COLD WATER STREAMS SURVEY

Fill out a survey sheet about every 200 yards or when the stream characteristics change; e.g. going from open to shaded sections, or from free-flowing to impounded, or impacted by a beaver dam. Take a meter reading at the downstream end of each segment.

Stream Name: _______________________________ Town: _______________________________

Date: ___________________________ Observers: _______________________________

Today’s weather: clear light rain rain heavy rain

Air Temperature: _________________ Time: __________________

GPS format (circle one): Decimal degrees Degrees, minutes, seconds

Segment upstream end (GPS coord): ______________________ / _______________________

Segment downstream end (GPS coord): ______________________ / _______________________

Instream characteristics for segment

What is the stream bottom made of? (mark from 1=most typical to 6=least typical)

_____ Organic debris (leaves, twigs) _____ Gravel (1/4 - 2”)

_____ Silt (mud) _____ Cobble (2 -10”)

_____ Sand (1/16” to 1/4”) _____ Boulders (>10”)

Water Color? Clear Cloudy Tea Milky Muddy Other _____________

Water Quality Impacts

Oily sheen or smell Fishy odor or fish kill

Sewage: smell, milky color, toilet paper Foam or scum (describe. Does a stick break it up?)

Typical Water Depth (in feet): __________________

How much of the channel is covered with water (bottom of bank to bottom of bank)

<table>
<thead>
<tr>
<th>Optimal</th>
<th>Suboptimal</th>
<th>Marginal</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.</td>
<td>Water fills more than 75% of the available channel; or &lt;25% of channel substrate is exposed.</td>
<td>Water fills 25 – 75% of the available channel, and/or riffle substrates are mostly exposed.</td>
<td>Very little water in channel and mostly present as standing pools.</td>
</tr>
</tbody>
</table>

Streamflow: Fast Slight Almost still

Gradient: Low Moderate Steep

Sinuosity: Straight Meandering Braided Channelized

Characterized by: Step pools Riffles/pools Riffle/runs Run

Is stream flow blocked by: Trees Trash / Large objects Beaver dam Other _____________

Reach Habitat

<table>
<thead>
<tr>
<th>Large woody material</th>
<th>Abundant</th>
<th>Moderate</th>
<th>Sparse</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small organic material</td>
<td>Abundant</td>
<td>Moderate</td>
<td>Sparse</td>
<td>None</td>
</tr>
<tr>
<td>Undercut banks</td>
<td>Abundant</td>
<td>Moderate</td>
<td>Sparse</td>
<td>None</td>
</tr>
<tr>
<td>Overhanging vegetation</td>
<td>Abundant</td>
<td>Moderate</td>
<td>Sparse</td>
<td>None</td>
</tr>
<tr>
<td>Aquatic vegetation</td>
<td>Abundant</td>
<td>Moderate</td>
<td>Sparse</td>
<td>None</td>
</tr>
</tbody>
</table>

Are there areas covered with algae? Streambed Around pipes Rocks
Appendix A: Sample Forms

Pg. 2: Stream Name_______________________________ Date _______________________

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### Alterations

#### Dams, Culverts, and Outfalls

____ Dam (GPS location __________________ / __________________)  
- Dam height (from downstream stream channel to top of spillway):  
  - < 3 ft  
  - 3 – 6 ft  
  - > 6 ft  
- Construction:  
  - rock  
  - masonry  
  - wood  
  - concrete  
  - earthen  
- Current use of dam:  
  - hydropower  
  - flood control  
  - recreation  
  - water supply  
  - unknown  
- Problems evident:  
  - leaks  
  - cracks  
  - holes  
  - erosion  
  - plant growth  

____ Culvert/Bridge (GPS location __________________ / __________________)  
*Fill out separate data sheet!*

____ Outfall (GPS location __________________ / __________________)  
*Fill out separate data sheet!*

____ Beaver dam (GPS location __________________ / __________________)  

___ Evidence of recent activity? _______________________________________________________

#### Runoff:  
Do you see runoff from any of the following? (circle. *If run-off is significant locate on map.)  
- Animal pasture  
- Parking lots  
- Sewage outfall  
- Roads  
- Bridges  
- Construction  
- Plowed fields  
- Lawns  
- Other__________

---

### Riparian Area and Land Use

#### Stream bank integrity?  
- Intact  
- Erosion in some areas  
- Erosion in many areas  
- Collapsed in some areas  
- Collapsed in many areas  
- Channelized or stabilized  

#### Stream bank cover?  
**LEFT and RIGHT BANK as looking downstream**  

**Left Bank:**  
- Eroding  
- Moss  
- Trees/Shrubs  
- Exposed Roots  
- Grass/Flowers  
- Loosestrife/Phragmites  
- Riprap/channelized  
- Shrubs/brambles  
- Wetlands/marsh  

**Right Bank:**  
- Eroding  
- Moss  
- Trees/Shrubs  
- Exposed Roots  
- Grass/Flowers  
- Loosestrife/Phragmites  
- Riprap/channelized  
- Shrubs/brambles  
- Wetlands/marsh  

Other invasive species present?___________________________________

Is there a **vegetated riparian** area beyond the stream bank? If yes, indicate condition.  

**Left Bank:**  
- Shrubs/grasses  
- Mowed pasture/meadow  
- Forested/trees  
- Park with few trees  
- Lawn  

**Right Bank:**  
- Shrubs/grasses  
- Mowed pasture/meadow  
- Forested/trees  
- Park with few trees  
- Lawn  

If riparian area is **not vegetated**, please describe condition: (i.e. parking lot, pavement, roadway, buildings)  

**Left Bank:** _____________________________________________________________

**Right Bank:** ___________________________________________________________
Appendix A: Sample Forms

Pg. 3: Stream Name_______________________________ Date _______________________

### Riparian Area and Land Use (continued)

What are the land uses **visible** from the river? (*checkmark all that apply & circle the dominant land use type*)

- ___ Industrial
- ___ Parking lots
- ___ Golf courses
- ___ Commercial
- ___ Roads
- ___ Protected/conservation land
- ___ Agricultural
- ___ Landfills
- ___ Undeveloped/unprotected land
- ___ Residential
- ___ Railroads
- ___ Wastewater treatment plants
- ___ Park/ ball fields
- ___ Junkyards
- ___ Wooded areas
- ___ Other (describe)

### WILDLIFE / HABITAT

**Aquatic Species**

Do you see fish or evidence of fish? (describe)_____________________________________________________

- Estimate number _____________ If possible, describe species & size._________________________________________
- Evidence of fish? (i.e. nests)______________________________________________

Other forms of aquatic life? (*circle, identify species if known*)

- Aquatic insects
- Turtles
- Frogs
- Salamander
- Snail
- Mussels
- Snakes
- Clams
- Other____________________________________________

- Evidence of aquatic species? (i.e. eggs, tracks)____________________________________________

### METER READINGS

Take readings about every 200 yards or when the stream characteristics change; e.g. going from open to shaded sections, or from free-flowing to impounded, or impacted by a beaver dam.

- GPS location of reading _____________________________ / _____________________________

<table>
<thead>
<tr>
<th>Position in stream: Lft/Ctr/Rt</th>
<th>Reading Dpth (ft)</th>
<th>Temp (°C)</th>
<th>Sp Cond (µS/cm)</th>
<th>Cond (µS/cm)</th>
<th>DO %</th>
<th>DO (mg/L)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Habitat Survey Ratings (0 to 5): scores totaled for each stream section surveyed (habitat survey data will be attached in a spreadsheet).

<table>
<thead>
<tr>
<th>INSTREAM CHARACTERISTICS</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bed Material</strong></td>
<td></td>
</tr>
<tr>
<td>Boulder/Cobble/Gravel</td>
<td>5</td>
</tr>
<tr>
<td>Cobble/Gravel/Sand</td>
<td>4</td>
</tr>
<tr>
<td>Sand/Silt</td>
<td>2</td>
</tr>
<tr>
<td>Sand/Silt/Organic</td>
<td>1</td>
</tr>
<tr>
<td>Organic/Clay</td>
<td>0</td>
</tr>
<tr>
<td><strong>Average Riparian Width</strong></td>
<td></td>
</tr>
<tr>
<td>&gt;30</td>
<td>5</td>
</tr>
<tr>
<td>10 to 30</td>
<td>3</td>
</tr>
<tr>
<td>2 to 10</td>
<td>2</td>
</tr>
<tr>
<td>&gt;2</td>
<td>0</td>
</tr>
<tr>
<td><strong>Channel Flow Status</strong></td>
<td></td>
</tr>
<tr>
<td>Optimal</td>
<td>5</td>
</tr>
<tr>
<td>Suboptimal</td>
<td>3</td>
</tr>
<tr>
<td>Marginal</td>
<td>2</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
</tr>
<tr>
<td><strong>Gradient</strong></td>
<td></td>
</tr>
<tr>
<td>Steep</td>
<td>5</td>
</tr>
<tr>
<td>Moderate</td>
<td>3</td>
</tr>
<tr>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td><strong>Sinuosity</strong></td>
<td></td>
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<tr>
<td>Meandering/Braided</td>
<td>5</td>
</tr>
<tr>
<td>Straight</td>
<td>3</td>
</tr>
<tr>
<td>Channelized</td>
<td>1</td>
</tr>
<tr>
<td><strong>Large Woody Debris</strong></td>
<td></td>
</tr>
<tr>
<td>Abundant</td>
<td>5</td>
</tr>
<tr>
<td>Moderate</td>
<td>3</td>
</tr>
<tr>
<td>Sparse</td>
<td>1</td>
</tr>
<tr>
<td>None</td>
<td>0</td>
</tr>
</tbody>
</table>

| Undercut Banks                           |       |
| Abundant                                  | 5     |
| Moderate                                  | 3     |
| Sparse                                    | 1     |
| None                                      | 0     |

| Overhanging Vegetation                    |       |
| Abundant                                  | 5     |
| Moderate                                  | 3     |
| Sparse                                    | 1     |
| None                                      | 0     |

| Bank Condition                           |       |
| Intact                                    | 5     |
| Erosion in some areas                    | 4     |
| Erosion in many areas                    | 3     |
| Collapsing in some areas                 | 1     |
| Collapsing in many areas                 | 0     |

<table>
<thead>
<tr>
<th>Length between crossings/ Culverts/Barriers</th>
<th>Score</th>
</tr>
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<tbody>
<tr>
<td>&gt;1000 m</td>
<td>5</td>
</tr>
<tr>
<td>500 - 1000 m</td>
<td>4</td>
</tr>
<tr>
<td>250 - 500</td>
<td>3</td>
</tr>
<tr>
<td>100 - 250</td>
<td>2</td>
</tr>
<tr>
<td>&lt;100 m</td>
<td>1</td>
</tr>
</tbody>
</table>

| Fish Present                              |       |
| yes                                        | 5     |
| unknown                                    | 1     |
| no                                         | 0     |

| WATER QUALITY                             |       |
| Dissolved Oxygen (mg/L)                   |       |
| >8 mg/L                                    | 5     |
| 6-8 mg/L                                   | 4     |
| 5-6 mg/L                                   | 3     |
| 3-5 mg/L                                   | 2     |
| 0-3 mg/L                                   | 0     |

| Summer Water temps                        |       |
| 11 to 16                                   | 5     |
| 16 - 20                                    | 4     |
| 20 - 24                                    | 3     |
| over 24                                    | 0     |

| pH                                         |       |
| 6.5 to 8.0                                 | 5     |
| 4.0 - 6.5 or 8.0 - 9.0                    | 3     |
| <4.0 or >9.0                               | 0     |

| Riparian area (within 10 meters)           |       |
| Forested/trees                            | 5     |
| Shrubs/grasses                            | 3     |
| Wetlands/marsh                            | 0     |

| Visible Landuses                          |       |
| Protected                                 | 5     |
| Fields                                    | 4     |
| Residential (lawns)                       | 3     |
| Farm fields                               | 3     |
| Paved                                     | 0     |
| Industrial                                | 0     |

OVER ALL RATING DESCRIPTION

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>55-65</td>
<td>EXCELLENT</td>
</tr>
<tr>
<td>45-54</td>
<td>GOOD</td>
</tr>
<tr>
<td>25-44</td>
<td>FAIR</td>
</tr>
<tr>
<td>&lt;25</td>
<td>POOR</td>
</tr>
</tbody>
</table>
## Appendix C

### Culvert Survey Results

(results can be viewed on the Stream Continuity database at [http://www.streamcontinuity.org/cdb2/search_crossings.cfm](http://www.streamcontinuity.org/cdb2/search_crossings.cfm) by searching coordinator “Sue Flint”)

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Road Name</th>
<th>Type</th>
<th>Evaluation</th>
<th>Crossing Span</th>
<th>Structure Length (ft)</th>
<th>Aquatic Score</th>
<th>Longitude</th>
<th>Latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranberry Brook outlet:</td>
<td>Goodale St inlet: Vega Rd.</td>
<td>Single Culvert</td>
<td>Moderate barrier</td>
<td>Severe Constriction</td>
<td>353</td>
<td>0.557</td>
<td>-71.50296</td>
<td>42.37484</td>
</tr>
<tr>
<td>Cranberry Brook</td>
<td>Parmenter Road</td>
<td>Single Culvert</td>
<td>Moderate barrier</td>
<td>Severe Constriction</td>
<td>32</td>
<td>0.604</td>
<td>-71.49446</td>
<td>42.37966</td>
</tr>
<tr>
<td>Cranberry Brook inlet:</td>
<td>Hemenway Street</td>
<td>Single Culvert</td>
<td>Moderate barrier</td>
<td>Mild Constriction</td>
<td>37</td>
<td>0.637</td>
<td>-71.49377</td>
<td>42.37711</td>
</tr>
<tr>
<td>Cranberry Brook</td>
<td>Concord Road</td>
<td>Single Culvert</td>
<td>Minor barrier</td>
<td>Mild Constriction</td>
<td>45</td>
<td>0.709</td>
<td>-71.49844</td>
<td>42.37333</td>
</tr>
<tr>
<td>Cranberry Brook inlet:</td>
<td>White Pond Road</td>
<td>Single Culvert</td>
<td>Moderate barrier</td>
<td>Severe Constriction</td>
<td>37</td>
<td>0.535</td>
<td>-71.48633</td>
<td>42.38103</td>
</tr>
<tr>
<td>Trout Brook</td>
<td>Draper Circle</td>
<td>Single Culvert</td>
<td>Minor barrier</td>
<td>Spans Bank to bank</td>
<td>60</td>
<td>0.810</td>
<td>-71.49727</td>
<td>42.36895</td>
</tr>
<tr>
<td>Trout Brook</td>
<td>Hemenway Street</td>
<td>Single Culvert</td>
<td>Significant barrier</td>
<td>Mild Constriction</td>
<td>55</td>
<td>0.467</td>
<td>-71.49561</td>
<td>42.36821</td>
</tr>
<tr>
<td>Trout Brook</td>
<td>Sheffield Terrace</td>
<td>Multiple Culverts</td>
<td>Minor barrier</td>
<td>Mild Constriction</td>
<td>54</td>
<td>0.768</td>
<td>-71.49416</td>
<td>42.36736</td>
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<tr>
<td>Trout Brook</td>
<td>Littlefield Lane</td>
<td>Single Culvert</td>
<td>Minor barrier</td>
<td>Mild Constriction</td>
<td>60</td>
<td>0.728</td>
<td>-71.49217</td>
<td>42.36581</td>
</tr>
<tr>
<td>Trout Brook</td>
<td>Woodcock Lane</td>
<td>Single Culvert</td>
<td>Moderate barrier</td>
<td>Severe Constriction</td>
<td>40</td>
<td>0.638</td>
<td>-71.49097</td>
<td>42.36443</td>
</tr>
<tr>
<td>Trout Brook</td>
<td>Harper Circle</td>
<td>Single Culvert</td>
<td>Moderate barrier</td>
<td>Severe Constriction</td>
<td>300</td>
<td>0.593</td>
<td>-71.48855</td>
<td>42.36463</td>
</tr>
<tr>
<td>Trout Brook</td>
<td>Sudbury Street</td>
<td>Single Culvert</td>
<td>Minor barrier</td>
<td>Mild Constriction</td>
<td>48</td>
<td>0.840</td>
<td>-71.48588</td>
<td>42.36601</td>
</tr>
<tr>
<td>Trout Brook</td>
<td>Hanlon Drive</td>
<td>Multiple Culverts</td>
<td>Minor barrier</td>
<td>Mild Constriction</td>
<td>21</td>
<td>0.845</td>
<td>-71.48413</td>
<td>42.36739</td>
</tr>
<tr>
<td>Trout Brook pipeline trail</td>
<td>in Memorial Forest</td>
<td>Footbridge</td>
<td>Insignificant barrier</td>
<td>Spans channel &amp; banks</td>
<td>3.5</td>
<td>0.976</td>
<td>-71.47777</td>
<td>42.37154</td>
</tr>
<tr>
<td>UNK tributary to Trout</td>
<td>Brook</td>
<td>Graham Path</td>
<td>Single Culvert</td>
<td>Severe Constriction</td>
<td>68</td>
<td>0.635</td>
<td>-71.49327</td>
<td>42.36158</td>
</tr>
<tr>
<td>UNK tributary to Trout</td>
<td>Brook</td>
<td>Prendiville Way</td>
<td>Single Culvert</td>
<td>Severe Constriction</td>
<td>418</td>
<td>0.661</td>
<td>-71.49021</td>
<td>42.366083</td>
</tr>
<tr>
<td>UNK tributary to Trout</td>
<td>Brook</td>
<td>Minehan Lane</td>
<td>Single Culvert</td>
<td>Severe barrier</td>
<td>nr</td>
<td>0.1</td>
<td>-71.48378</td>
<td>42.3679</td>
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<td>UNK tributary to Cranberry</td>
<td>Brook</td>
<td>Old Concord Road</td>
<td>Single Culvert</td>
<td>Severe Constriction</td>
<td>42</td>
<td>0.525</td>
<td>-71.48464</td>
<td>42.37756</td>
</tr>
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</table>
Appendix D PICTURES

**Pictures:**
Culvert at Harper Lane and Woodcock Lane, Marlborough

- **Inlet**
  - View upstream

- **Outlet**
  - View Downstream
Appendix D PICTURES
Culvert at Minehan Road
Outlet

View downstream

Upstream pond and inlet
Appendix D PICTURES

Old dam and pond at Hemenway Street, Marlborough
Dam spillway/ culvert inlet

Culvert outlet

Upstream view (pond)
Appendix D PICTURES

Culvert at Vega and Goodale Roads, Marlborough

Inlet

Upstream view

Outlet
Appendix D PICTURES
Culvert at White Pond Road, Hudson
Inlet

View upstream towards beaver dam

Downstream scour pool

Outlet
Conservation genetic analysis of brook trout from Sudbury Massachusetts
Andrew Whiteley, UMass Amherst Conservation Genetics Lab
December 22, 2013

We examined a total of 57 brook trout (*Salvelinus fontinalis*) at eight microsatellite loci from Hop Seep and Cranberry Brook in Sudbury, Massachusetts. There were 27 fish from Hop Seep and 30 fish from Cranberry Brook. Of these, there were 13 young-of-the-year (YOY, defined as < 100mm) from Hop Seep and 15 YOY from Cranberry Brook. We performed several data quality tests that revealed no quality issues for the genetic data. The large proportion of YOY included in the sample could influence results if there were strong full-sibling family structure. We therefore tested for the presence of full-siblings in the YOY from both sites. The largest family contained seven full-siblings, all from Hop Seep. Thus, of the 13 YOY sampled in Hop Seep, 54% of them appear to belong to one full-sibling family. Other full-sibling families were smaller and less credible, given the small sample size. Additional support for the accuracy of the largest family comes from a clustering program called STRUCTURE. Each individual was assigned to one of two genetic groups. One of these groups consisted entirely of the seven-member full-sibling family (Fig. 1). If population-level structure were present, this method would have allowed us to detect it. Instead, we observed little-to-no population level structure.

![Figure 1](image.jpg)

Fig. 1. Results from STRUCTURE analysis of Hop Seep and Cranberry Brook, Sudbury, MA. Each vertical bar represents the genetic assignment for one individual. Hop Seep is site 1, Cranberry Brook is site 2. A black vertical bar separates the two sites. Individuals assigning to group 1 are in red, those assigning to group 2 are in green. Partial genome assignments are possible. The seven individuals for which the majority of the genome assigns to group 1 (in red) belong to one full-sibling family from Hop Seep.

Subsequent analyses were performed with all over-yearlings and one sibling per full-sibling family. Removal of all but one full-sibling minimizes bias from including family groups. Samples sizes became \( N = 21 \) for Hop Seep and \( N = 29 \) for Cranberry Brook. Genetic diversity was high in both sites (Table 1). We compared genetic variation for the two Sudbury sites to representative brook trout from other regions. We have examined a series of brook trout in Virginian Appalachian Mountain streams at the same genetic markers. Shown in Table 1 are the sites with highest (DV-a) and lowest (DN-a) genetic diversity from Whiteley et al. (2013). The Sudbury sites have similar heterozygosity but half the allelic diversity as DV-a from Virginia. The Sudbury sites have higher heterozygosity and greater allelic diversity than DN-a from Virginia. DN-a is among brook trout populations with the least genetic diversity examined at the UMass Conservation Genetics Lab to date. The Sudbury sites also have similar amounts of genetic diversity as western Massachusetts sites that are part of our long-term brook trout study conducted by the USGS Conte Lab, USFS, and UMass Amherst (Table 1). We show genetic diversity for representative samples of the mainstem West Brook and a small connected tributary (Mitchell Brook; Table 1).
Table 1. Summary of genetic diversity within sites. $H_s$ is mean within-population heterozygosity. $A_o$ is mean number of observed alleles. $AR$ is allelic richness, the number of alleles standardized for sample size. Shown for comparison are two populations from Virginia, collected in 2010, with the most and least genetic diversity from Whiteley et al. (2013). Also shown are two sites from within our long-term brook trout study in West Brook in western Massachusetts (Whately, MA). Mitchell Brook is a tributary of the West Brook mainstem. Results are a subset from 2004 but are representative of the populations.

<table>
<thead>
<tr>
<th>Site</th>
<th>$N$</th>
<th>$H_s$</th>
<th>$A_o$</th>
<th>$AR$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sudbury sites</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hop Seep</td>
<td>21</td>
<td>0.712</td>
<td>5.0</td>
<td>5.0</td>
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<tr>
<td>Cranberry Bk</td>
<td>29</td>
<td>0.669</td>
<td>5.5</td>
<td>5.4</td>
</tr>
<tr>
<td><strong>Virginia comparison</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DV-a (most gen. var.)</td>
<td>379</td>
<td>0.780</td>
<td>10.9</td>
<td>8.2</td>
</tr>
<tr>
<td>DN-a (least gen. var.)</td>
<td>46</td>
<td>0.565</td>
<td>3.4</td>
<td>3.48</td>
</tr>
<tr>
<td><strong>West Brook (MA) comparison</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West Brook mainstem</td>
<td>60</td>
<td>0.630</td>
<td>7.1</td>
<td>7.1</td>
</tr>
<tr>
<td>Mitchell Brook</td>
<td>66</td>
<td>0.600</td>
<td>5.1</td>
<td>5.1</td>
</tr>
</tbody>
</table>

There was very little evidence of genetic divergence between Hop Seep and Cranberry Brook. A standard measure of genetic differentiation is $F_{ST}$. $F_{ST}$ provides a measure of allele frequency divergence between populations and ranges from zero to 1. $F_{ST}$ was 0.013 and the 95% confidence interval contained zero (95% CI: -0.001 – 0.024). We can also directly test for significant allele frequency divergence. Results of this test revealed significant divergence ($P = 0.006$). Together, these results suggest that there is some genetic divergence between the two sites, but it is slight. It is not unusual to observe $F_{ST}$ values between 0.15 and 0.30 at this spatial scale elsewhere in the brook trout native range.

There are two major takeaway points from this analysis: 1) both Sudbury sites had a surprisingly high amount of within-population genetic diversity. 2) there appears to be genetic connectivity among sites. Isolated populations lose genetic diversity each generation. However, gene flow serves to maintain genetic diversity within sites and minimize genetic divergence between sites. These results suggest that movement between Hop Seep and Cranberry Brook occurs, possibly seasonally when downstream conditions are favorable. While genetic diversity was high in both populations, over half of the YOY in Hop Seep appeared to belong to a single half-sibling family. This could indicate a tendency for inbreeding and successful reproduction by few adults in this site. However, if few adults successfully reproduce each year, heterozygosity would likely not be as high as it is. Yet, heterozygosity tends to be lost slowly, so it would be worth analyzing this population again to see if relatively few adults tend to contribute to subsequent cohorts.

**Literature Cited**