An inventory of barriers to fish migration on tributaries to the Bay of Quinte

Bay of Quinte Remedial Action Plan

May 2006
Acknowledgements

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1.0 Introduction

Under the Great Lakes Water Quality Agreement, the governments of Canada and the United States identified the Bay of Quinte as one of 43 Great Lakes Areas of Concern (AOC) in 1985. One of the Impaired Beneficial Uses (IBUs) identified was the loss of fish and wildlife habitat. Loss of coastal wetland, nearshore habitat and aquatic vegetation were cited as major factors in this determination, however, the loss of habitat by damming rivers has also been identified as an issue for the Bay of Quinte.

Major tributaries to the Bay of Quinte, including the Trent, Moira and Salmon Rivers have barriers to fish migration within the first 3 km of the Bay of Quinte. This has resulted in a significant loss and alteration of important fish habitat. Numerous species native to the Bay of Quinte utilize tributaries and floodplain habitat for spawning and nursery habitat, including: walleye, northern pike, muskellunge, Atlantic salmon, lake sturgeon, suckers and numerous forage fish species.

1.1 Purpose and scope

The purpose of this preliminary study is to summarize the available information on barriers to fish migration within the Bay of Quinte AOC. This information will help the Bay of Quinte Remedial Action Plan (RAP) in its efforts to restore the loss of fish habitat (IBU 14) by providing information on the nature and scope of the problem. Field investigations were not within the scope of this study, however, the information compiled in this report would provide a starting point for future investigations.

This report does not attempt to prioritize sites for restoration or advocate that barrier mitigation projects should be carried out before other management techniques. Rather, it provides information for weighing management options in the overall RAP context.

1.2 Study area

The study areas includes all tributaries which enter the Bay of Quinte, from the Murray Canal in the western end of the bay, eastward past Trenton, Belleville and Picton to the eastern end of the Bay at Amherst Island.

Given the enormous size of the Bay of Quinte AOC watershed (nearly 18,000 km²), the focus of this study will be on the first few barriers that exist on each watercourse flowing into the Bay.

1.3 Types of migratory barriers

Barriers to fish migration may be naturally occurring or 'man-made'. Types of artificial barriers include: hydro-electric generating stations, flood control structures, dams and locks for navigation, sea lamprey barriers, historical 'mill
pond' dams, perched road culverts, velocity barriers (e.g., inappropriately sized culverts that create flows too strong to allow passage), structures which create shallow depths (e.g., poorly designed road culverts), private dams to create ‘on-line’ ponds for recreation/water supply and dams built to retain water and create wetland habitat. Natural barriers to fish migration include beaver dams, logjams or waterfalls.

1.4 Impacts of migratory barriers
Barriers to fish migration come in numerous forms, and depending on their physical characteristics, operation and location, differ in their effects on the ecosystem. Barriers may have a negative effect on riverine systems, including the loss of usable spawning, nursery and feeding habitat, disruption of flow regimes required for spawning, incubation and hatching and disruption of sediment transport.

Although barriers may disrupt fish habitat and ecosystem functions, they may also serve a variety of beneficial functions. Some of the potential benefits of dams include flood protection, water storage and supply, exclusion of exotic species from sensitive habitats or populations and creation of wetland habitat.

1.5 Options for barrier management
Depending on the design and function of the barrier, local geography, target fish community and fish community management objectives, there are a number of potential options for managing barriers. Some of these options include: leave barrier in place, remove barrier entirely, modify the barrier structure, construction of fishways (e.g., denil fishways) or creation of a by-pass channel around the barrier. Barrier management needs to be evaluated on a site-by-site basis, taking into account technical considerations, fish and wildlife management objectives, and local community desires.
2.0 Data sources

2.1 Agencies contacted

Applicable resource management agencies were contacted to collect all available information on barriers to fish migration in the Bay of Quinte study area. Agency contacts and available information are summarized below.

Ontario Ministry of Natural Resources

- 2003 Status of In-Stream Barrier Information in the Lake Ontario Watershed, Canada-Ontario Agreement (COA) Project LO9-Watershed Planning/Watershed Health
  - A useful general resource on information sources for in-stream barriers.

- Peterborough District Ministry of Natural Resources
  - Water_structures.shp: This shapefile identifies locations of the following features:
    - Dam
    - Dam and Lock
    - Lock
    - Other Potential
  Although there is some attribute data associated with this shapefile there is no corresponding documentation or metadata to support the accuracy or precision of the data. MNR staff is aware of this issue and are currently looking into this matter.

  - Private_dams_2002.shp: This shapefile provides the locations of private dams within the Peterborough District from the 2002 Private Dams Inventory: Pilot Project by the Peterborough District MNR. This data set includes the following features:
    - By-pass Ponds
    - In-Stream Ponds
    - Earth Dams
    - Concrete Dams
    - Timber Crib Structures
    - Weir Structures
  This data set contained a rather extensive attribute table; however no documentation or metadata was associated with the supplied data. MNR staff did supply a Power Point Presentation associated with the project. From this we can verify that the data was prepared using the 1971 Private Dams Inventory, OBM Mapping and data from Lakes and Rivers Improvement Act files. From this presentation we can also confirm that the data has been spatially
referenced to a lot / concession scale using aerial photos and satellite imagery.

- **MNR_Dams.shp**: This shapefile may identify locations of MNR owned dams; however no metadata or documentation has been supplied to confirm this. This shapefile contains attribute data regarding the dam name, the MNR District it resides within and watercourse name it resides on, but there is no reference as to the date it was collected or the accuracy at which it was mapped. The Peterborough District MNR office is certain that this is a provincial data set for which documentation does exist and they are currently looking into collecting some metadata on this file.

- **Non_MNR_Dams.shp**: Although no metadata or documentation can be found for this data set each point represented in this shape file falls directly in the exact same location as a point from the NRVIS Water Structure layer GUT Number 1061: Dam. This GUT corresponds to the Ontario Base Map feature of the same name. Dams form part of the delineation of the body of water, superseding the shoreline feature. For more information, see Digital Topographic Data Base Overview Version 2 OMNR Provincial Mapping Office, 1994.

- **CA_Dams.shp**: Although there is some attribute data associated with this shapefile there is no corresponding documentation or metadata to support the accuracy or precision of the data. MNR staff is aware of this issue and are currently looking into this matter. An updated version of the Water and Erosion Control Infrastructure Database may be used to confirm if these are CA dams.

- **Land Information Ontario (LIO): NRVIS Water Structure shapefile**
  - This data refers to Structures (usually man-made) inside a water body. The data obtained from LIO contained the following GUT codes:
    - **Data Type Name**: Dam  **GUT Number**: 1061
      
      This GUT corresponds to the Ontario Base Map feature of the same name. Dams form part of the delineation of the body of water, superseding the shoreline feature. For more information, see Digital Topographic Data Base Overview Version 2 OMNR Provincial Mapping Office, 1994.
    
    - **Data Type Name**: Lock-gate  **GUT Number**: 1715
      
      Lock-gate
Quinte Conservation
• Water and Erosion Control Infrastructure Database (WECI) (2004): This rather extensive access database is a joint MNR / Conservation Ontario undertaking. The database contains information regarding all of the Conservation Authority controlled water structures in the province, however, each Conservation Authority is responsible for maintaining their own water structure data therefore accuracy and completeness varies from CA to CA. Structure locations were provided in Lat/Long.

• Qc_Dams.shp: This layer identifies water structures within the Quinte Conservation boundary. There was no documentation or metadata associated with this shape file.

• Private_dams.shp: There was no documentation or metadata associated with this shape file.

Cataraqui Region Conservation Authority
A .pdf map identifying all water control structures in the Cataraqui Region was provided by the Cataraqui Region Conservation Authority (also available on their website). No structures were identified within the AOC. See Appendix A

Department of Fisheries and Oceans’ Sea Lamprey website:
The Department of Fisheries and Oceans’ Sea Lamprey website identifies where sea lamprey barriers are operated to restrict access to spawning tributaries. Only 1 tributary in the study area (Salmon River) has a sea lamprey barrier. Other tributaries in the study area are treated periodically with lampricide. [http://www.glfc.org/sealamp/where.php](http://www.glfc.org/sealamp/where.php)

Ducks Unlimited Canada:
Ducks Unlimited Canada provided information on projects within the RAP area where water control structures have been constructed to create or enhance wetland habitat. For the most part, these structures are typically located well upstream from the Bay of Quinte and do not significantly affect fish migration.

Bay of Quinte RAP:
In once case (Dead Creek) the Bay of Quinte RAP had information on a barrier at Dead Creek (a failing culvert). This information was included as anecdotal information but is not captured in any of the existing GIS layers.
3.0 Results

3.1 Tributary information
A total of 258 tributaries were identified as flowing into the Bay of Quinte, within the survey area. Tributaries were summarized according to 'stream order', at their point of intersection with the Bay of Quinte (Table 1).

Table 1. Summary of tributary information for the Bay of Quinte.

<table>
<thead>
<tr>
<th>Stream Order</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td># of tributaries</td>
<td>142</td>
<td>75</td>
<td>29</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>258</td>
</tr>
</tbody>
</table>

*stream order provided is based on Strahler classification model

3.2 Barrier layers
Each of the following barrier layers has been mapped, see Appendix A:

Figure 1: Fish migration barriers on tributaries to the Bay of Quinte and surrounding areas – Peterborough District MNR Water Structures

Figure 2: Fish migration barriers on tributaries to the Bay of Quinte and surrounding areas – Peterborough District MNR Private Dams 2002

Figure 3: Fish migration barriers on tributaries to the Bay of Quinte and surrounding areas – Peterborough District MNR Dams & Peterborough District Non-MNR Dams

Figure 4: Fish migration barriers on tributaries to the Bay of Quinte and surrounding areas – Peterborough District MNR CA Dams

Figure 5: Fish migration barriers on tributaries to the Bay of Quinte and surrounding areas – Quinte Conservation Dams, Quinte Conservation Private Dams and WECI 2004 data

Figures 6a through 6h – LIO Water Structures, Block A

3.2 Migratory barrier database
Table 2 summarizes the available information for the first known barrier on tributaries entering the Bay of Quinte. Due to data limitations the information provided in Table 2 should be considered preliminary until verified through further study. Upon further study, updated information should be entered into the database template included in Appendix B.
<table>
<thead>
<tr>
<th>Table 2. Preliminary migratory barrier database for tributaries entering the Bay of Quinte.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>---------</td>
</tr>
</tbody>
</table>
| Trent River Dam & Lock¹ | 3.0 | -- | Yes | 1.2 | - Trenton Dam and Lock #1  
- Next upstream barrier is Sydney Dam & Lock #2 |
| Moira River Dam² | 1.8 | -- | Yes | 1.2 | - Lott Dam in Belleville  
- Series of dams and ice control structures immediately upstream of Lott Dam |
| Salmon River Concrete dam, overflow² | 3.0 | -- | Yes | 2.1 | - Shannonville Dam  
- Operated for sea lamprey control  
- Next upstream barrier is the Milltown Dam (stop log gate – built in 1992) |
| Napanee River Dam¹ | 7.0 | -- | Yes | 10.0 | - Identified as “other potential” in Water Structures layer, however, this is known to be an existing dam |
| Dead Creek Perched culvert³ | 0.3 | -- | Extent unknown | -- | - Not identified on any barrier layer  
- Known to the BQ Rap through previous work  
- Preventing access to Dead Creek Marsh  
- Passage may be possible under high flows |
<p>| Meyers Creek Earth dam² | 3.9 | -- | Extent unknown | -- | |
| Potter Creek Dam, overflow and flowthrough² | 10.0 | 2.2 | Extent unknown | -- | - Ducks Unlimited project on tributary to Potter Cr. |
| Bell Creek Check dam² | 0.5 | 0.6 | Extent unknown | -- | |</p>
<table>
<thead>
<tr>
<th>Type</th>
<th>Approximate distance from Bay (km)</th>
<th>Height (m)</th>
<th>Barrier to fish passage</th>
<th>Distance to next barrier upstream (km)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blessington Creek</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>No barriers found in databases</td>
</tr>
<tr>
<td>Sawguin Creek</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>-2 duck habitat creation projects, over 15km upstream of the Bay of Quinte.</td>
</tr>
</tbody>
</table>
| Marysville Creek (Mud)    | Dam, removable wooden boards<1.0   | --         | Yes                     | See comments                           | -Ducks Unlimited habitat project  
-additional Ducks Unlimited projects > 10km upstream from site            |
| Selby (Sucker) Creek      | --                                | --         | --                      | --                                     | No barriers found in databases                                          |
| Little Creek              | --                                | --         | --                      | --                                     | -No barriers identified within first 10km upstream from the Bay of Quinte  
-There are 2 Ducks Unlimited projects located > 10km upstream from the Bay |
| Wilton (Big) Creek        | --                                | --         | --                      | --                                     | -No barriers identified within first 10km upstream from the Bay  
-A weir at the Wilton bridge and Ducks Unlimited project exist, over 20km upstream from the Bay of Quinte |
| Loyst Creek               | --                                | --         | --                      | --                                     | No barriers found in databases                                          |
| Townline Creek            | --                                | --         | --                      | --                                     | No barriers found in databases                                          |
| Platts Creek²<4           | Dam, overflow and flowthrough     | 1.3        | Extent unknown          | --                                     | -Ducks Unlimited Garrison Project  
-less than 1km upstream habitat (using MNR water layer)                    |
<p>| Fish Lake Creek           | Concrete                          | 5          | Yes                     | --                                     | -Dam owned by Conservation Authority and operated to maintain water levels in Fish Lake |</p>
<table>
<thead>
<tr>
<th>Type</th>
<th>Approximate distance from Bay (km)</th>
<th>Height (m)</th>
<th>Barrier to fish passage</th>
<th>Distance to next barrier upstream (km)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed Creek #1</td>
<td>Rock, flowthrough(^2)</td>
<td>0.2</td>
<td>3</td>
<td>Extent unknown</td>
<td>- small unnamed creek immediately to west of Salmon River</td>
</tr>
</tbody>
</table>
| Unnamed Creek #2            | Dam, earthen\(^2\)                 | 1.2        | 0.9                     | Extent unknown                         | - Ducks Unlimited project at Lennox and Addington generating station  
- potentially restricting access to 2-3km upstream habitat, but would require site visit to assess |
| Unnamed Creek #3            | Rock, gravel\(^2\)                 | 0.3        | --                      | Extent unknown                         | - small tributary immediately to west of Potter Creek  
- approximately 600m upstream habitat (based on MNR water layer)                                                                         |
| Wemps Bay                   | Overflow and flowthrough\(^2\)     | 1.3        | 0.9                     | Extent unknown                         | - Ducks Unlimited project on north shore of Amherst Island  
- less than 1km of upstream habitat (using MNR water layer)                                                                                 |

\(^1\) MNR water structures layer  
\(^2\) Peterborough private dams layer  
\(^3\) BQRAP data  
\(^4\) Data provided from Ducks Unlimited
4.0 Study limitations

Although there is an abundance of spatial data associated with fish barriers, compiling this information into a central database at this time would be premature and likely to contain considerable errors. Due to the lack of supporting documentation and metadata regarding the accuracy, precision, collection methods and date of the datasets provided no definite decisions could be made with regards to accurately locating and identifying fish barriers. Furthermore it was not possible to generate new layers because of insufficient data (i.e. metadata) and our unfamiliarity with each dataset (i.e. date collected, accuracy, precision, collection methods).

Further compounding this problem was a lack of up-to-date aerial photos and satellite imagery in the AOC which made it impractical to complete desktop verification. Field verification would benefit this process, but was not part of this study. Therefore, this data should only be used as a general guide for site locations and before proceeding with any analysis, site by site field verification and detailed documentation exercises should be completed.

5.0 Recommendations

There are a number of improvements that can be made to increase the functionality of this resource. A description of the recommended process for improving this resource is provided below.

**Step 1. Update information with new 2006 LIO Water Structures layer (Proposed Spring 2006)**

The Ministry of Natural Resources is currently undertaking a GIS project to improve its existing information on water structures. Based on discussions with MNR staff, this process will take all *existing* water structure information and consolidate these information sources into one layer, with standardized attribute information.

This information will be available from Land Information Ontario as part of the Ontario Geospatial Data Exchange and will replace the existing water structure layer.

**Step 2. Interpretation of aerial photos**

The MNR dam layer identified in Step 1 can be used as the basis for well-known structures and structures identified through their review process for the Lakes and Rivers Improvement Act. However, these layers are likely to miss smaller barriers, perched culverts, beaver dams, etc, and this is a limitation for the purposes of identifying rehabilitation projects.
Aerial photos can be interpreted to identify potential barrier sites by looking for areas with impounded water or road crossings. Aerial photos (1980s data) exist for the entire Bay of Quinte area and could be analyzed for barriers information. Alternatively, interpretation of aerial photos could wait until satellite imagery is updated, potentially within the next few years (i.e. Quick Bird).

The Niagara River Restoration Council undertook an inventory of migratory barriers, utilizing orthographic image inspection and identified 208 sites where fish passage was impeded. Common barrier types included: perched/infilled culverts (20%), dams/weirs/spillways (21%), stream bed altered (17%), logjams (13%), in-stream debris affecting flows (9%) and low level crossings (9%). This information shows that there are a variety of barriers to fish migration on the landscape and detailed orthographic image inspection will likely be required to identify sites not identified using existing data layers.

**Step 3. Consultation with MNR, DFO and CA staff**

Consultation with experienced, local MNR, DFO or CA staff who deal with project reviews under the *Fisheries Act, Lakes and Rivers Improvement Act* or CA regulations should also be conducted to identify additional sites. Field staff may know from personal experience where barriers exist, such as perched culverts.

**Step 4. Field verification**

Once potential barriers have been identified, field verification should be completed to determine whether the barrier still exists and details on the structure (type, height, ownership, purpose, etc) collected. Photographs should be taken of all barriers (from above and below the barrier) to characterize the site.

**Step 5. Database updating**

Once field verification is completed, all data and metadata should be compiled into a central database. Appendix B provides a template for data entry that would capture the necessary information to evaluate the impact and nature of the barrier.

**6.0 Summary**

This report has summarized existing data sources for fish migration barriers within the Bay of Quinte AOC. Utilizing the existing information, maps have been generated that show the known extent of barriers to fish migration.

A series of recommendations have been provided that outline the process for further study of migratory barriers. The evolution of this project would allow habitat managers to further assess the extent and impact of barriers to fish migration in the Bay of Quinte AOC, and potentially identify sites for remediation.
For the Bay of Quinte RAP, this could assist efforts to improve fish habitat, in pursuit of restoring IBU 14: loss of fish habitat. However, it must be stressed that potential barrier mitigation or removal projects would need to be reviewed by all applicable resource management agencies, on a case-by-case basis, where benefits are weighed against costs.
Appendix A: Fish migration barrier maps

Figure 1: Fish migration barriers on tributaries to the Bay of Quinte and surrounding areas – Peterborough District MNR Water Structures

Figure 2: Fish migration barriers on tributaries to the Bay of Quinte and surrounding areas – Peterborough District MNR Private Dams 2002

Figure 3: Fish migration barriers on tributaries to the Bay of Quinte and surrounding areas – Peterborough District MNR Dams & Peterborough District Non-MNR Dams

Figure 4: Fish migration barriers on tributaries to the Bay of Quinte and surrounding areas – Peterborough District MNR CA Dams

Figure 5: Fish migration barriers on tributaries to the Bay of Quinte and surrounding areas – Quinte Conservation Dams, Quinte Conservation Private Dams and WECI 2004 data

Figure 6a – LIO Water Structures, Block A
Figure 6b – LIO Water Structures, Block B
Figure 6c – LIO Water Structures, Block C
Figure 6d – LIO Water Structures, Block D
Figure 6e – LIO Water Structures, Block E
Figure 6f – LIO Water Structures, Block F
Figure 6g – LIO Water Structures, Block G
Figure 6h – LIO Water Structures, Block H
Figure 1. Fish Migration Barriers on Tributaries to the Bay of Quinte and Surrounding Area
Figure 2. Fish Migration Barriers on Tributaries to the Bay of Quinte and Surrounding Area
Figure 3. Fish Migration Barriers on Tributaries to the Bay of Quinte and Surrounding Area
Figure 4. Fish Migration Barriers on Tributaries to the Bay of Quinte and Surrounding Area
Figure 5. Fish Migration Barriers on Tributaries to the Bay of Quinte and Surrounding Area
Figure 6b. LIO Water Structures - Block B

Key Map

Legend
LIO Water Structures
- GUT: 1091
- GUT: 1715

Waterbody
Watercourses

Produced by Lower Trent Conservation with Data Supplied under Licence by Members of the Ontario Geospatial Data Exchange.

LOWER TRENT CONSERVATION
Figure 6c. LIO Water Structures - Block C
Figure 6d. LIO Water Structures - Block D
Figure 6e. LIO Water Structures - Block E

Key Map

Legend
LIO Water Structures
- LUT: 1061
- LUT: 1715
- Waterbody
- Watercourses

Produced by Lower Trent Conservation with Data Supplied under Licence by Members of the Ontario Geospatial Data Exchange.
Figure 6f. LIO Water Structures - Block F

Key Map

Legend
LIO Water Structures
- GUT: 1061
- GUT: 1715
Waterbody
Watercourses

Produced by Lower Trent Conservation with Data Supplied under Licence by Members of the Ontario Geospatial Data Exchange.
Figure 6g. LIO Water Structures - Block G
Figure 6h. LIO Water Structures - Block H

Key Map

Legend

- LIO Water Structures
- GUT: 1001
- GUT: 1715
- Waterbody
- Watercourses

Produced by Lower Trent Conservation with Data Supplied under Licence by Members of the Ontario Geospatial Data Exchange.
<table>
<thead>
<tr>
<th>Watercourse name</th>
<th>Watershed name</th>
<th>ID number</th>
<th>Type</th>
<th>Ownership</th>
<th>Easting</th>
<th>Northing</th>
<th>Height (m)</th>
<th>Width (m)</th>
<th>Distance to the Bay of Quinte (km)</th>
<th>Distance to next barrier upstream (km)</th>
<th>Degree of blockage (full/partial/requires field verification)</th>
<th>Used for flood protection (y/n)</th>
<th>Site photos available (y/n)</th>
<th>Comments</th>
</tr>
</thead>
</table>