Drainage basin size as a predictor of fish species richness in the Otsego Lake Watershed

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Abstract: This study was conducted to determine if fish faunal richness can be predicted from the size of the drainage basin of individual tributary streams in the Otsego Lake watershed. Previous electro-fishing surveys conducted since 1989, plus two surveys conducted in this study were downloaded into a Geographic Information Systems Data Base and analyzed. The number of species present in each tributary stream was strongly correlated to the drainage area of that stream. However, anthropomorphic factors, such as road crossings and channelization also impacted species richness.

INTRODUCTION

Within the same watershed, stream order, stream size, stream length, discharge and drainage basin are highly correlated (Harrel et al. 1967, Platts 1979). In previous studies, these various watershed measures have been correlated with the number of fish species present, i.e. species richness (Eadie et al. 1986, Hugueny 1989, Barila et al. 1981).

The Otsego Lake watershed encompasses an area of 18,811 ha. (Harman et al. 1997). The tributary streams in the Otsego Lake watershed have been individually surveyed by numerous authors (Hayes 1989, 1990, Bassista & Foster 1995, Reynolds et al. 2010, Miner 1997, Foster 1996, Jamieson et al. 2004). Unfortunately, the data from these surveys are not available in a comprehensive database that would allow for comparisons across studies and watersheds.

The goal of this study was two-fold; the first was to develop a Geographic Information Systems (GIS) database that would allow the examination of fish fauna data collected since 1989 by the SUNY Oneonta Biological Field Station and SUNY Cobleskill. In order to meet this goal, the location of each species collected in the Otsego Lake watershed was plotted on a map using SUNY Cobleskill’s Geographic Information Systems (GIS) database. Streams that had not been surveyed (Glimmerglen and Mount Wellington) were surveyed as part of this report. The second objective of this study was to utilize the newly created database to determine the correlation between fish species richness and the size of the drainage basins of the Otsego Lake tributary streams.

MATERIALS & METHODS

The Otsego Lake watershed is located in the Towns of Otsego, Springfield and Middlefield in Otsego County, New York, with the northern most part of the watershed in

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Herkimer County. Elevation of the mouths of tributary streams in Otsego Lake is 1190 feet above sea level, and the upper regions of the watershed reach as high as 1900 feet in elevation. The data utilized for this study were limited to the permanent streams named in Figure 1 and Table1. Ephemeral streams were not included in this study.

Figure 1. Otsego Lake’s watershed tributary streams. Named streams were studied in this report.

Data utilized in this study were collected from 1989 – 2012 (Table 1). Data reported were from single surveys and did not represent the accumulation of species found in a given watershed through multiple surveys. In most cases survey information has been published in the Annual Reports of the SUNY Oneonta Biological Field Station, although the studies by Cornwell and Lewis represent new surveys conducted for this paper. Surveys were conducted primarily with backpack electro-shockers, although occasionally seines were also used. A minimum of 1,000 seconds of electrofishing was used for each survey.
Table 1. Otsego Lake tributary stream drainage basin, species richness, sample year and information source.

<table>
<thead>
<tr>
<th>Stream</th>
<th>Watershed Acres</th>
<th>Number of Species</th>
<th>Sample Year</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shadow Brook</td>
<td>11,660.2</td>
<td>28</td>
<td>1994</td>
<td>Bassista &amp; Foster 1995</td>
</tr>
<tr>
<td>Shadow Brook</td>
<td>11,660.2</td>
<td>24</td>
<td>2010</td>
<td>Reynolds et al.2011</td>
</tr>
<tr>
<td>Cripple Creek</td>
<td>10,179.8</td>
<td>17</td>
<td>1996</td>
<td>Miner 1997</td>
</tr>
<tr>
<td>Hayden Creek</td>
<td>7,822.2</td>
<td>17</td>
<td>1996</td>
<td>Foster 1996</td>
</tr>
<tr>
<td>White Cr./Trout Brook</td>
<td>3,241.6</td>
<td>16</td>
<td>1996</td>
<td>Foster 1996</td>
</tr>
<tr>
<td>Leatherstocking Creek</td>
<td>2,073.3</td>
<td>13</td>
<td>1990</td>
<td>Hayes 1990</td>
</tr>
<tr>
<td>Mt. Wellington Stream</td>
<td>1,899.1</td>
<td>2</td>
<td>2012</td>
<td>Cornwell, pers. com.</td>
</tr>
<tr>
<td>Brookwood Creek</td>
<td>1,568.0</td>
<td>7</td>
<td>1989</td>
<td>Hayes 1989</td>
</tr>
<tr>
<td>Mohican Creek</td>
<td>1,112.4</td>
<td>8</td>
<td>1989</td>
<td>Hayes 1989</td>
</tr>
<tr>
<td>Glimmerglen Creek</td>
<td>1,039.5</td>
<td>2</td>
<td>2010</td>
<td>Lewis in prep.</td>
</tr>
<tr>
<td>Willow Brook</td>
<td>926.9</td>
<td>2</td>
<td>1989</td>
<td>Hayes 1989</td>
</tr>
<tr>
<td>Three Mile Point Stream</td>
<td>308.9</td>
<td>3</td>
<td>1989</td>
<td>Hayes 1989</td>
</tr>
</tbody>
</table>

RESULTS

There was a strong correlation between the size of the drainage basin of individual streams and species richness (Figure 2, Pearson Product Moment Correlation r = .900, P < .001). Relatively few fish were considered to be widely distributed throughout the Otsego Lake watershed. Blacknose dace (*Rhinichthys atratulus*), longose dace (*R. cataractae*) and creek chubs (*Semotilus atromaculatus*) were found in over two thirds of the streams sampled. However, most species had very restricted distributions and occurred in less than one third of the stream sampled. These included rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), alewife (*Alosa pseudoharengus*), redsided dace (*Clinostomus elongatus*), cutlips minnow (*Exoglossum maxillingua*), golden shiner (*Notemigonus crysoleucas*), emerald shiner (*Notropis atherinoides*), common shiner (*Luxilus cornutus*), spottail shiner (*N. hudsonius*), northern redbelly dace (*Chrosomus eos*), bluntnose minnow (*Pimephales notatus*), fallfish (*Semotilus corporalis*), pearl dace (*Margariscus margarita*), central mud minnow (*Umbra limi*), chain pickerel (*Esox niger*), channel catfish (*Ictalurus punctatus*), margined madtom (*Noturus insignis*), redbreasted sunfish (*Lepomis auritus*), black crappie (*Pomoxis nigromaculatus*), smallmouth bass (*Micropterus dolomieu*) and yellow perch (*Perca flavescens*). A number of these fish were primarily lentic species (emerald shiner, spottail shiner, chain pickerel, channel catfish, redbreasted sunfish, black crappie, and yellow perch) and were only found in the stream mouths or in association with watershed lakes.
DISCUSSION

Fish species richness in Otsego Lake's watershed was strongly correlated with drainage area of the individual streams. The correlation between species richness and drainage basin size appears to be based on the fact that as watershed size increases, habitat diversity and complexity also increase (Eadie et. al. 1986, Hugueny 1989, Gratwicke and Speight 2005). However, other factors were certainly at work here. Stream drainage basin is also strongly correlated with stream order, stream size, stream length and discharge (Harrel et al. 1967, Platts, 1979).

Figure 2. The relationship between drainage acreage and fish species richness in the Otsego Lakes watershed.

Confounding this study was the fact that access to the full drainage basin was lacking for most of the streams studied. Access to the upper portions of the drainage basins along the west side of Otsego Lake was severely restricted by elevated culverts at road crossings (Hayden Creek, White Cr./Trout Brook, Leatherstocking Creek, Brookwood Creek, Mohican Creek, Glimmerglen Creek, and Three Mile Point Stream), dams (Cripple Creek and Hayden Brook) and waterfalls (Leatherstocking Brook). Species richness was much higher near the lake and below the insurmountable barriers. For example, in Leatherstocking Creek only four species were found above the Route-80 culvert, while 19 species were found in the much smaller reach below this obstruction (Hayes 1990, Hakala 1994). In Trout Brook, five species were found above the road crossing, while 14 species were found below.
Other environmental issues impacted the relationship between species richness and drainage basin. Mount Wellington stream was severely channelized and access to Otsego Lake was restricted by the passage of the stream through a long pipe. A watershed of its size (1,899 acres) would be expected to hold at least 8 species of fish. Instead, only two species were found, creek chubs and largemouth bass (which are more often associated with standing water than flowing water).

GIS can be a powerful tool in studying fisheries distributions and aquatic ecosystems (Valavanis et al. 2004). In setting up the data base it was clear that some streams had not been thoroughly surveyed, and recent data were lacking from a number of other streams. In fact, most streams have not been surveyed in the last 20 years. Recent surveys have discovered new species and expanding distributions of others (Jamieson et al. 2005, Somerville et al. 2005). More surveys of the fish fauna in the Otsego Lake watershed should be conducted in the near future.

ACKNOWLEDGEMENTS

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LITERATURE CITED


