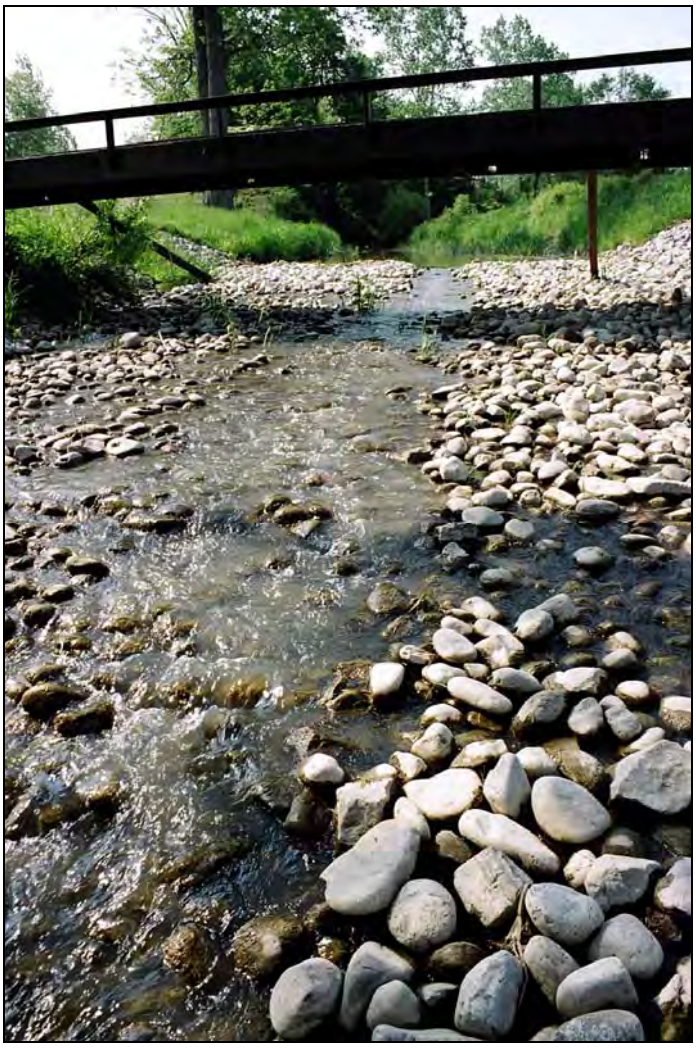
NIAGARA RESTORATION COUNCIL



NIAGARA RIVER AREA OF CONCERN (AOC)

FISH BARRIER PROJECT – March 29, 2010

Fish Population Data Analysis Report

ACKNOWLEDGEMENTS

This project could not have been carried out without the help of the individuals, groups, and agencies mentioned here. We would like to thank them for their time, help, generosity and/or contributions.

Department of Fisheries and Oceans (DFO)

Environment Canada - Great Lakes Sustainability Fund

> The Great Lakes Sustainability Fund is a component of the Federal Government's Great Lakes program. The Sustainability Fund provides resources to demonstrate and implement technologies and techniques to assist in the remediation of Areas of Concern and other priority areas in the Great Lakes. The report that follows was sponsored by the Great Lakes Sustainability Fund and addresses fish migration issues in the Niagara River Area of Concern in the Niagara Region. Although the report was subject to technical review, it does not necessarily reflect the views of the Sustainability Fund or Environment Canada.

Niagara Region – WaterSmart Niagara Funding

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Also all of the other staff at the Niagara Peninsula Conservation Authority

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Canadian Ontario Agreement-Respecting the Great Lakes Basin Ecosystem

Wetland Habitat Fund

Ontario Great Lakes Renewal Foundation

Ontario Power Generation

The Region of Niagara

Niagara College Glendale Campus

Niagara Conservation Foundation

Welland River Keepers

…Our project landowners, and all of the other participants in this program!

Introduction:

Over the course of many years, various in-stream structures (both privately and publicly owned) have appeared throughout the Niagara River watershed. The majority of these have been installed in order to cross the stream or to hold back water for various purposes such as an irrigation water supply or to create a pond. Barriers may also include major structures such as hydro dams or natural structures such as beaver dams and water falls. Such structures are defined as 'fish barriers' because they restrict the ability of fish to swim upstream to access their spawning habitat. Up until now, fish were prevented from accessing hundreds of kilometres of spawning habitat, contributing to the decline of fish populations and their distribution throughout the Niagara River watershed.

In May 2001, The Niagara Restoration Council (NRC) started the Niagara River Area of Concern (AOC) - Fish Barrier Project. For the first time, both private and public fish barriers were inventoried, assessed, and a grant program created to help in their removal. Depending on their severity, barriers were divided into 'critical', 'major', or 'minor' barriers. The project was designed in response to the goals of the Niagara River AOC – Remedial Action Plan. More specifically, de-listing criteria #14 of the updated Niagara River Remedial Action Plan Stage 2 Report whereas "75% of the potential barriers to fish movement (as identified through the Niagara River AOC Fish Barriers Project 2001) must be removed or remediated restoring access to potential spawning habitat", was the target for this project.

Of the 210 barriers to fish migration identified since 2001, 169 have been remediated. Remediation of these barriers including the removal of several tonnes of garbage and debris, replacement of collapsed and perched culverts with new culverts and clear-span bridges, and the installation of river stone riffles, creating fish 'ladders' over barriers. As a result, the project has exceeded the goal of removing 75% of the potential barriers to fish migration in the Niagara River Watershed.

Aside from a telemetry study, where Northern Pike (*Esox lucius*) were tagged with radio transmitters to determine their movement past the remediated Port Davidson Weir (FB #3) and Canborough Weir (FB #4), there has been little data collected to determine if this project has been successful in terms of fish movement and populations. This report will analyze existing fish population data (Yagi, 2008), provided by the Ontario Ministry of Natural Resources, to determine if there have been any changes in fish populations and biodiversity upstream and downstream of remediated 'major' barriers, where possible.

Data Analysis:

The first task of this data analysis was to compare remediated fish barrier locations with the locations of past fish sampling sites using GPS coordinates and GIS software. Out of all the 'major' barriers, which have been remediated, only six barriers had enough comparable data, which has been analyzed in this report. Since sampling site locations were not targeted for the fish barrier project, much of the existing data locations did not correspond with barrier locations, or data was only collected before the barriers were remediated. In most cases, fish populations were only sampled once for a given location

therefore there was no comparable data. Also, in some cases, data was only collected upstream or downstream of a remediated barrier which prevents any comparison of fish populations upstream and downstream of the remediated barrier. Due to a lack of repeated data, statistical analysis could not be used to accurately determine any differences in fish populations. For this report, comparisons will be made by reviewing the sampled populations of various fish species and any changes to species diversity, which will provide some insight to the effectiveness of this project.

Other Factors to Consider:

Since we are comparing data that was not designed specifically for this project, there are various other factors to consider when comparing fish population data as they may result in differences in the sampled fish populations. This includes
1) sampling techniques, 2) weather, date, and time, and 3) habitat type and conditions.

1) Sampling Techniques: In all cases, fish were sampled by either electro-fishing, seine netting, or minnow traps or a combination of 2 or more. Wherever possible, this report will analyze data collected by the same technique in order to reduce any variables with the sampling techniques.

2) Weather, Dates, and Times: Seasonal changes, weather conditions, and time of day can impact fish species differently, whereas some will be more active/inactive, hiding under cover, or no longer in the area due to spawning. Without knowing the weather conditions or the time of day fish were sampled, whenever possible, we will only compare data which was collected on approximately the same day and/or season.

3) Habitat Types/Conditions: Many fish species have specific habitat requirements in which they are more likely to be commonly found. This may include areas with significant woody debris, river stone/sand streambed, and/or quick/slow moving water. Since we do not know the specific habitat type where sampling occurred, we have not taken this factor into consideration when analyzing the existing data. In some cases, the habitat upstream may be considerably different than downstream (or vice versa) due to shoreline characteristics (forested, cleared, buffered), pollution sources (agricultural runoff), or availability of woody debris.

Fish Barrier Analysis:

Fish Barrier #3:

The Port Davidson Weir on the West Main Welland River was a significant barrier to fish migration due to its extreme slope and composition of large stones, making it impassable to most fish species throughout most of the year. In the winter of 2002/03, river stone was added and a by-pass channel created, with a gentler slope, enabling fish passage throughout most of the year.

Figure 1&2: FB #3 Before and after remediation.

Figure 3: Fish sampling sites around FB#3

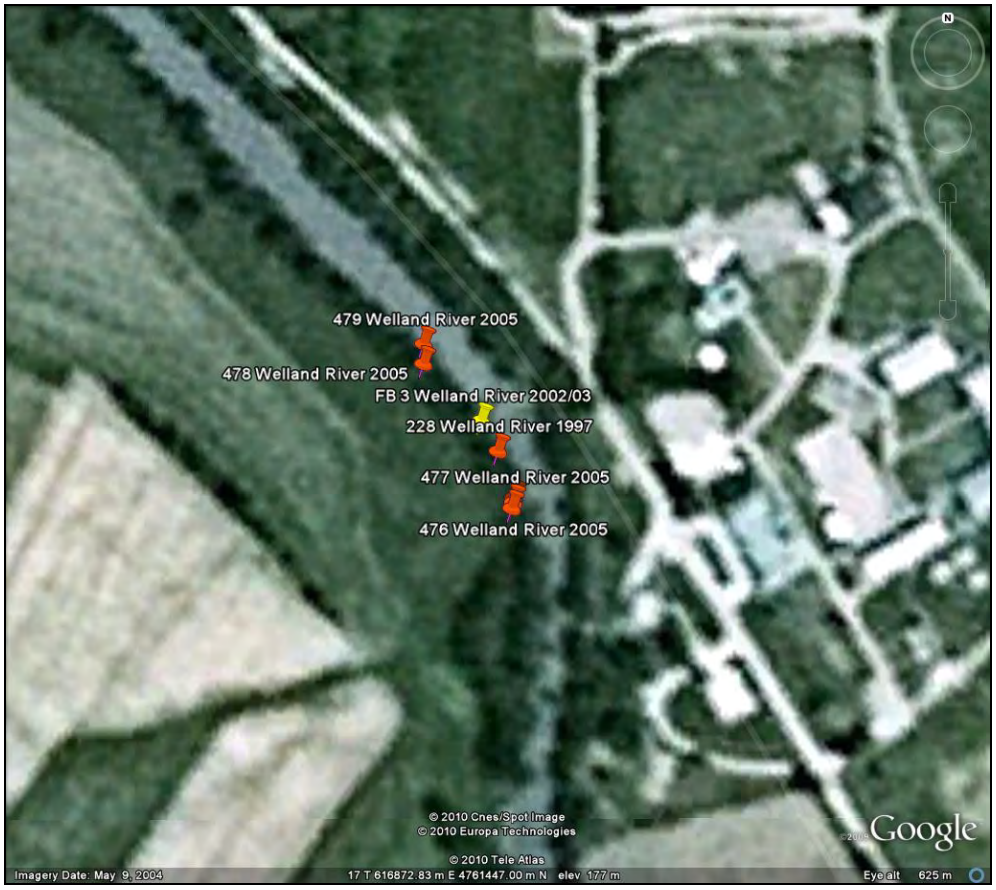

Figure 4: Fish sampling sites around FB#3 (close-up)

In order to compare this data, fish sampled over 2 days over a period of 1 week in 2005 were combined to increase sample sizes. Overall, species diversity remained relatively similar with 11 species upstream opposed to 9 species downstream of the remediated barrier. This would suggest that fish movement is occurring across the barrier. The most significant difference between upstream and downstream of the remediated barrier was the greater number of Channel Catfish sampled downstream. This may be due to the differences in water flow and habitat as this species prefers slow-moving water and because they are sensitive to light, they seek out shaded, deep pools around submerged logs, rocks, and other debris.

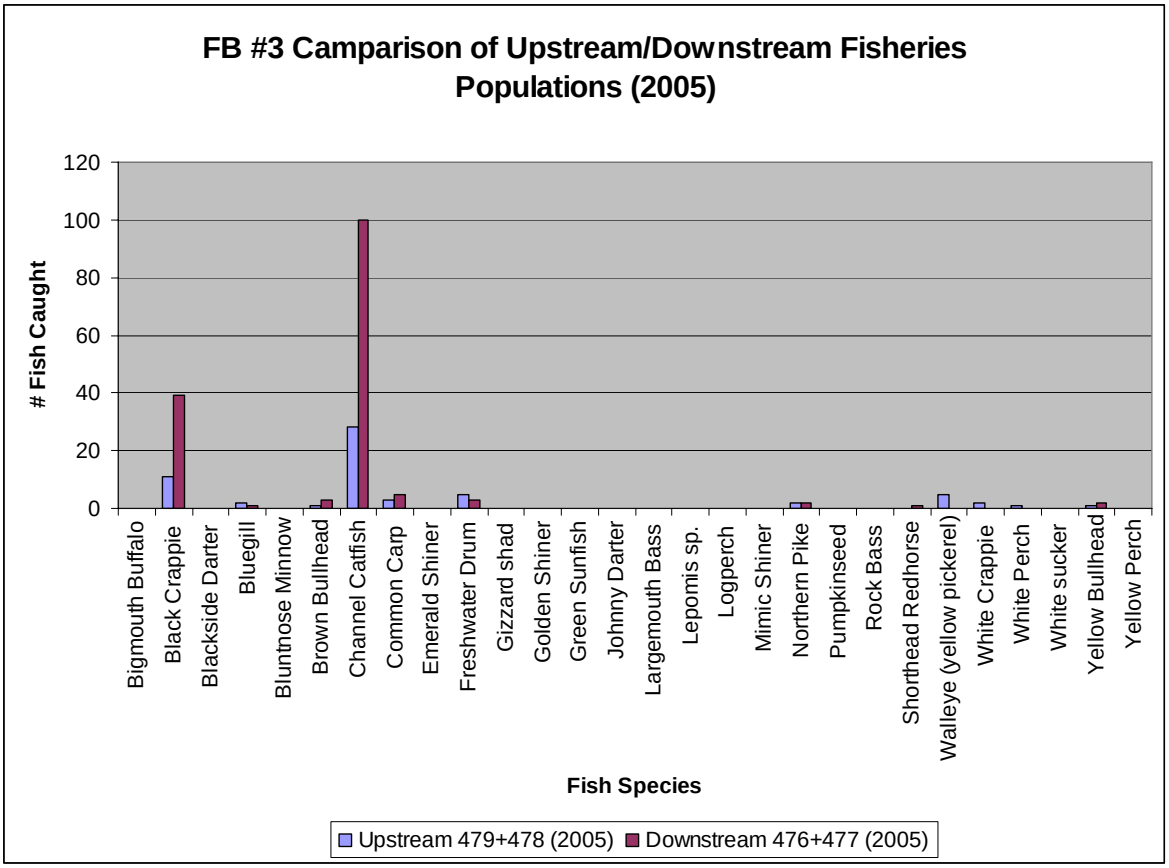

Figure 5: Comparison of 2005 fish populations upstream and downstream of FB#3
*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Fish Telemetry Study – Port Davidson Weir

In 2003, Biotactic Inc. was hired by the Niagara Restoration Council and Niagara Peninsula Conservation Authority to test the effectiveness of the Port Davidson weir bypass channel and Canborough Weir bypass channel for upstream and downstream passage of northern pike (*Esox lucius*). In March 2003, ten northern pike had radio transmitters surgically implanted into their body cavity (Bunt, 2003). Fish were then released downstream from the Port Davidson Weir fish bypass channel, where tracking began was done over a 6 month period using mobile multiplexed scanning receivers and GPS (Bunt, 2003). Movement patterns showed that northern pike were successfully moving upstream and downstream through the newly constructed bypass channel (Bunt, 2003). Passage rates at the Port Davidson Weir were 80% for upstream migrating northern pike and 50% for downstream migrating northern pike (Bunt, 2003). As a result of this study, it was shown that the remediation of FB #3 was successful in promoting fish passage, allowing fish species to move upstream of this barrier once again.

Table 1: Fish Barrier 3 Relevant Fisheries Data

Barrier ID: 3 Port Davidson Weir
Sub watershed: West Main Welland River
Date Removed: 2002/03

	Code/Date										
Common Name	Upstream 553 - 9/11/1996	Upstream 463 - 11/8/2005	Upstream 479+478 (2005)	Upstrea m 479 - 10/18/20 05	Upstream 478 - 10/26/2005	Downstream 228 - 8/8/1997	Downstream 460 - 10/24/2005	Downstream 476+477 (2005)	Downstrea m 476 - 10/11/2005	Downstream 477 - 10/17/2005	Downstream 466 - 11/11/2005
Bigmouth Buffalo	0	1	0	0	0	0	0	0	0	0	0
Black Crappie	0	6	11	2	9	0	0	39	1	38	0
Blackside Darter	10	0	0	0	0	0	0	0	0	0	0
Bluegill	0	34	2	2	0	0	0	1	0	1	0
Bluntnose Minnow	44	0	0	0	0	1	0	0	0	0	0
Brown Bullhead	0	0	1	1	0	6	0	3	2	1	0
Channel Catfish	0	0	28	12	16	4	0	100	80	20	0
Common Carp	0	1	3	0	3	12	0	5	1	4	0
Emerald Shiner	0	0	0	0	0	7	0	0	0	0	0
Freshwater Drum	0	0	5	0	5	8	0	3	2	1	0
Gizzard shad	0	0	0	0	0	1	0	0	0	0	0
Golden Shiner	0	1	0	0	0	0	0	0	0	0	0
Green Sunfish	7	1	0	0	0	0	0	0	0	0	0
Johnny Darter	11	0	0	0	0	0	0	0	0	0	0
Largemouth Bass	0	1	0	0	0	0	0	0	0	0	0
Lepomis sp.	1	1	0	0	0	0	0	0	0	0	0
Logperch	1	0	0	0	0	1	0	0	0	0	0
Mimic Shiner	1	0	0	0	0	0	0	0	0	0	0
Northern Pike	0	0	2	1	1	0	1	2	0	2	0
Pumpkinseed	3	33	0	0	0	24	0	0	0	0	0
Rock Bass	4	5	0	0	0	0	0	0	0	0	0
Shorthead Redhorse	0	1	0	0	0	1	0	1	1	0	0
Walleye (yellow pickerel)	0	6	5	0	5	0	8	0	0	0	3

White Crappie	0	0	2	1	1	6	0	0	0	0	0
White Perch	0	2	1	0	1	0	0	0	0	0	0
White sucker	0	0	0	0	0	1	0	0	0	0	0
Yellow Bullhead	1	1	1	1	0	0	0	2	1	1	0
Yellow Perch	0	6	0	0	0	3	0	0	0	0	0
# individuals caught	83	100	61	20	41	75	9	156	88	68	3
# species caught	11	15	11	7	8	13	2	9	7	8	1

*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Fish Barrier #4

The Canborough Weir, located on Oswego Creek was remediated in the winter 2002/03. Since the complete removal of the weir was not practical, a by-pass channel with a gentle slope was installed to permit fish passage over their weir. A radio telemetry study, where Northern Pike were tagged with radio transmitters, confirmed that they were able to pass the weir via the by-pass channel.

Figure 6&7: FB #4 Before and after remediation.

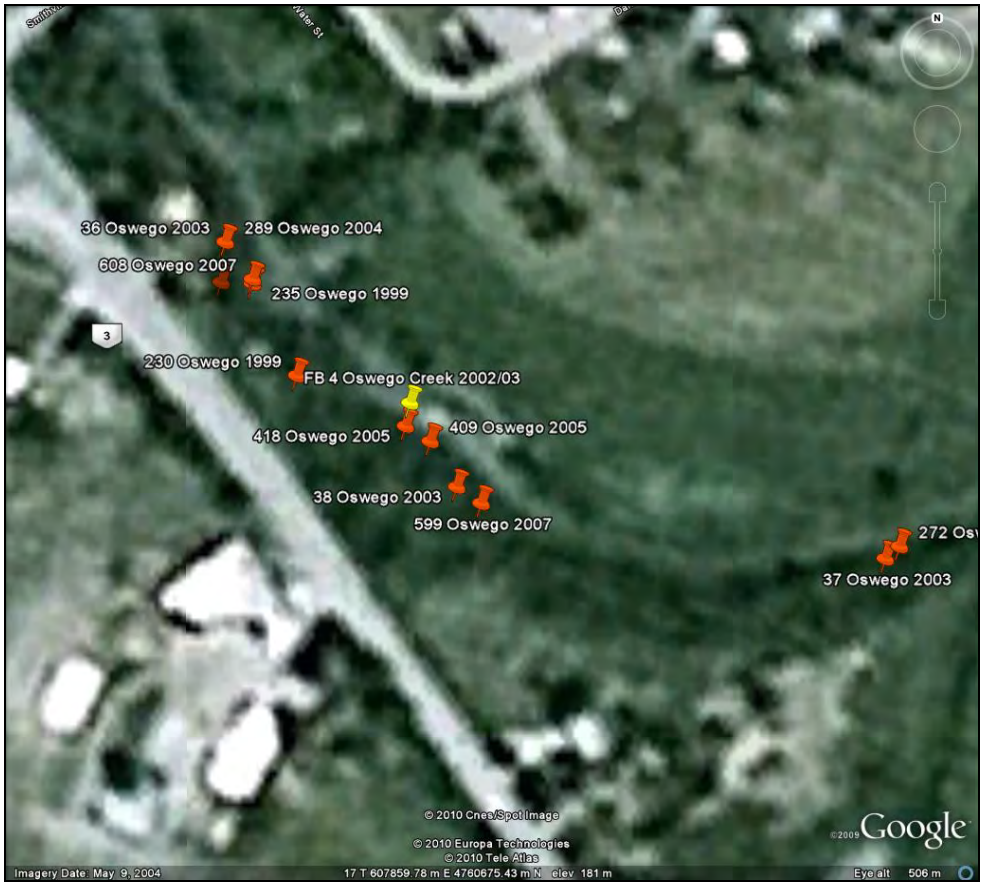

Figure 8: Fish sampling sites around FB#4 (close-up)

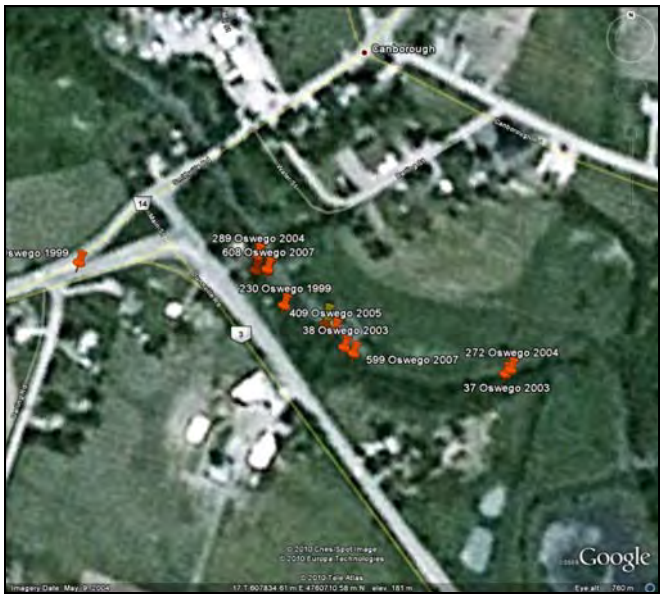

Figure 9: Fish sampling sites around FB#4

By comparing fish populations from 1999 to 2007 at the same location upstream of the remediated barrier, it can be determined that the remediation of barrier #4 may have increased biodiversity (from 8 species to 12). In 1999, Lepomis spp. were abundant, however they no longer present in 2007, possible due to changes in habitat and water quality.

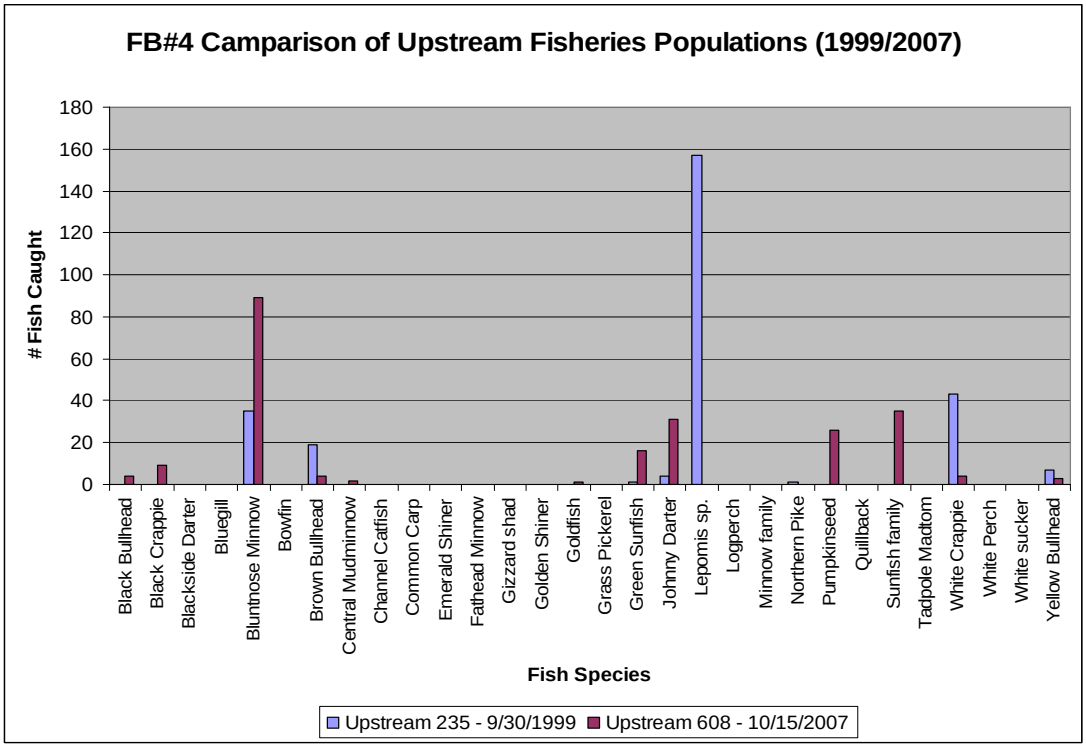

Figure 10: Comparison of 1999 to 2007 fish populations upstream of FB#4

*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Using data collected upstream and downstream of the remediated barrier in 2007, it appears that biodiversity remains higher downstream (18 species downstream opposed to 12 upstream) which may suggest that some species are not using or able to use the by-pass channel. It could also suggest that certain species are better suited to the downstream habitat over the upstream habitat. Overall, this area remains a highly productive area for fish populations.

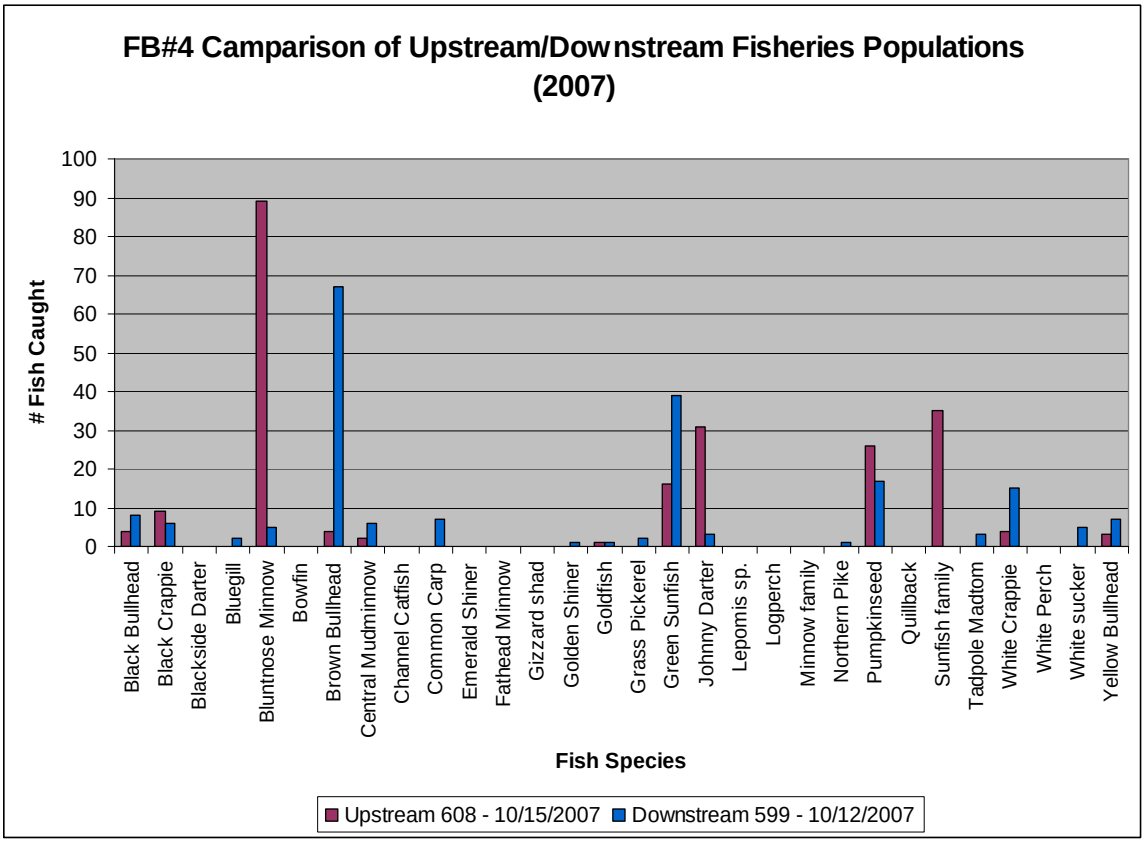

Figure 11: Comparison of 2007 fish populations upstream and downstream of FB#4
*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Fish Telemetry Study – Canborough Weir

While the fish telemetry study at the Port Davidson Weir (FB#3) was being implemented, an identical study was being executed at the Canborough Weir (FB#4) to determine the effectiveness of the new bypass channel for upstream and downstream passage of northern pike (*Esox lucius*). Another ten northern pike had radio transmitters surgically implanted into their body cavity (Bunt, 2003). Fish were then released upstream and downstream from the Canborough Weir. This study was designed to test bi-directional passage though the new fish bypass channel (Bunt, 2003). Movement patterns showed that the upstream passage rate of northern pike was 100% while the downstream passage rate was 89% (Bunt, 2003). Once again, this study proved that the construction of the Canborough Weir fish bypass channel was successful in unlocking potential fish habitat and promoting fish migration.

Table 2: Fish Barrier 4 Relevant Fisheries Data

Barrier ID: 4 Canborough Weir

Sub watershed: Oswego Creek

Date Removed: 2002/03

	Code/Date											
Common Name	Upstream 232 - 9/9/1999	Upstream 230 - 9/29/1999	Upstream 235 - 9/30/1999	Upstream 36 - 7/3/2003	Upstream 289 - 10/18/2004	Upstream 608 - 10/15/2007	Down stream 37 – 7/7/2003	Down stream 38 – 7/7/2003	Down stream 272 - 10/6/2004	Down stream 409 - 7/19/2005	Down stream 418 - 7/20/2005	Down stream 599 - 10/12/2007
Black Bullhead	0	0	0	4	11	4	12	0	21	25	40	8
Black Crappie	57	0	0	0	16	9	0	0	128	20	46	6
Blackside Darter	0	0	0	0	0	0	0	0	1	0	0	0
Bluegill	0	0	0	0	0	0	2	0	0	0	0	2
Bluntnose Minnow	31	0	35	19	1	89	1	24	125	2	47	5
Bowfin	0	0	0	0	0	0	0	0	0	2	0	0
Brown Bullhead	6	0	19	17	27	4	25	0	57	131	143	67
Central Mudminnow	0	0	0	0	1	2	4	0	4	6	1	6
Channel Catfish	0	1	0	0	0	0	0	0	0	0	0	0
Common Carp	0	3	0	0	0	0	0	0	0	0	23	7
Emerald Shiner	0	0	0	0	0	0	1	0	0	2	0	0
Fathead Minnow	0	0	0	1	0	0	1	0	5	0	0	0
Gizzard shad	0	0	0	0	63	0	0	0	56	0	0	0
Golden Shiner	0	1	0	11	1	0	5	0	77	20	22	1
Goldfish	0	1	0	1	0	1	0	0	2	2	0	1
Grass Pickerel	0	0	0	5	0	0	2	0	8	4	2	2
Green Sunfish	86	27	1	13	67	16	30	0	534	321	18	39
Johnny Darter	0	0	4	0	37	31	1	0	42	21	13	3
Lepomis sp.	0	23	157	0	0	0	0	0	0	0	0	0
Logperch	0	0	0	0	0	0	1	0	0	1	0	0
Minnow family	0	81	0	0	0	0	0	0	0	0	0	0
Northern Pike	1	1	1	9	0	0	33	0	3	0	0	1
Pumpkinseed	62	5	0	32	61	26	100	0	480	305	54	17

Quillback	0	0	0	0	1	0	0	0	0	0	0	0
Sunfish family	16	0	0	0	0	35	0	0	0	0	0	0
Tadpole Madtom	0	1	0	1	3	0	4	0	13	3	5	3
White Crappie	207	23	43	16	8	4	9	0	11	0	2	15
White Perch	0	7	0	0	0	0	0	0	0	0	0	0
White sucker	0	0	0	1	0	0	1	0	0	2	0	5
Yellow Bullhead	9	44	7	0	0	3	0	0	6	0	7	7
# individuals caught	475	218	267	130	297	224	232	24	1573	867	423	195
# species caught	9	13	8	13	13	12	17	1	18	16	14	18

*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Fish Barrier #16

The landowner was no longer using this former crossing, located in the West Main Watershed. As a result, the crossing was completely removed in 2003/04, returning the stream to its natural flow.

Figure 12&13: FB #16 Before and after remediation.

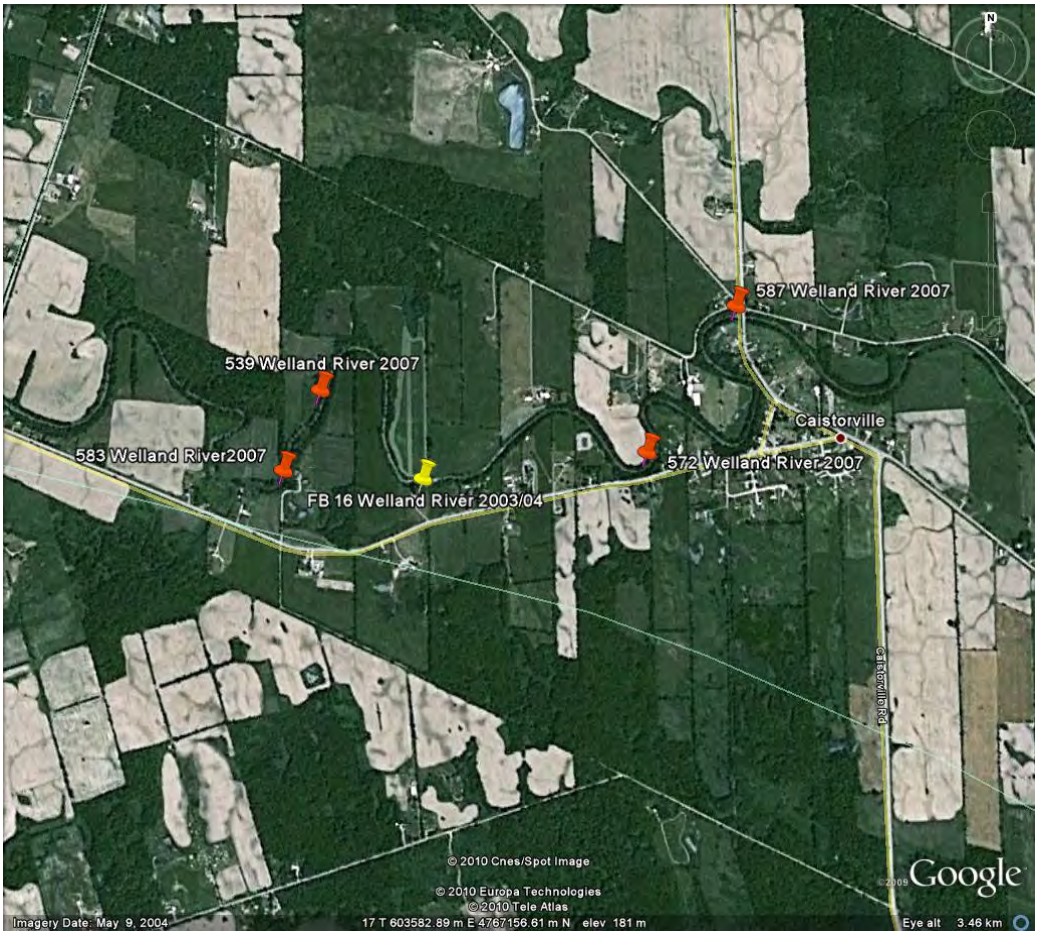

Figure 14: Fish sampling sites around FB#16

A comparison of the upstream and downstream fish populations in close proximity to the remediated barrier suggests that fish movement is occurring, whereas the biodiversity and sampled population sizes upstream is actually higher than the biodiversity downstream (12 species upstream to 9 species downstream). There was a significantly higher sampled population of Bluntnose minnows upstream. The Grass Pickerel, a species at risk, was only present upstream of the barrier.

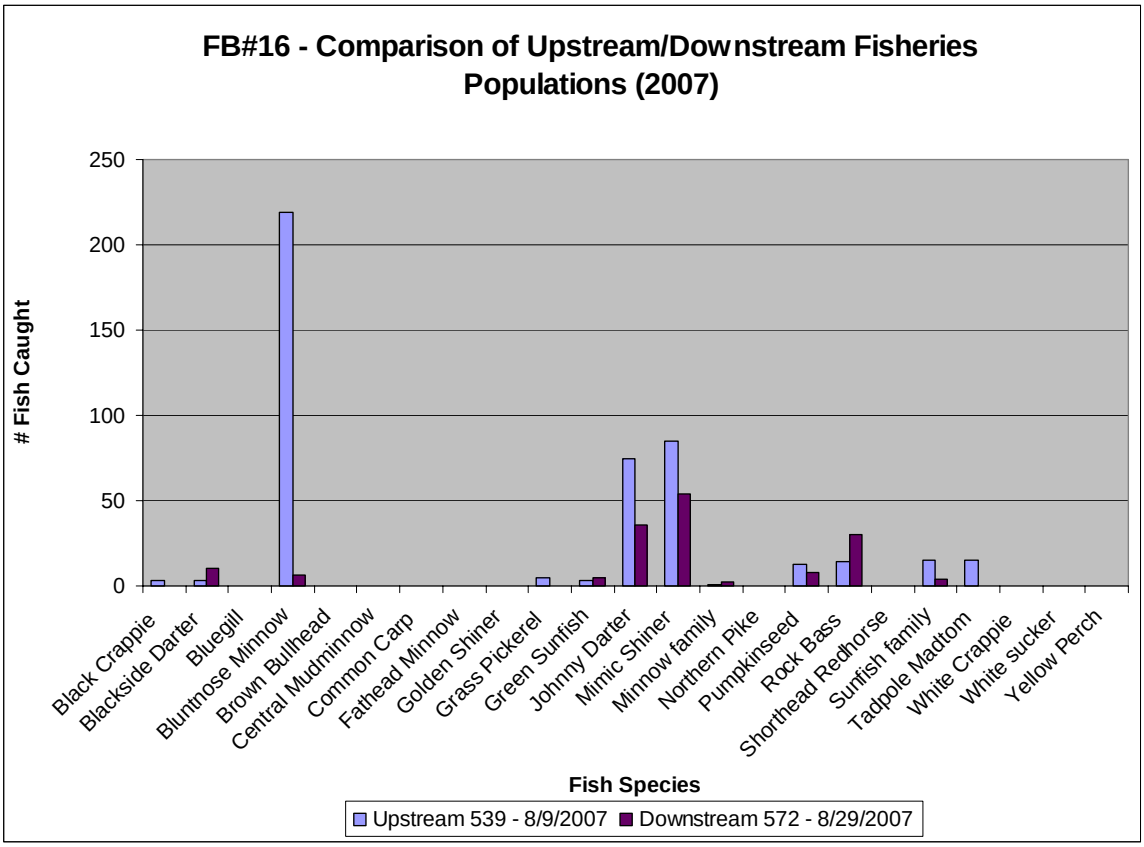

Figure 15: Comparison of 2007 fish populations upstream and downstream of FB#16

*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

A comparison of the upstream and downstream fish populations in locations further from the remediated barrier suggests that fish movement is occurring. Species biodiversity remains very similar (18 species upstream to 17 species downstream) and overall species composition appears stable. Since species diversity is higher further from the remediated barrier, this may suggest that the habitat at the former barrier site has not fully recovered yet. The sampled population size of Bluntnose minnow remains higher upstream.

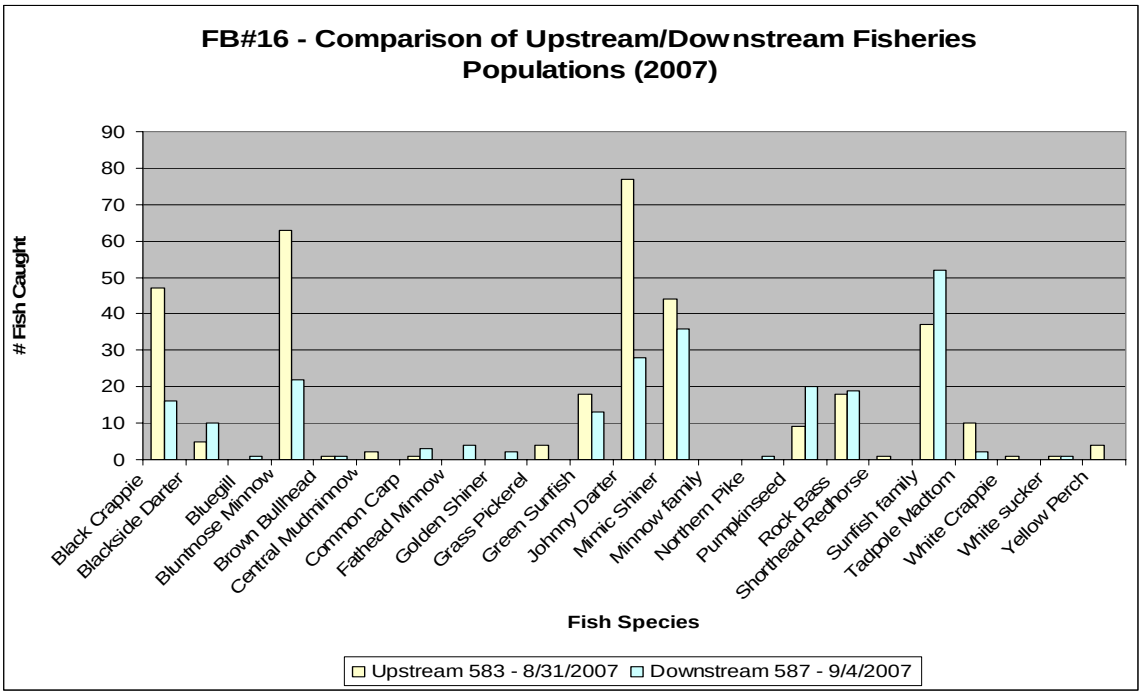

Figure 16: Comparison of 2007 fish populations further upstream and downstream of FB#16
*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Combining the data from the two locations sampled upstream and the two locations sampled downstream, species diversity remains fairly similar except for the presence of the Fathead Minnow, which is only found in downstream. Overall, while population sizes remain higher upstream of the remediated barrier, migration is occurring.

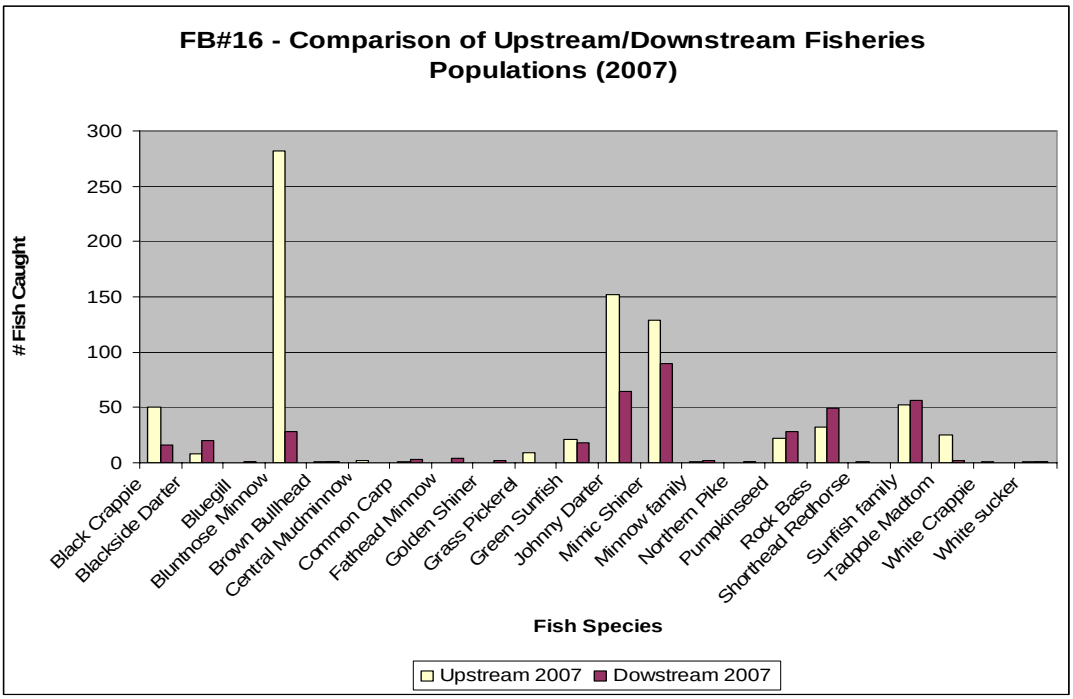

Figure 17: Comparison of combined 2007 fish population data upstream/downstream of FB#16
*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Table 3: Fish Barrier 16 - Relevant Fisheries Data

*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Barrier ID: 16
Sub watershed: West Main Welland River
Date Removed: 2003/04

		Code / Date					
Common Name	**Species**	Upstream 539 - 8/9/2007	Upstream 583 - 8/31/2007	Upstream 2007 Total	Downstream 572 - 8/29/2007	Downstream 587 - 9/4/2007	Downstream 2007 Total
Black Crappie	Pomoxis nigromaculatus	3	47	50	0	16	16
Blackside Darter	Percina maculata	3	5	8	10	10	20
Bluegill	Lepomis macrochirus	0	0	0	0	1	1
Bluntnose Minnow	Pimephales notatus	219	63	282	6	22	28
Brown Bullhead	Ameiurus nebulosus	0	1	1	0	1	1
Central Mudminnow	Umbra limi	0	2	2	0	0	0
Common Carp	Cyprinus carpio	0	1	1	0	3	3
Fathead Minnow	Pimephales promelas	0	0	0	0	4	4
Golden Shiner	Notemigonus crysoleucas	0	0	0	0	2	2
Grass Pickerel	Esox americanus	5	4	9	0	0	0
Green Sunfish	Lepomis cyanellus	3	18	21	5	13	18
Johnny Darter	Etheostoma nigrum	75	77	152	36	28	64
Mimic Shiner	Notropis volucellus	85	44	129	54	36	90
Minnow family	CYPRINIDAE	1	0	1	2	0	2
Northern Pike	Esox lucius	0	0	0	0	1	1
Pumpkinseed	Lepomis gibbosus	13	9	22	8	20	28
Rock Bass	Ambloplites rupestris	14	18	32	30	19	49
Shorthead Redhorse	Moxostoma macrolepidotum	0	1	1	0	0	0
Sunfish family	CENTRARCHIDAE	15	37	52	4	52	56
Tadpole Madtom	Noturus gyrinus	15	10	25	0	2	2
White Crappie	Pomoxis annularis	0	1	1	0	0	0
White sucker	Catostomus commersoni	0	1	1	0	1	1
Yellow Perch	Perca flavescens	0	4	4	0	0	0
# individuals caught		451	343	794	155	231	386
# species caught		12	18	19	9	17	18

Fish Barrier #28

Over several decades, this portion of Drapers Creek was altered by the installation of concrete debris to stabilize the stream banks. As result, flow was significantly altered and the streambed destroyed. In the winter 2006/07, all debris was removed and replaced with river stone. Bioengineering was then used to stabilize the stream banks with native vegetation.

Figure 18&19: FB #28 Before and after remediation.

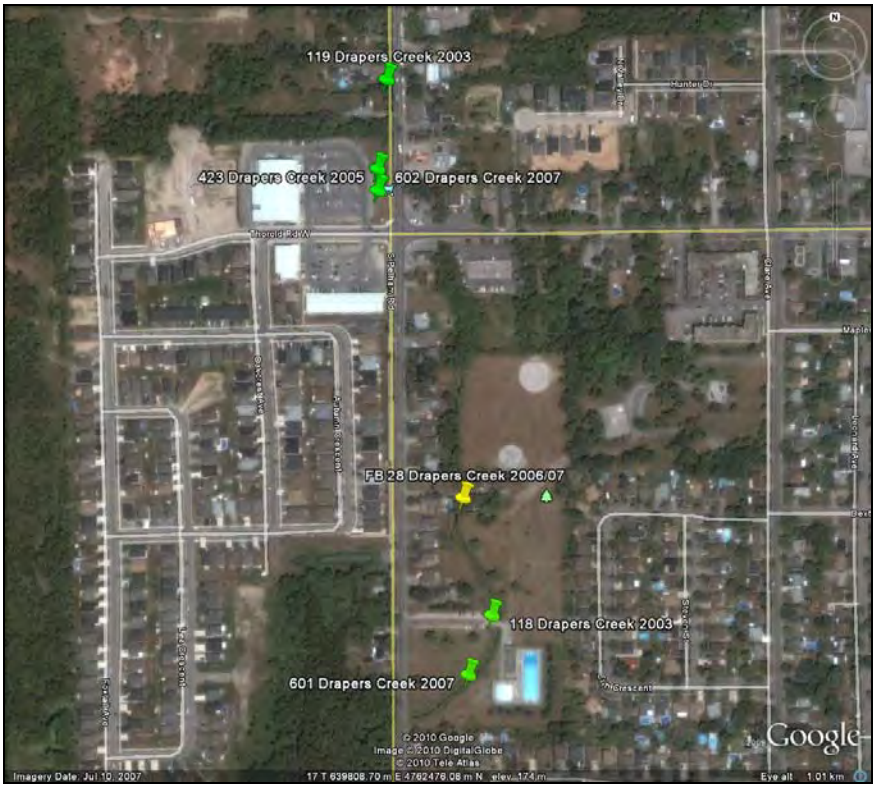

Figure 20: Fish sampling sites around FB#28

Looking at differences in fisheries populations from 2003, 2005, and 2007, upstream of the remediated barrier, it appears that sampled population sizes have increased for some species and species diversity has also increased after 2003. Unfortunately, these sample sites are relatively far from the barrier location therefore contributing any impacts to the fish populations from the barrier remediation is difficult.

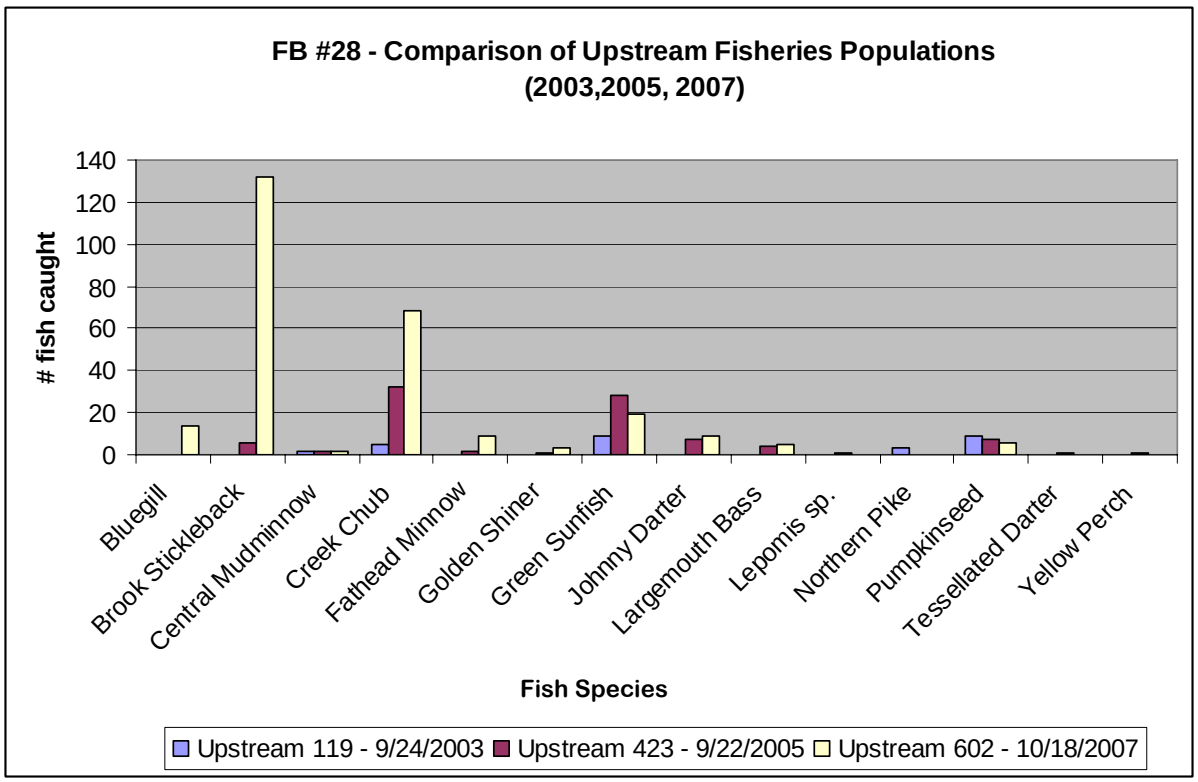

Figure 21: Comparison of 2003, 2005, and 2007 fish populations upstream of FB#28
*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

In a comparison of sampled fish populations at relatively distant locations upstream and down stream of the remediated barrier, species diversity is slightly higher upstream (10 species) with only 8 species downstream. Sample population sizes also remain significantly higher upstream. This lower species diversity and smaller sample population sizes downstream may be a result of a large stretch of stream crossing through Maple Park, which had no riparian vegetation many years. By 2007, the planted riparian buffer vegetation was only beginning to establish and contribute to improved habitat conditions.

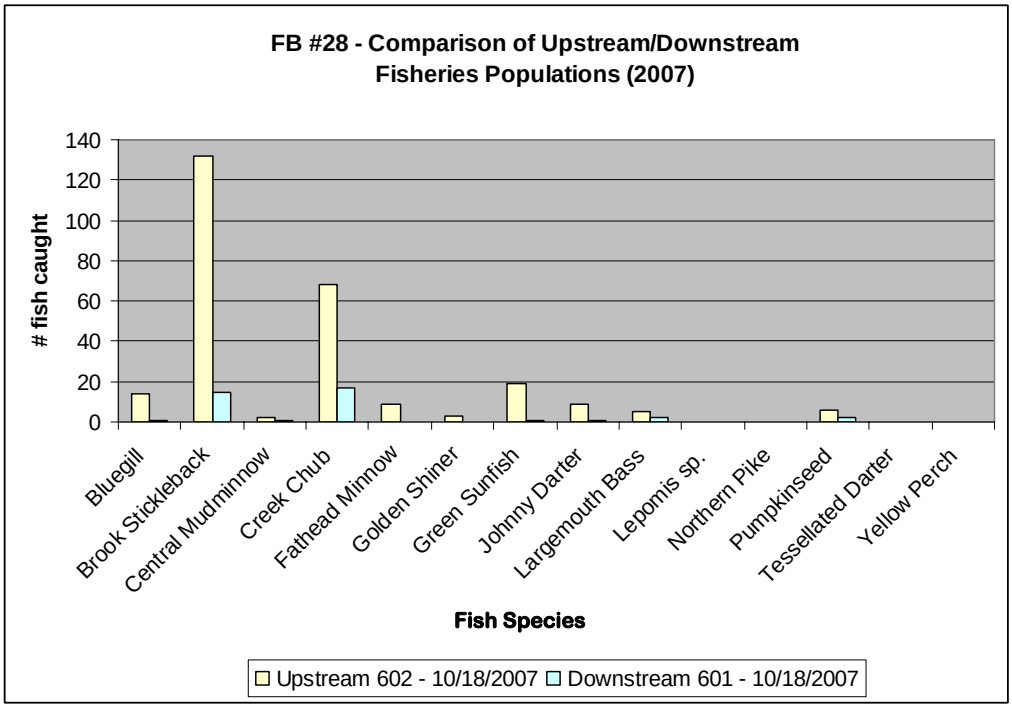

Figure 22: Comparison of 2007 fish populations upstream and downstream of FB#28
*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

The fisheries data collected upstream and downstream of the barrier location in 2003, before the barrier was remediated suggests that aquatic habitat was poor, resulting in low species diversity, and a large number of Pumpkinseed, generally an indication of poor water and habitat quality.

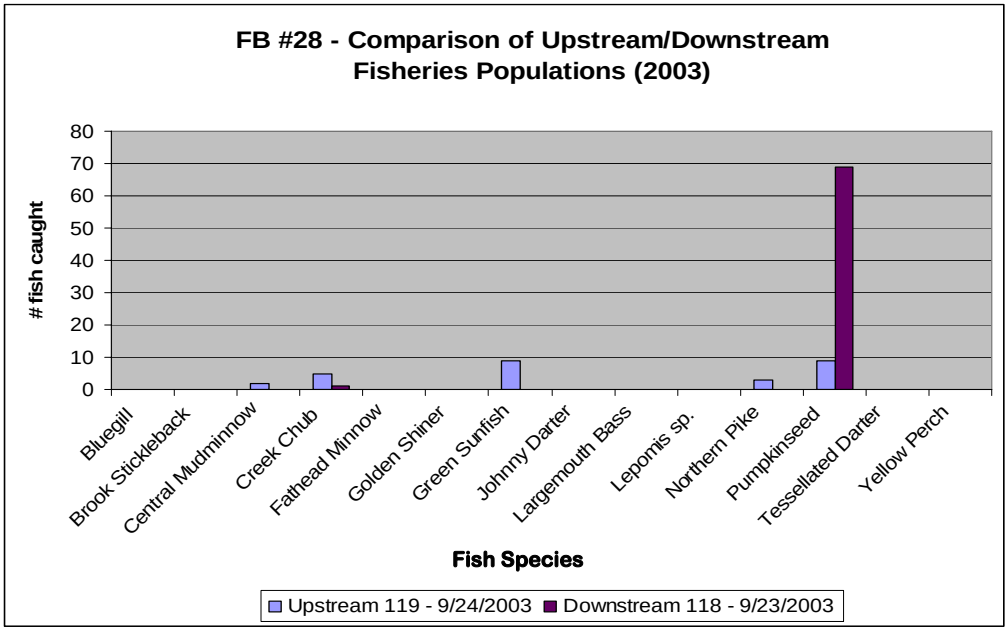

Figure 23: Comparison of 2003 fish populations upstream and downstream of FB#28
*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Maple Park Buffer Planting

In addition to removing barriers to fish migration, the NRC also planted several riparian buffers within municipal parks and golf courses around Niagara. One of the largest buffers planted by the NRC was in Maple Park, which contained a tributary of Drapers Creek. This was part of the Niagara Restoration Council's Building Stream Buffers Project funded by Environment Canada's Great Lakes Sustainability Fund.

Figure 24&25: Maple Park before and after buffer planting (2004/2009).

Comparing fisheries data collected within Maple Park in 2003 and 2005, species diversity has gone up significantly, from 2 species to 8. Also, there is significantly less Pumpkinseed, which suggest water quality has improved.

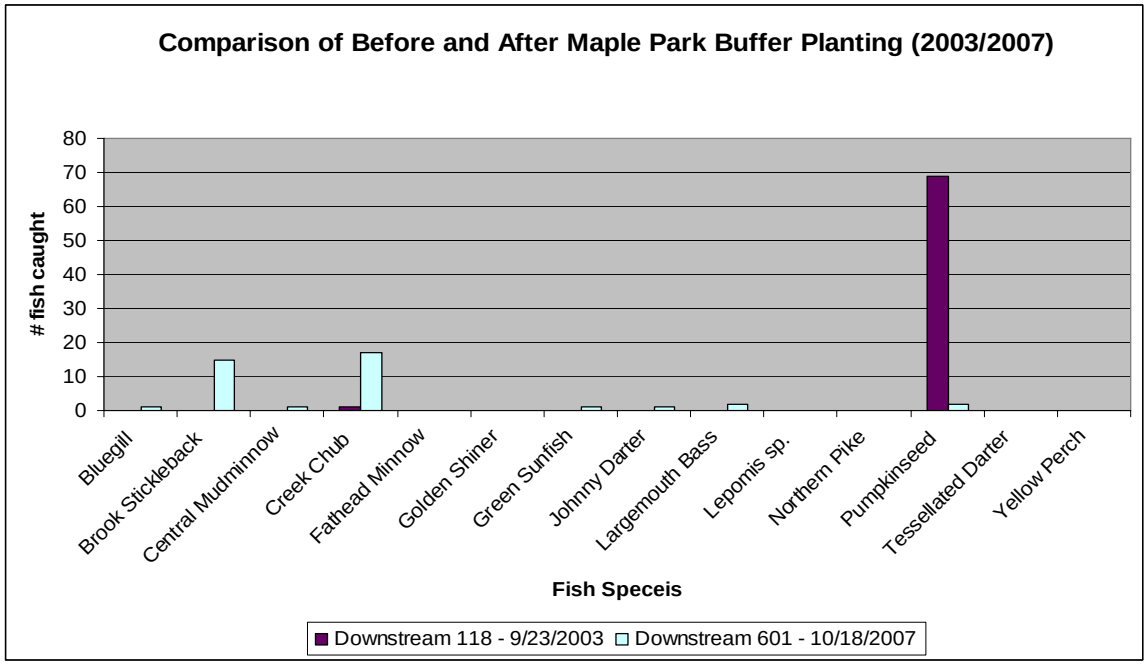

Figure 26: Comparison of 2003 and 2007 fish populations at Maple Park Buffer Planting Project site

*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Table 4: Fish Barrier 28 - Relevant Fisheries Data

Barrier ID: 28 Warankie
Sub watershed: Drapers Creek
Date Removed: 2006/07

		Code/Date				
Common Name	**Species**	Upstream 119 - 9/24/2003	Upstream 423 - 9/22/2005	Upstream 602 - 10/18/2007	Downstream 118 - 9/23/2003	Downstream 601 - 10/18/2007
Bluegill	*Lepomis macrochirus*	0	0	14	0	1
Brook Stickleback	*Culaea inconstans*	0	6	132	0	15
Central Mudminnow	*Umbra limi*	2	2	2	0	1
Creek Chub	*Semotilus atromaculatus*	5	32	68	1	17
Fathead Minnow	*Pimephales promelas*	0	2	9	0	0
Golden Shiner	*Notemigonus crysoleucas*	0	1	3	0	0
Green Sunfish	*Lepomis cyanellus*	9	28	19	0	1
Johnny Darter	*Etheostoma nigrum*	0	7	9	0	1
Largemouth Bass	*Micropterus salmoides*	0	4	5	0	2
Lepomis sp.	*Lepomis sp.*	0	1	0	0	0
Northern Pike	*Esox lucius*	3	0	0	0	0
Pumpkinseed	*Lepomis gibbosus*	9	7	6	69	2
Tessellated Darter	*Etheostoma olmstedi*	0	1	0	0	0
Yellow Perch	*Perca flavescens*	0	1	0	0	0
# individuals caught		28	92	267	70	40
# species caught		5	12	10	2	8

*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Fish Barrier # 34

This perched culvert on Drapers Creek prevented fish migration upstream. In a partnership with the NRC, NPCA, and the City of Welland, the culvert was replaced in 2005/06 with an open bottom concrete box culvert. Additionally, a Newbury riffle was installed with a low-flow channel, using river stone, creating fish 'pools' and essential fish habitat.

Figure 27&28: FB #34 Before and after remediation.

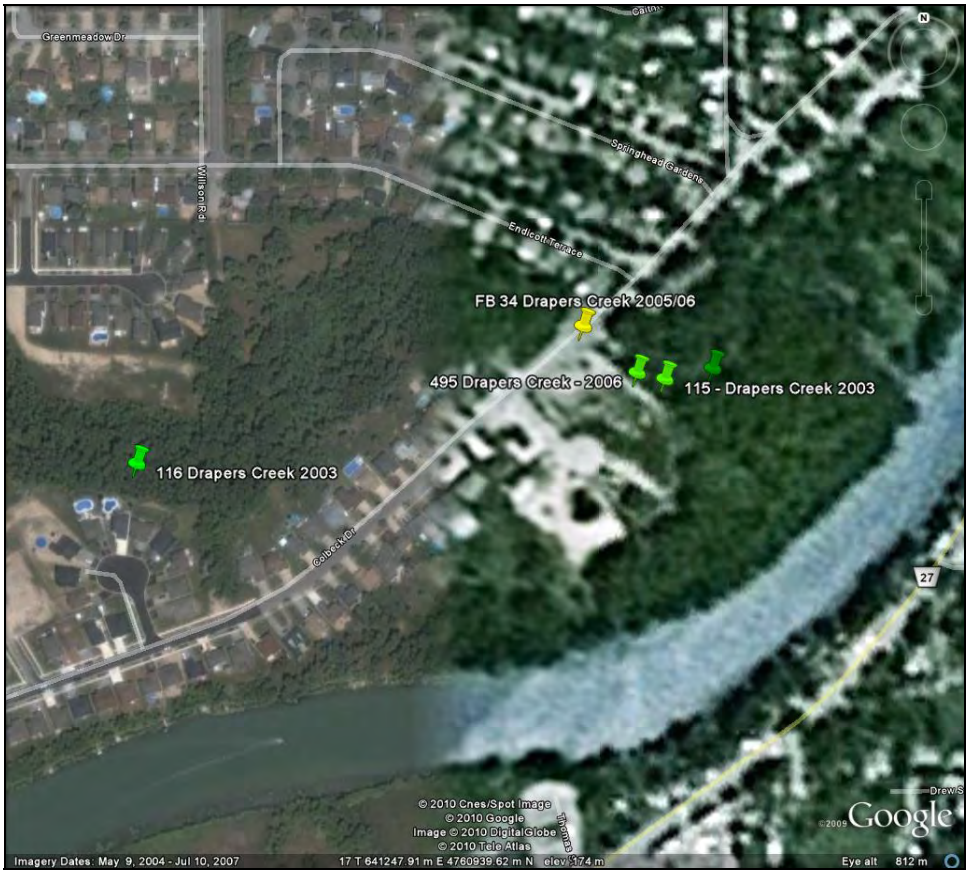

Figure 29: Fish sampling sites around FB#34

Upstream and downstream fisheries data collected in 2003 suggests that there was a significant difference in species composition before the barrier was remediated. Only 4 species were found upstream of the barrier opposed to 15 species found downstream, which would indicated that this perched culvert was preventing fish migration.

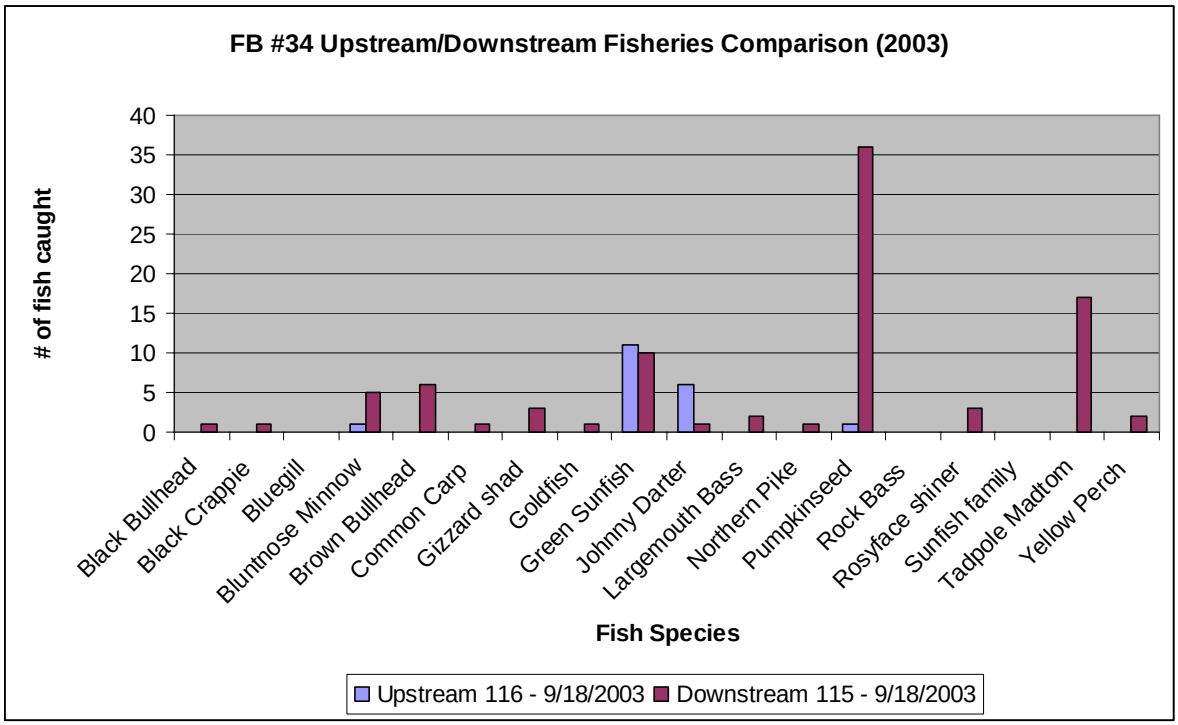

Figure 30: Comparison of 2003 fish populations upstream/downstream of FB#34
*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Since there has been no further data collected upstream, a comparison of upstream and downstream data after the barrier has been remediated could not be completed. However, looking at data collected downstream of the barrier collected in 2003 and 2007 raises concerns as species diversity has gone down while the sampled population sizes of generally poor water quality tolerant species has increased. The construction of a new subdivision in this area, adjacent to the creek, may have impacted water and habitat quality.

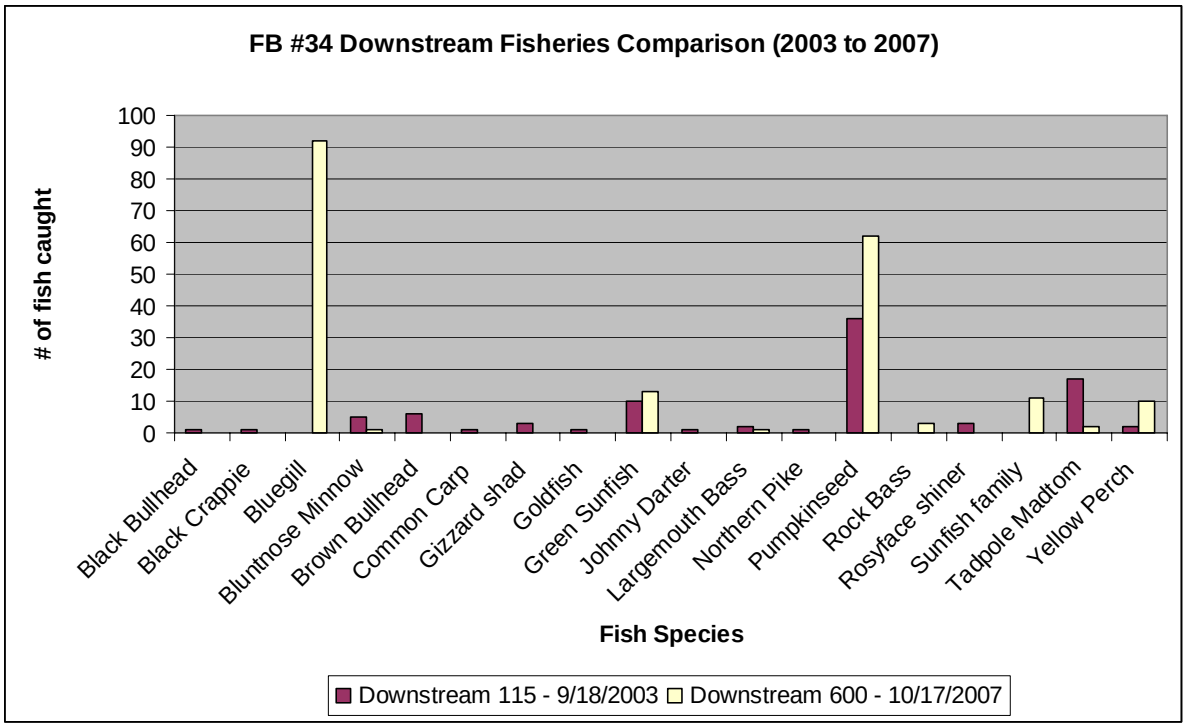

Figure 31: Comparison of 2003 and 2007 fish populations downstream of FB#34
*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Table 5: Fish Barrier 34 - Relevant Fisheries Data

Barrier ID: 34
Sub watershed: Drapers Creek
Date Removed: 2005/06

		Code/Date		
Common Name	**Species**	Upstream 116 - 9/18/2003	Downstream 115 - 9/18/2003	Downstream 600 - 10/17/2007
Black Bullhead	*Ameiurus melas*	0	1	0
Black Crappie	*Pomoxis nigromaculatus*	0	1	0
Bluegill	*Lepomis macrochirus*	0	0	92
Bluntnose Minnow	*Pimephales notatus*	1	5	1
Brown Bullhead	*Ameiurus nebulosus*	0	6	0
Common Carp	*Cyprinus carpio*	0	1	0
Gizzard shad	*Dorosoma cepedianum*	0	3	0
Goldfish	*Carassius auratus*	0	1	0
Green Sunfish	*Lepomis cyanellus*	11	10	13
Johnny Darter	*Etheostoma nigrum*	6	1	0
Largemouth Bass	*Micropterus salmoides*	0	2	1
Northern Pike	*Esox lucius*	0	1	0
Pumpkinseed	*Lepomis gibbosus*	1	36	62
Rock Bass	*Ambloplites rupestris*	0	0	3
Rosyface shiner	*Notropis rubellus*	0	3	0
Sunfish family	*CENTRARCHIDAE*	0	0	11
Tadpole Madtom	*Noturus gyrinus*	0	17	2
Yellow Perch	*Perca flavescens*	0	2	10
# individuals caught		19	90	195
# species caught		4	15	9

*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Fish Barrier # 109

This agricultural crossing in the West Main Welland River Watershed consisted of 3 severely perched and undersized culverts, which resulted in a barrier to fish migration and significant property flooding. In 2006/2007, these culverts were removed and replaced with an engineered concrete clear-span bridge. This design reduced property flooding while returning the streambed to its natural state, permitting unimpeded fish migration.

Figure 32&33: FB #109 Before and after remediation.

Figure 34: Fish sampling sites around FB#109

A comparison of the 2007 sampled fish population data upstream and downstream of the remediation barrier shows that species diversity is relatively similar, which would suggest fish are migrating past this remediated barrier. The sampled population sizes were higher downstream, due mainly to the high population of Bluntnose Minnow. This is likely due to better suitable habitat downstream as opposed to impacts of a fish barrier as this remediated barrier no longer influences fish migration or water flow in any way.

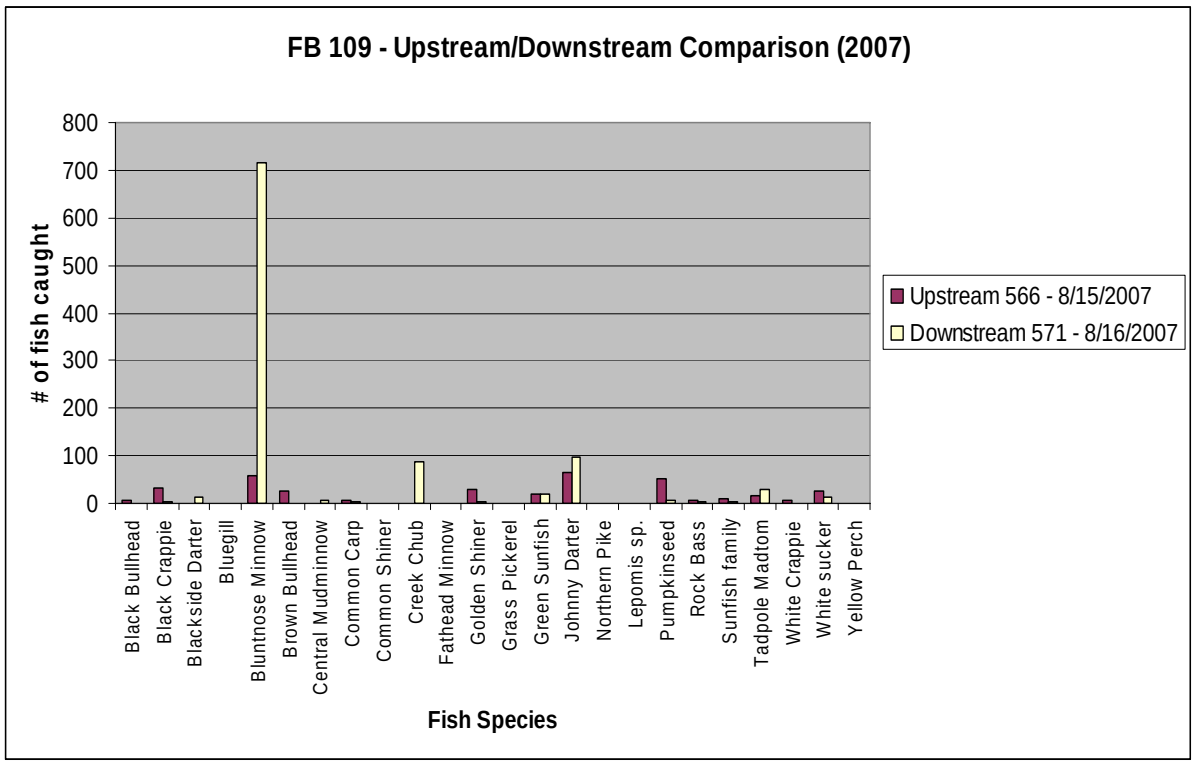

Figure 35: Comparison of 2007 fish populations upstream and downstream of FB#109

*Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Table 6: Fish Barrier 109 - Relevant Fisheries Data *Data provided by Anne Yagi – Ontario Ministry of Natural Resources

Barrier ID: 109
Sub watershed: West Main Welland River
Date Removed: 2006/07

		Code/Date			
Common Name	**Species**	Upstream 538 - 7/31/2007	Upstream 566 - 8/15/2007	Downstream 564 - 8/14/2007	Downstream 571 - 8/16/2007
Black Bullhead	*Ameiurus melas*	0	5	1	0
Black Crappie	*Pomoxis nigromaculatus*	1	33	6	2
Blackside Darter	*Percina maculata*	1	0	5	14
Bluegill	*Lepomis macrochirus*	0	1	0	0
Bluntnose Minnow	*Pimephales notatus*	130	58	307	717
Brown Bullhead	*Ameiurus nebulosus*	0	25	4	0
Central Mudminnow	*Umbra limi*	0	1	0	5
Common Carp	*Cyprinus carpio*	0	7	6	2
Common Shiner	*Luxilus cornutus*	0	0	0	1
Creek Chub	*Semotilus atromaculatus*	21	0	0	87
Fathead Minnow	*Pimephales promelas*	11	0	0	0
Golden Shiner	*Notemigonus crysoleucas*	3	30	0	2
Grass Pickerel	*Esox americanus vermiculatus*	0	0	1	1
Green Sunfish	*Lepomis cyanellus*	6	19	15	18
Johnny Darter	*Etheostoma nigrum*	168	64	36	97
Northern Pike	*Esox lucius*	0	1	1	1
Lepomis sp.	*Lepomis sp.*	1	0	0	0
Pumpkinseed	*Lepomis gibbosus*	14	52	10	5
Rock Bass	*Ambloplites rupestris*	4	6	5	4
Sunfish family	*CENTRARCHIDAE*	0	10	5	2
Tadpole Madtom	*Noturus gyrinus*	7	16	52	30
White Crappie	*Pomoxis annularis*	0	5	1	0
White sucker	*Catostomus commersoni*	3	25	14	13
Yellow Perch	*Perca flavescens*	0	1	0	1
# individuals caught		370	359	469	1002
# species caught		13	17	16	18

Conclusions:

While many factors influence fish species diversity and population, it appears that barriers that were remediated generally contributed to improved fish movement and stabilized species diversity. In the case of Fish Barrier #34, the data suggested that fish migration was not occurring, resulting in low species diversity upstream of the barrier. While current data is not available for comparison, it would be expected to show a significant improvement in fish populations upstream of the barrier. Overall, using the data that was available, it appears that the remediation techniques have been suitable and the project was a success.

In order to accurately determine the success of the project and each individual remediation site, further studies will be required, such as the fish telemetry study completed at Fish Barriers #3 and #4, which proved that northern pike were successfully migrating past these remediated barriers (Bunt, 2003). There are significant data gaps, especially in relation to barrier remediation sites. In most cases, data from year to year was not available, making any comparisons in fish populations impossible. As a result, there was only enough relevant data to make any comparisons for 6 of the 169 remediated barriers. Further fish sampling should be carried out, with a focus on sampling the same sites from year to year.

While fish sampling through electro-fishing, seine netting, and minnow traps, provides good information on relative species diversity and populations for a given area, from which various assumptions can be made, it can not accurately determine whether fish are migrating through a remediated barrier. While relatively more expensive, radio telemetry and GPS tracking can monitor specific individuals to determine fish movement through remediated barriers. This technique was proven through the study done at the Canborough Weir with Northern Pike, which showed tagged individuals migrating upstream through the by-pass channel.

References:

Bunt, Dr. Christopher. 2003. Northern Pike Passage, Critical Habitat and Effects of Barriers on Movement in the Welland River West and Oswego Creek. Biotactic Inc. 79 pp.

Yagi, Anne. 2008. Niagara Area Fisheries Data 1997-2007. Microsoft Access File. Ontario Ministry of Natural Resources – Vineland, Ontario.