm with DO levels near 1.0ppm being lethal. Spawning for smallmouth bass begins when water temperatures reach 13-20°C. Nest are created within tributaries or backwaters, with clean stone, rock, or gravel substrate. Nest are usually built in areas with less plant material and protection from rough waters. Once spawning has occured, like other centrarchids smallmouth bass will guard the nest even after the eggs have hatched, until the fry are approximately 1in. long.	Low DO conditions of the canal may potentially lead to barriers for these species as the lack of water movement during periods after lock passages have stopped. Lock may present a physical barrier, but it is likely that these species pass through the canal accidentally and will move through the lock when open.	Moderate	Moderately Tolerant	
	Micropterus salmoides	Largemouth bass	NYSDEC observed largemouth bass within the Upper Niagara River. It can be assumed that largemouth bass are using the river's backwaters and edges for cover from the river's fast moving waters. The fast flowing mainstem is likely mostly used by largemouth bass to migrate from one area to another of ideal habitat. The area's backwaters are likely to be used by the bass for spawning, but it is unlikely that largemouth bass would spawn within the mainstem of the Niagara River.	NYSDEC observed the largemouth bass within the Black Rock Canal. It can be assumed, due to the system's slower flow compared to the Upper Niagara, that these fish are regularly using the area for both passage as well as spawning. Largemouth bass have been recorded within Scajaquada Creek, which may be where the fish prefer to inhabit, but the canal does offer ideal nesting habitat for largemouth with an abundance of forage species year-round.	Seen as a higher-tier predator, this species is known to eat smaller fish and almost anything that can fit in their mouths. Each age class focuses on different foods: fry-microcrustaceans, juveniles-insects/crawfish/small fish, adults-primarily fish and crawfish. However, adults will also eat amphibians, reptiles, birds, and small mammals. Juveniles are a common food source for larger predators such as walleye, northern pike, muskellunge, largemouth bass, turtles, osprey/eagles, and herons; adulthood largemouth bass do not face much predation.	Seen as a highly sought-after gamefish, largemouth bass are used frequently as a food source for people in the Great Lakes region as well as a purely recreationally fished species. Not as commonly caught or sought-after as smallmouth bass though. This species brings economic benefit to the region through charter fishing and fishing targeting this species.	Fairly strong swimmer that swims upstream through swift moving streams/creeks/rivers with ease. Species is adapted for short burst of speed to ambush prey, but is also know to briefly chase faster prey items that swim past their ambush site.	Laregmouth bass prefer clear, warm, shallow lakes, bays, ponds, marshes and backwaters and pools of creeks and small to large rivers, often with soft mud or sand substrate and dense aquatic vegetation. Similar to panfish, largemouth bass prefer areas with an abundance of cover/structure and thrive in rivers with a higher percentange of pools and backwaters. Spawning for this species occurs between May and June, when water temperatures reach between 15-21°C. Nest construction and egg rearing is not limited by substrate type, as largemouth bass will use vegetation, roots, mud, sand, cobble, and gravel. DO levels do limit growth and success of largemouth bass, but largemouth bass can survive in DO conditions as low as 1.0 ppm. Optimal DO ranges for largemouth development is >8.0ppm, but distress is not evident until conditions are <5.0ppm. This species will begin to relocate at DO levels <3.0ppm.	Low DO conditions of the canal may potentially lead to barriers for these species as the lack of water movement during periods after lock passages have stopped. Lock may present a physical barrier, but it is likely that these species pass through the canal accidentally and will move through the lock when open.	Tolerant	Not Intolerant (Little Data)	
	Pomoxis nigromaculatus	Black crappie	NYSDEC observed both white and black crappie within the Upper Niagara. Crappie use the river for passage and movement as they are found within the river's tributaries as well as Lake Erie. The river is home to some crappie spawning habitat, with some areas such as harbors, backwaters, and marinas.	USFWS observed black crappie within Black Rock Canal. It can be assumed, due to the system's slower flow as compared to the Upper Niagara, that crappie regularly using the canal for passage and spawning. Crappie have been recorded within Scajaquada Creek, which may be where the fish prefer to inhabit, but the canal does offer ideal nesting habitat with abundant forage species year-round. There is anecdotal evidence of crappie being angled near the train bridge year-round.	Seen as a mid-tier predator, crappie are known to eat smaller fish and almost anything that can fit in their mouths. Each age class of crappie focuses on different foods: fry-algae/zooplankton, juveniles-insects/invertebrates, adults-exclusively fish. Crappie often travel in large schools and will move, following schools of baitfish. Crappie are also seen as a common food source for larger predators such as walleye, northern pike, muskellunge, largemouth bass, turtles, osprey/eagles, and herons.	Often seen as an ideal fish for recreation, crappie are sought out as both a trophy fish as well as a species for eating. These fish are often fished for year-round with the fish being caught commonly while ice fishing.	Fairly strong swimmer that swims upstream through swift moving streams/creeks/rivers with ease. Species is adapted for short burst of speed to ambush prey, but is also know to briefly chase faster prey items that swim past their ambush site.	Prefers clear, quiet waters of large ponds, small lakes, bays and shallower areas of larger lakes and areas of low flow in larger rivers, associated with abundant aquatic vegetation and mud or sand substrate. Both species spawn in similar situations, begining in May and ending in June between water temperatures of 14-22°C. When spawning, crappie prefer low/slower flowing waterways, but will spawn in a variety of substrates and waterways. However, crappie will mostly always construct nest near vegetation or other cover types. When nest are constructed and spawning has begun, the nest will be guarded by the parents. In most cases, food abundance will be the limiting factor for crappie availability, with a significant correlation of total dissolved solids of 100-350ppm and high crappie density. Crappie have been found in water with DO as low as 2.0ppm, but prefer a DO >5.0ppm for optimal growth and survival.	Low DO conditions of the canal may potentially lead to barriers for these species as the lack of water movement during periods after lock passages have stopped. Lock may present a physical barrier, but it is likely that these species pass through the canal accidentally and will move through the lock when open.	Tolerant	Moderately Tolerant	White and black crappie are known to hybridize.
	Pomoxis annularis	White crappie										

Family	Scientific Name	Common Name	Upper Niagara River Use	Black Rock Canal Use	Ecosystem Role	Recreational Role	Swimming Power	Habitat Requirements	Potential Barriers to Fish Passage Present	Pollution Tolerance	Turbidity Tolerance	Notes
Clupeidae	*Alosa pseudoharengus*	Alewife	NYSDEC observed alewife within the Upper Niagara River. These fish are found all year long in the river and increase in numbers during the spawning season with fish moving from Lake Erie for spawning.	NYSDEC and USFWS did not observe alewife within the Black Rock Canal. Likely incidental schooling and passing while spawning. Not likely spawning in the canal.	Often sought as forage for shorebirds, northern pike, rock bass, smallmouth bass, walleye and other gamefish. The fish's introduction to the Great Lakes system has created problems as it has drastically reduced the availablility of zooplankton for planktivorous fish and fish that seek zooplankton in various lifestages. This is likely the cause of the decrease in native whitefish, yellow perch, emerald shiners, burbot, and other native fish populations. Large scale die-offs also lead to potential health hazards from rotting fish covered shorelines within the Great Lakes. Since alewife introduction, pacific salmon have also been introduced to attempt to combat the large numbers of alewife.	Fairly commonly used as a baitfish, but can be used for the purpose of human consumption and as fish meal for animal feeds.	Strong swimmers, often found schooling as they swim up river for spawning. Appears to prefer consistent swimming patterns versus burst swimming.	Alewife prefers open waters and are known in the Great Lakes to inhabit pelagic and coastal lake zones prior to migrating up rivers and stream to spawn. The fish have been known to spawn both diurnally and nocturnally, but prefer to do so at night. Spawning peaks between 13-16°C, and stops when temperature reach above 27.8°C. Mostly found spawning between May and June. This species prefers rocky over sandy substrates for spawning, and reproduce through broadcast spawning.	The lock structure may be a physical barrier to movement as the fish travel along the shoreline of the Niagara River and get caught within the lock or canal where they may be more heavily predated.	Moderately Tolerant	Tolerant	Listed as invasive within Lake Erie and Lake Ontario
	Dorosoma cepedianum	Gizzard shad	NYSDEC observed gizzard shad within the upper Niagara River. These fish are found all year long in the river and increase in numbers during the spawning season with fish moving from Lake Erie for spawning.	NYSDEC and USFWS observed alewife within the Black Rock Canal. Likely incidental schooling and passing while spawning. Not likely spawning in the canal.	Often sought as a preferred forage for shorebirds, walleye, northern pike, and muskellunge other gamefish are also known to target this species. This species' mass schooling and migrations within the Upper Niagara are an important event for the survival of many fish and waterbirds within the system, often having direct impacts on those species' populations. This species is mostly feeding on plankton, algae, insect larvae, and other floating particulate in the water column.	Commonly used baitfish for anglers targeting multiple species of gamefish.	Strong swimmers, often found schooling as they swim up river for spawning. Appears to prefer consistent swimming patterns versus burst swimming. Schools will swim near the water's surface and swim upstream and downstream large rivers such as the Upper Niagara.	Gizzard shad live in awide variety of waterways throughout the U.S. , but prefer the deep open waters of rivers and lakes with, sparcely vegetated, muddy bottoms. Spawning begins for this species as early as April and usually ends in June, mostly correlating to water temperature. The shad will begin schooling, creating dense masses of shad at the surface of the water, when the school reaches warmer shallow water (such as creeks and streams) the will begin broadcast spawning. The eggs will sink to the bottom and stick to anything they come in contact with.	The lock structure may be a physical barrier to movement as the fish travel along the shoreline of the Niagara River and get caught within the lock or canal where they may be more heavily predated.	Tolerant	Tolerant	Species prone to die-offs in winter when waters become too cold. Species also avoids waters with low DO (< 2mg/L). Reports differ as to the native status of species in Lake Erie, but gizzard shad are native to surrounding areas as well as Lake Ontario.
Esocidae	*Esox americanus*	Grass pickerel	Grass pickerel have been documented inhabiting and spawning within the Upper Niagara River. Grass Pickerel commonly inhabit and spawn in backwater areas and shallow flats of the Niagara River as well as areas of moderate water column velocities which help to maintain their preferred firm muddy-sand to sand substrate for spawning.	While not directly observed in the canal, it is likely that this, and other Esocidae, species is using the canal. It may be possible that the species uses the canal for reproduction. Due to known presence of prey, slower moving waters, and presence of woody debris and vegetation along the canal bottom, it would not be impossible for spawning to occur. Occurences in canal may also be incidental as they move for spawning.	Often sought as a preferred forage for piscivorous birds, other pickerel, catfish, sunfish, northern pike, and muskellunge other gamefish are also known to target this species. This species is mostly feeding on shiners, minnows, and other bait fish, as well as crawfish and other larger macroinvertebrates.	Due to this being one of the smallest esocids, grass pickerel are often sought out for the aquariam hobby. This species is often caught by recreational fishermen.	Grass pickerel are mostly considered burst swimming predators, focused on waiting in a position to quickly burst out and catch unsuspecting prey. Not often known to migrate, but invduals will travel long distances and have been known to swim upstream of creeks after the ice begins to disapear in spring.	Grass pickerel, when undisturbed, are often observed near shore, or at the outer edge of patches of vegetation, oriented with the head toward the shore or vegetation. There is vertical distribution with the younger individuals near the surface and the adults in deeper water, if it exists. Pikerel are often found in a variety of habitats, but specifically prefer slower moving waterways/waterbodies with thick vegetation mats or access to flooded terrestrial habitat. Preferred temperatures for the species range between 4-29°C, with a preference of temperatures around 25.5°C, and spawning occuring around 4-12°C. Tolerance level for dissolved oxygen was recorded at 0.3-0.4 ppm.	Altered flow regimes caused by the lock, physical barriers created by the lock, presence of young may be limited by polluted output of Scajaquada Creek, and increases in turbidity briefly caused by the lock may impact individuals in the canal.	Moderately Intolerant	Moderately Intolerant	
	Esox lucius	Northern pike	Pike have been documented inhabiting and spawning within the Upper Niagara River. Pike commonly inhabit and spawn in backwater areas and shallow flats of the Niagara River as well as areas of moderate water column velocities which help to maintain their preferred firm muddy-sand to sand substrate for spawning.	Pike have been observed/documented within the canal by NYSDEC and USFWS, but it is unclear if the species is using the canal for spawning. Due to the known presence of prey, slower moving waters, and presence of woody debris and vegetation along the canal bottom, it would not be impossible for spawning to occur. Occurences in canal may be incidental as they move for spawning.	Pike diet includes but is not limited to soft-rayed fish, invertebrates, amphibians, small reptiles, small birds, and small mammals. Acting as one of the major aquatic apex predators of the Great Lakes region, pike act to prevent the over population of baitfish in the region. This fish is solitary except when spawning.	Seen as a highly sought-after gamefish in the region, pike are used frequently as a food source for people in the Great Lakes region as well as a purely recreationally fished species. This species brings economic benefit to the region through charter fishing and fishing targeting this species.	Pike are mostly considered burst swimming predators, focused on waiting in a position to quickly burst out and catch unsuspecting prey. Not often known to migrate, but individuals will travel long distances.	Pike are more readily found in backwaters, pools, and lakes; however, pike will inhabit a wide variety of habitats including small to large rivers and resevoirs. Spawning habitat is often considered the largest limiting factor for pike, as highly vegetated areas with slower/weaker currents often provide the most ideal spawning habitat for pike. Spawning tends to occur between April and May and begins as soon as winter ice begins to disapate, where the pike will begin to move upstream from deeper waters into tributaries or rivers. Spawning mostly occurs during daylight hours.	Altered flow regimes caused by the lock, presence of young may be limited by polluted output of Scajaquada Creek.	Moderate	Moderately Tolerant	
	Esox masquinongy	Muskellunge	Muskellunge have been documented spawning within the Upper Niagara River. Muskellunge commonly inhabit backwater areas of the Niagara River as well as areas of moderate water column velocities which help to maintain their preferred firm muddy-sand to sand substrate for spawning.	Muskellunge have been observed and documented within the canal by NYSDEC, but it is unclear if the species is using the canal for spawning. Due to the known presence of prey fish, slower moving waters, woody debris and vegetation along the canal bottom, it would not be impossible for spawning to occur. Occurences in the canal may be incidental as they move for spawning.	Diet includes, but is not limited to, soft-rayed fish, invertebrates, amphibians, small reptiles, small birds, and small mammals. As one of the major aquatic apex predators of the Great Lakes region, muskellunge act to prevent the over population of baitfish. Fish is solitary except when spawning. Their metabolism pushes preference for one large rather than multiple small meals.	Seen as one of the ultimate trophy fish within North America's freshwater fisheries, the muskellunge is highly sought-after due to their scarcity, size, and fight. Economic value of muskellunge fishing to resorts, fishing goods stores and other associated businesses is high. Not often seen as fish for eating due to their scarcity and challenge presented in catching them.	Muskellunge are mostly considered burst swimmers or lurking predators, focused on waiting in a position to quickly burst out and catch unsuspecting prey. Not often known to migrate, some individuals will travel long distances during spawning periods and will travel long distances within its territory.	Muskellunge are most commonly found and prefer to live in densely vegetated areas (i.e., weed beds) in waterbodies like clear lakes, backwaters, quiet pools, and ponds. However, muskellunge can also be found within clear, sterile lakes with almost no weed beds. Spawning occurs when water temperature reach near 12°C, but can be limited heavily by fluctuating water temps, low oxygen, predation, and prey availability. However, when spawning does occur it occurs in shallow waters with dense aquatic vegetation beds and/or woody debris.	Altered flow regimes caused by the lock, presence of young may be limited by polluted output of Scajaquada Creek.	Younger individuals more intolerant than adults. Adults are Moderately Tolerant	Moderately Tolerant (Little Data)	Tiger Muskellunge (*Esox lucius* x *Esox masquinongy*) have also been recorded within the Black Rock canal.
Fundulidae	*Fundulus diaphanus*	Banded killifish	Inhabit and spawn within the slower moving and backwater areas of the river and tributary mouths.	Potentially inhabiting and spawning within the Black Rock canal. Slower moving waters, access to Scajaquada Creek, and presence of aquatic plants make the area habitable for the species.	Due to it's strong schooling behavior, the banded killifish is seen as a forage fish for predatory fish (bass, perch, small pike, etc.), piscivorous birds (kingfishers, mergansers, herons, etc.), and even the common mudpuppy.	Mostly used for bait when caught live, but is also used in the aquarium trade.	Favors slow moving water and tends to swim just below the surface. Non-migratory species.	Inhabits shallow, quiet margins of lakes, ponds and sluggish streams, usually over sand or mud and often near vegetation. Banded killifish spawn in late spring and summer (June to mid-August) where it spawns by releasing its eggs in filamentous clusters attached to vegetation.	Altered flow regimes caused by the lock.	Tolerant	Moderately Tolerant	
Ictaluridae	*Ameiurus melas*	Black bullhead	NYSDEC observed these species within the Upper Niagara River. It can be assumed that bullheads are using the river's backwaters and edges for cover from the river's fast moving waters. The fast flowing mainstem is likely mostly used by bullheads to migrate from one area to another of ideal habitat. The area's backwaters are likely to be used by bullheads for spawning. It is unlikely that bullheads would spawn within the mainstem of the Niagara River due to its current.	NYSDEC and USFWS observed these bullhead species within the Black Rock Canal. It can be assumed, due to the system's slower flow compared to the Upper Niagara, that these fish are regularly using the area for both passage as well as spawning. Bullheads have been recorded within Scajaquada Creek, which may be where the fish prefer to inhabit, but the canal does offer ideal nesting habitat for bullhead with an abundance of forage diversity year-round.	These species often considered bottom-feeders with an omnivorous diet that changes with size. As young-of-year, bullheads often eat mainly plankton, but become more opportunistic with size and eat a wide variety of forage, including mollusk, crustaceans, soft-bodied invertebrates, plant matter, detritis, and eventually forage fish when given the chance in summer. These species may be predated by a variety of piscivorous species while smaller, but become more secure as size increases.	Often seen as an ideal fish for recreation, bullheads are sought out as a fish for eating, though not always targetted as often as other edible species. Bullheads, like other catfish, are extremely easy to catch due to their proclivaty to eat anything that is available to them.	Favors slow moving water and tends to swim along the bottom of the waterways they inhabit. Non-migratory species, but can be found in waterways with consistent flows.	Bullheads commonly inhabit backwaters, oxbows, impoundments, swamps, ponds, lakes, and low-gradient streams (including pools of intermittent creeks). They prefer stagnant, slow-moving, warm, and turbid (muddy) waters with a preference for mud or silt substrates. Spawning begins when water temperatures reach 14-25°C between May and July and usually takes place at night. When spawning, bullheads construct saucer-shaped nest beneath logs or other large objects, where parents guard the nest and fan developing eggs with water to keep them well-oxygenated. These species are mostly limited by availability of food and cover, with most species success seen in small water bodies with abundant cover and food availabilty, food production in this case being measured by total dissolved solids and the optimal range being 100-600ppm. DO ranges for bullheads can range depending on time of year and other stressors, but it is commonly seen that during summer the lethal DO level is 3.0ppm and winter is 0.2-0.3ppm, with the optimal DO being >7.0ppm.	The lock structure may be a physical barrier to movement as the fish travel along the shoreline of the Niagara River and get caught within the lock or canal where they may be more heavily predated. These species do also tend to spawn at night, when the lock is no longer operated regularly, which may inhibit their success in spawning.	Moderately Tolerant-Tolerant	Moderately Tolerant-Tolerant	
	Ameiurus natalis	Yellow bullhead										
	Ameiurus nebulosus	Brown bullhead										
	Ictalurus punctatus	Channel catfish	Though channel catfish have not been noted/observed recently by NYSDEC within the Upper Niagara, it is very likely that they do use the river for passage and movement as they are found within the river's tributaries as well as Lake Erie. It is also possible that the river is home to some channel catfish spawning habitat, with some areas such as harbors, backwaters, marinas, and even stone banks providing nesting structure.	NYSDEC and USFWS observed channel catfish within the Black Rock Canal. It can be assumed, due to the system's slower flow compared to the Upper Niagara, that these fish are regularly using the area for both passage as well as spawning. It can be assumed that the canal does provide the required cavity nesting habitat required by channel catfish through trees, roots, structures, and crevices along the bank.	Species often considered bottom-feeder but will also eat food found throughout the water column. As young-of-year, channel catfish often eat mainly plankton, but become more opportunistic with size and eat a wide variety of forage, including mollusk, crustaceans, soft-bodied invertebrates, terestrial invertebrates, plant matter, detritis, and fish which make up a large portion of their diet in adulthood. This species may be predated by a variety of piscivorous species while smaller, but become more secure as size increases.	Often seen as an ideal fish for recreation, channel catfish are sought out as a fish for eating. Channel catfish, like other catfish, are extremely easy to catch due to their strong sense of smell and proclivaty to eat anything that is available to them.	Favors slow moving water and tends to swim along the bottom of the waterways they inhabit. Non-migratory species, but can be found in waterways with consistent flows.	Channel catfish commonly inhabit rivers, backwaters, oxbows, impoundments, swamps, ponds, lakes, and streams. Channel catfish prefer areas with deep water, clean gravel or boulder substrates, and low to moderate current and move to riffles, runs, and/or tributaries at night to feed. However, they are tolerant of a wide range of conditions Unlike bullheads, channel catfish prefer clear, non-turbid conditions. Spawning begins when water temperatures reach 18-27°C between May and July and usually takes place at night. When spawning, channel catfish use natural cavities, rubble, boulder, undercut banks, muskrat burrows, logs, and spaces under large objects to lay their eggs. The male, or both parents, will then guard the nest and fan the developing eggs with water to keep them well-oxygenated. Fry for this species have a very high cover-seeking tendency, and require an abundance of cover when young. DO requirements vary for this species, but >5.0ppm are considered adequate for survival and growth.	The lock structure may be a physical barrier to movement as the fish travel along the shoreline of the Niagara River and get caught within the lock or canal where they may be more heavily predated. This species does also tend to forage, move, and spawn at night, when the lock is no longer operated regularly, which may inhibit the species success in the area.	Moderately Tolerant	Tolerant	

Family	Scientific Name	Common Name	Upper Niagara River Use	Black Rock Canal Use	Ecosystem Role	Recreational Role	Swimming Power	Habitat Requirements	Potential Barriers to Fish Passage Present	Pollution Tolerance	Turbidity Tolerance	Notes
Lepisosteidae	*Lepisosteus osseus*	Longnose gar	NYSDEC observed the longnose gar within the Upper Niagara River. It can be assumed that the species is using the river's backwaters and edges for cover from the river's fast moving waters. The fast flowing mainstem is likely mostly used by the longnose gar to migrate from one area to another of ideal habitat. The area's backwaters are likely to be used by the gar for spawning, but it is unlikely that they would spawn within the mainstem of the Niagara River due to its current.	NYSDEC and USFWS have observed lognose gar in Black Rock Canal. It can be assumed, due to the system's slower flow compared to the Upper Niagara, that these fish are regularly using the area for passage and spawning. Species is known to thrive within impoundments, and is likely benefiting from additional habitat created by the slower waters behind the lock. Though it may prefer to spawn in tributaries and some individuals may be migrating from Lake Erie to spawn, some individuals may still spawn within the canal. The canal also offers an abundance of forage for the gar to eat throughout their lives stages.	Longnose gar is a high-tier predator that eats a large variety of crustaceans, small mammals, small reptiles, amphibians, and most of its diet being comprised of small fish. It is an ambush predator that waits in or near cover for prey to pass by before bursting from cover and grabbing the prey. The gar is not often predated by other fish due to its size, shape, and hard scales but will be predated by mammals and birds like osprey. Species has been observed participating in brood parasitism where they lay eggs in a bass nest, which provides protection for the eggs/young as the male bass protects his nest.	Not a highly sought-after gamefish. The longnose gar is sometimes targeted as a trophy species, due to its larger size. It is not very common for the species to be used as a source of food due to the species' thick scales, the species is eaten along with other species of gar throughout the US.	Favors slow moving water and tends to swim along the bottom of the waterways they inhabit. Non-migratory species, but can be found in waterways with consistent flows.	Longnose gar prefer vegetated, sluggish pools, backwaters and oxbows of medium to large rivers and weedy, quiet shallows of warm lakes with silty, sandy substrates; often near logs and brushpiles. Longnose gars are found near the surface in pelagic areas of lakes, reservoirs, and the quieter regions of rivers and streams. Species is usually found in areas with abundant vegetation. While longnose gar can be observed feeding and moving at all times of the day, they are noted as being more active at night. Species is tolerant of low DO levels, and can even be found in anoxic conditions due to its modified swim bladder, which allows the gar to breathe atmospheric oxygen when needed, by gulping air rather than breathing through its gills. Spawning begins when water temperatures are between 16-21°C in May-June. Seasonal migration may occur as individuals move from lakes into rivers and tributaries to spawn; however, spawning may also occur in shallow waters of lakes and streams. Spawning occurs over vegetation, rocks, and gravel bars where the eggs will adhere as a mass. Species has also been observed participating in brood parasitism, where they lay eggs in a bass nest and the male bass will protect the gar eggs as he protects his nest/eggs.	The lock structure may be a physical barrier to movement as the fish travel along the shoreline of the Niagara River and get caught within the lock or canal. This species does also tend to forage and move more at night, when the lock is no longer operated regularly, which may inhibit the species success in the area.	Tolerant	Tolerant	Not yet listed as threatened for NY state, but is considered as vunerable within the state.
Leuciscidae	*Notropis atherinoides*	Emerald shiner	Emerald shiners are found in the upper Niagara River. The backwater gyre areas serve as spawning areas with eggs and hatchlings becoming entrapped in these areas during early development. Juveniles and adults are resident and found in higher numbers during fall and spring migrations.	NYSDEC, USFWS, and USACE have found emerald shiners in the Black Rock Canal and Black Rock lock. These are found more commonly during spring and to a lesser extent fall migration times as some fish may use this as a corridor to travel past the higher velocity areas encountered along the shorelines especially areas like Freedom Park.	Emerald shiner are an essential keystone forage species for native piscivorous fish and birds. Emerald shiners are the top ranked prey item for walleye and steelhead trout and the New York State threatened common tern (*Sterna hirundo*).	This is an important baitfish used by fisherman and as a result there is an economically important bait fishery for emerald shiners. This species is also used by certain groups as food.	This species is a pelagic species found in moderate to large schools in Lake Erie as well as the upper Niagara River. Laboratory studies have identified sustained swimming speeds of 0.4 m/sec with burst speeds of 0.81 m/sec for shorter distances.	The emerald shiner is a pelagic species found in moderate to large schools in moderate to large rivers and large lakes like the Great Lakes. They exhibit vertical migrations in deeper water approaching the surface at night and retreating to deeper water during the day. Their preferred water temperatures range from 9-23°C and spawn in June-August when temperatures are 20-24°C. The are pelagic spawners and in the upper Niagara River use the backwater gyre areas as spawning areas with eggs and hatchlings becoming entrapped in these areas during early development. They are commonly associated with spottail shiner and rainbow smelt.	While the majority of emerald shiners are moving along the Niagara River shoreline when they move back to Lake Erie, there are fish documented moving through the Black Rock lock and Black Rock Canal. This passage currently only occurs when the lock is operating which is after the majority of the spring run and intermittently during the fall run.	Intolerant-used as an indicator of water quality	Tolerant	
Percidae	*Percina caprodes*	Logperch	NYSDEC observed the logperch within the Upper Niagara River. It can be assumed that the species is using the river's backwaters and edges for cover from the river's fast moving waters. The fast flowing mainstem is likely mostly used by logperch to migrate from one area to another of ideal habitat. The area's backwaters, gravely or rocky banks, and tributaries are likely to be used by the logperch for spawning and permanant habitation, but it is unlikely that they would spawn within the headwaters of the Niagara River due to its current.	NYSDEC has observed the logperch within the Black Rock Canal. However, it is uncertain what the logperch is specifically using the site for. Due to the low flow of the canal it is potential that the logperch is using the site for refuge from the fast flowing waters of the Niagara River, but due to the site's lack of riffles and pools reproduction by the species is likely limited to the surrounding creeks and river areas. Turbidity within the canal may also limit the success of the logperch within the canal, as this species is extremely sensitive to turbidity.	Logperch are vital part of stream, river, and lake ecology. Species is a major prey item for many piscivorous fishes such as walleye, lake trout, steelhead / rainbow trout, yellow perch, and both largemouth and smallmouth bass. Logperch are also a sign of a healthy ecosystem, as low numbers can be a sign of poor water quality and low presence of macroinvertebrates. Species' reliance on aquatic insects is often a limiting factor to what waters they can inhabit. Logperch are commonly seen as a host species for reproduction of freshwater mussels.	Though the logperch is a relative of other commonly sought after gamefish, such as walleye and yellow perch, the logperch is not a commonly targeted gamefish species. Occasionally used by anglers as a baitfish, or even mimicked by artifical lures.	This species is found within a variety of habitats, but prefers slower moving water such as deep pools in streams, rocky or gravely banks, riffles in small rivers and streams, and river backwaters. This species has the ability to traverse fast currents, but is not a highly migratory species and prefers traversing a small range for foraging.	Logperch use a variety of habitats throughout its range and have a range of observed water depths between 1.64ft and 32.8ft. However, logperch prefer pools and riffles of small creeks and streams, gravel bottomed river banks and banks of lakes, and medium to large rivers with little to no turbidity or fine sediment. Species prefers sand, gravel, and rock substrates and will actively avoid habitats with silt and swift currents. Species is highly correlated with presence of aquatic insects, as logperch movement is associated with foraging, moving upstream and downstream to look for macroinvertebrates hiding under small rocks and gravel. Spawning occurs between May and June for this species when water temps consistently reach 10°C and cease when temps get above 18°C. Species is not a schooling fish, but is frequently in small groups outside of spawning season. When spawning occurs large groups of males and females aggregate over riffles of sand, gravel, or rocky substrate, and begin broadcast spawning. While females release their eggs, a male or many males will swim against her and release milt to fertilize the eggs. Eggs will then be hidden, but not guarded, and left to hatch.	Altered flow regimes caused by the lock, physical barriers created by the lock, presence of species may be limited by polluted output of Scajaquada Creek, and increases in turbidity breifly caused by the lock may impact individuals in the canal. Insufficient numbers of insects within the canal due to water quality and preferd sediment may also limit the species. Little data is present on maroinvertebrates of the canal, so this may not be true.	Moderate	Moderately Intolerant	
	Perca flavescens	Yellow perch	NYSDEC has observed yellow perch in the Upper Niagara River, due to the species' preference for lacustrian and littoral habitat, it can be expected that the species mostly avoids areas of the river with consistent and swift currents. The species likely prefers areas that mimic that of lacustrian habitats, with moderate vegetation presence and slower currents such as backwaters and slackwaters. Due to the variety of habitat the river offers, it is very likely that yellow perch are spawning within the Upper Niagara.	NYSDEC has observed yellow perch within the Black Rock Canal. It can be assumed, due to the system's slower flow compared to the Upper Niagara, that these fish are regularly using the area for both passage as well as spawning. The canal may offer ideal nesting habitat for these perch with an abundance of forage species year-round. There is also anecdotal evidence of evidence of the species being caught by fisherman near the train bridge year-round.	Seen as a mid-tier predator, yellow perch and other panfish are known to predate smaller fish and almost anything that can fit in their mouths. Panfish are primarily insectivores, focusing on invertebrates, zooplankton, and sometimes small fish and amphibians. Panfish are also seen as a common food source for larger predators such as walleye, northern pike, muskellunge, largemouth bass, turtles, osprey/eagles, herons, and other piscivorous predators.	Seen as a highly sought-after gamefish in the region, yellow perch are used frequently as a food source for people in the Great Lakes region as well as a purely recreationally fished species. This species brings economic benefit to the region through charter fishing and fishing targeting this species.	Commonly found in large rivers and lakes, this fish has the ability to traverse strong currents and is known to target prey by quick bursts of speed.	Yellow perch prefer habitat that is lacustrian, littoral, or large rivirine habitats with habitat features similar to those found in lakes. Clear waters with moderate presence of vegetation (>20% coverarge), and shallow water availability. Species will often school in loosely organized groups in larger waterbodies. Schools favor warmer waterbodies and prefer regular temperature ranges between 17.6°C -25°C for growth, but can survive temperature ranges of 0°C and 32.3°C. Spawning occurs between 6°C-10°C and begins when females travel to vegetated shallow waters and lay their eggs in random ribbon like strands. Males will later travel to the same waters and distribute their milt to fertilize the eggs. Eggs randomly float until they attach to vegetation, rocks, or other debris. Larval survival is inversely correlated to wind and current velocity, so fry often seek calm and warmer waters immediately after hatching. Limiting factors for perch populations are availability of vegetation and a low presence of pollutants and turbidity. DO levels are not a major limiting factor, as perch can usually handle levels 1.5ppm to 5.0ppm.	The lock structure may be a physical barrier to movement as the fish travel along the Niagara River and get caught within the lock or canal. Increases in turbidity breifly caused by the lock may impact individuals in the canal.	Moderately Tolerant	Moderately Intolerant	
	Sander vitreus	Walleye	Walleye were observed by NYSDEC within the Upper Niagara River. It is expected that walleye not only use the Upper Niagara for year-round forage habitat, often leaving Lake Erie at night to hunt within the river, but walleye are using the river to spawn along rock walls, shallow shorelines, and other reinforced banks with good water circulation.	While the species has not been directly observed within the canal, it is likely that, like other percidae, this species is using the canal. However, it is expected that the this species is only incidentally using the canal for travel to and from spawning habitat, they have also been observed by lock operators traveling through the lock as they chase schools of emerald shiners.	Seen as a higher-tier predator, walleye are known to eat smaller fish and almost anything that can fit in their mouths. Each age class of walleye focuses on different foods: fry-microcrustaceans, juveniles-insects/crawfish/small fish, adults-primarily fish and crawfish but will also eat leeches, snails, amphibians (frogs and mudpuppies), and even small mammals. One of the walleye's main sources of forage is the emerald shiner, with shiners known to make up 71% of walleye diet. Smaller walleye are a common prey for larger predators such as other walleye, northern pike, muskellunge, largemouth bass, turtles, osprey/eagles, and herons; adult walleye do not face much predation.	Seen as a highly sought-after gamefish in the region, walleye are used frequently as a food source for people in the Great Lakes region as well as a purely recreationally fished species. This species brings economic benefit to the region through charter fishing and fishing targeting this species.	Commonly found in large rivers and lakes, this fish has the ability to traverse strong currents and is known to target prey by quick bursts of speed.	Walleye are found in a variety of habitats, but prefer and are often found in medium to large rivers and lakes. Prefering cooler temperature, walleye require variety within their habitats for better success, including shallow to moderate depths, extensive littoral zones, low to moderate turbidities, extensive areas of clean rocky substrate, and mesotrophic conditions. Walleye associate strongly with small baitfish. Walleye survival is positively correlated with the abundance of small baitfish and moderate turbidity. When walleye are fry, they are considered photopositive; however, when walleye reach >40mm they become photosensitive and actively seek shelter from light, and will use covers such as boulders, log piles, brush, and dense beds of submerged vegetation during the day. Walleye spawn in spring, during periods of rapid warming, or as soon as the ice begins to break around 7°C-9°C. Most spawning occurs between 6°C-11°C. Spawning habitat includes shallow shorelines, shoals, riffles, dam faces with rocky substrate, and rock walls or rock reinforced banks with good water circulation from currents and wave action. Lacustrine populations often migrate from the lake habitat to riverine habitats to spawn. Walleye spawning occurs during the night. Eggs and sperm are broadcast over substrates and fall into cracks and crevices. Walleye can tolerate a variety of water quality conditions; preferred DO for walleye is between 3-5 mg/L (ppm) but can survive DO levels between 1-2 mg/L (ppm) for short periods. Walleye prefer temperatures between 3°C and 24°C but can survive between 0°C-3°C and 29°C-35°C for short periods.	The lock structure may be a physical barrier to movement as the fish travel along the Niagara River and get caught within the lock or canal. Walleye are mostly nocturnal and will move and forage after the lock is no longer operational, which may inhibit their movement in the area. The lock has also become a physical barrier to the walleye's main prey species, the emerald shiner.	Moderately Tolerant	Moderately Tolerant	
Salmonidae	*Oncorhynchus mykiss*	Rainbow trout	Both rainbow trout and brown trout have been observed within the upper Niagara River. However, most observations of these species are during periods of migration for spawning. These species are not using the river for spawning, but are using the river to migrate to spawning grounds such as creeks and streams. These species are also using the upper Niagara for feeding ground, where they will chase "bait balls" of emerald shiners. They will often overwinter in the deeper waters of the Niagara.	Both trout species have been observed within the Black Rock Canal. However, it is expected that the two species are only incidentally using the canal for travel to and from spawning habitat, they have also been observed by lock operators traveling through the lock as they chase schools of emerald shiners.	Due to the life histories and movement of these species, ecosystems that involve trout often experience major booms and recessions. Trout often bring many nutrients to a system as they begin their migration for spawning. Eggs, dead trout, fry, and feces provide nutrients to the systems they migrate to. Targeted at all stages by predators such as osprey/eagles, herons, pike, muskellunge, walleye, other trout, and bass, trout are valuable to the environments they inhabit. Trout also target macroinvertebrates, other fish species, mollusks, and fish eggs as major food sources.	Trout are a major focus for both recreational fishermen as well as subsitency fishermen. These species are a major economic interest for the Great Lakes area, as the create jobs for charters, fishermen, baitshops, and aquaculture. Some estimates place the industry for rainbow trout recreational fishing at ~$12-$14 million.	Strong swimmers, often found schooling as they swim up river for spawning. Appears to prefer consistent swimming patterns versus burst swimming. Schools will swim near the water's surface and swim upstream and downstream large rivers such as the Upper Niagara. An average size, 250mm long, rainbow trout can swim 1m/s for 250 seconds, with some 250mm individuals swimming at 1m/s for longer than 1800 seconds. Overall these species are relatively strong swimmers who prefer swimming in systems with moderate and consistent flows.	These species prefer mid-waters of lakes, creeks, and rivers with moderate flow, gravelly bottoms and riffle-pool habitat. Preferred water temperatures for the species range 12-18°C, with brown trout prefering temperature above 15°C. This species is relatively intolerant to both turbidity and pollution, with turbidity levels of 50ppm being their max tolerance. The species prefer clear rivers and lakes, and requires tributary streams to spawn. When spawning occurs the species will school and move upstream the creeks and streams connected to Lake Erie and the Niagara River. These species create shallow nest, called redds, along the stream beds; eggs are released by the female and fertilized by a male, and then quickly buried in gravel. After the eggs hatch, the young trout will live in these streams for one to two years before migrating to Lake Erie.	Altered flow regimes caused by the lock, physical barriers created by the lock, presence of trout may be limited by polluted output of Scajaquada Creek, and increases in turbidity breifly caused by the lock may impact individuals in the canal.	Moderately Intolerant	Moderately Intolerant	
	Salmo trutta	Brown trout										
Sciaenidae	*Aplodinotus grunniens*	Freshwater drum	NYSDEC observed freshwater drum within the Upper Niagara River. It can be assumed that the species is using the river's backwaters and edges for cover from the river's fast moving waters, or using the river as it forages on the bottom of the river. The area's backwaters are likely to be used by the gar for spawning, but it is unlikely that they would spawn within the mainstem of the Niagara River due to its current.	NYSDEC and USFWS have observed freshwater drum in Black Rock Canal. It can be assumed, due to the system's slower flow compared to the Upper Niagara, that these fish regularly use the area for passage and spawning. Species is known to thrive in impoundments, and is likely benefiting from the additional habitat created by the slower waters behind the lock. Though it may prefer to spawn in tributaries and some individuals may be migrating from Lake Erie to spawn, some individuals may spawn within the canal.	A bottom-feeder, it feeds on microcrustaceans, aquatic insects, detritus, algae, and small mollusks. As young fish these species are often used as forage fish for bass and other predatory gamefish. This species is also used as forage for piscivorous birds such as osprey and herons.	Often seen as an ideal fish for recreation, freshwater drum are sought out as both a trophy fish as well as a species for eating. These fish are often fished for year-round and said to be ideal for recreational fishing due to their strong fighting ability.	Fairly strong swimmer that swims upstream through large swift moving streams/creeks/rivers with ease.	Freshwater drum prefer inhabiting sandy, silty bottoms of lakes and reservoirs (with water depths to 18m), and pools in low to moderate-gradient, often turbid, rivers. Freshwater drum prefer water temperatures ranging from 24-28°C for growth. Spawning usually occurs between May-July when temperatures reach 18-26°C. Females will begin spawning by broadcasting her eggs within the water column of larger rivers or lakes, males will then fertilize those eggs by releasing their sperm, these large eggs are buoyant and will float to the surface before hatching ~24 hours later in warmer waters. Due to the fish's wide range of habitats throughout North America, the fish can survive in a variety of turbidities and DO levels.	The lock structure may be a physical barrier to movement as the fish travel along the shoreline of the Niagara River and get caught within the lock or canal. This species does also tend to forage and move more at night, when the lock is no longer operated regularly, which may inhibit the species success in the area.	Moderate	Tolerant	While considered naturalized in Lake Erie, USGS considers this species as non-native within Lake Erie. The species is common in both Lake Erie and Lake Ontario, and it is unknown how the non-native species affected the ecosystem of Lake Erie.