Riparian Habitat Restoration Monitoring

U.S. Fish and Wildlife Service and The Intervale Center
Project Background

Goals and Objectives:

• To gain a more comprehensive understanding of the successes and failures of riparian buffer planting projects in Vermont by tracking plant survival after project completion

• Share monitoring results with the conservation community

• Develop monitoring capacity within our partners

• To inform the adaptive management process and improve overall project success
Project Background

- Developed in partnership by The Intervale Center and the U.S. Fish and Wildlife Service
- 6 field seasons: 2008 – 2013
- Various funding sources:
  - Lake Champlain Basin Program
  - Great Lakes Fisheries Commission
  - The U. S. Fish and Wildlife Service
- Project Management:
  - Karina Dailey 2008 – 2010
  - Leah Szafranski 2010 – 2013
- Assisted by interns from St. Michael’s College
Project Background

Site Selection

• Riparian restoration planting projects

• Included various programs:
  • CRP/CREP
  • Partners for Fish and Wildlife
  • Conservation organizations
Monitoring Protocol

- Initiate monitoring shortly after planting is completed
- Set up transects:
  - At least 3 transects per site
  - >200 feet apart, evenly distributed throughout the site
  - Perpendicular to the watercourse
- Visit every tree within 10’ of either side of the transect
- Mark each tree with a tree tag, take a photo and mark with a GPS point
- Collect tree data variables...
Tree Variables...

- Tree tag #
  - Each tree receives a tag
- Species identification
  - Further identifies each seedling
Tree Variables...

- Tree height
  - Base to tallest living point (inches)
  - Height of dead leader
- Condition (health) based on the foliage:
  - Vigorous
  - Healthy
  - Moderate
  - Unhealthy
  - Very Unhealthy
  - Dead
Tree Variables...

- Plant Material Type
  - Bareroot
  - Balled and Burlap
  - Tubling
  - Container
  - Live Stake
  - Fascine

- Tree Protection:
  - Mat and Type
  - Tree Tube and Type
Tree Variables...

- Stem Browse
- Leaf Browse
- Girdling
Tree Variables...

- Competing Species
  - Note the 3 most dominant around the seedling
- Competing Cover Density
  - Sparse
  - Medium
  - Dense
- Competition height
  - Average of the dominant surrounding vegetation
Project Point Locations

- 27 sites throughout VT
- Total Stems = 1,450
- Watersheds include:
  - Missisquoi
  - Lamoille
  - Winooski
  - Otter Creek
  - Lake Champlain Direct
  - White River
  - Connecticut
Data Analysis

- 3 Main Variables
  - Growth
  - Health
  - Survivorship

- Classification variables
  - Plant Material Type
  - Species
  - Tree Protection
  - Stem Browse
  - Beaver Browse
  - Girdling
  - Annual Precipitation

Image source: http://www.londonderry.org/lms/teacherPage.cfm?teacherId=953
Overall Average Growth

- Growth is shown as cumulative
- Represents the average growth of all projects combined
- Includes all plant material types, species, and protection variables
- Total average growth over 5 years is 29 inches
• The overall trend is moving toward more “Healthy” trees and fewer “Unhealthy” trees as health increases and unhealthy trees become dead.

• Suggesting that these sites are stabilizing and mortality levels should not continue to increase at the same rate.
Overall Survivorship

- Includes all plants monitored at 26 sites
- @ 250 stems/acre = 163 stems by year 5
- If the 16% of unhealthy stems decline and become dead - survivorship will = 49%
Summary of Overall 5th Year Data

- Growth - 29 inches
- Health - 84% (Healthy and Moderate)
- Survivorship – 65%
What else contributes to stem growth?

- Plant material?
- Species?
- Stem Browse?
- Beaver Damage?
Assume the average at planting is:

- Bareroot = 36 inches
- B&B = 72 inches

5 years later:

- Bareroot = 73 inches
- B&B = 54 inches

On average bareroot stems are surpassing balled and burlap stems that were significantly larger at the time of planting.
• Growth is widely variable across species

• Later successional species such as: sugar maple, red oak or hop hornbeam do not appear to be growing

• The early successional species such as: speckled alder, American elm, and green ash are quickly increasing in height
Speckled Alder
Silky Dogwood

2009

2013
Sugar Maple

2011

2013
Growth - 5th Year Balled and Burlap by Species

- Balled and Burlap Average = -18”
- What if we look at species separately?
- Assuming the height at planting is 72 inches, 5th Year height would look like this:
  - White Ash, Red Maple and Sugar Maple (B&B) (average decrease 33”) = 39”
  - White Pine (B&B) (average increase 62”) = +134”
- All other species were included in the overall average but sample size was too small to include separately
Stem Browse

<table>
<thead>
<tr>
<th>Years Since Planting</th>
<th>% of Stems Showing Signs of Stems Browse</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Year</td>
<td>16%</td>
</tr>
<tr>
<td>2nd Year</td>
<td>26%</td>
</tr>
<tr>
<td>3rd Year</td>
<td>19%</td>
</tr>
<tr>
<td>4th Year</td>
<td>20%</td>
</tr>
<tr>
<td>5th Year</td>
<td>24%</td>
</tr>
<tr>
<td>Average</td>
<td>21%</td>
</tr>
</tbody>
</table>

Of the 21% of stems that showed signs of browse:
- 12% = Red Osier Dogwood
- 19% = Silky Dogwood
- 22% = Red Maple
- 13% = Silver Maple
- All other species with some browse represented 1-3%

The majority of stems showing signs of browse were only lightly browsed
Beaver Browse

- Only 4 out of 26 sites showed signs of beaver damage.

- Species that regenerate well from basal stem shoots showed signs of regrowth.

- Selecting species that can tolerate browse may improve survival at sites where beavers are present.
## Growth Summary

<table>
<thead>
<tr>
<th>Bareroot</th>
<th>Balled and Burlap</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Growth</strong> – increase 37 inches</td>
<td><strong>Growth</strong> – decrease 18 inches</td>
</tr>
<tr>
<td><strong>Health</strong> – 84% (Healthy to Moderate)</td>
<td><strong>Health</strong> – 67% (Healthy to Moderate)</td>
</tr>
<tr>
<td>Species growth – variable, vigorous early successional species grow the most</td>
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</tr>
<tr>
<td><strong>Stem browse</strong> – 21% of stems showed signs of browse</td>
<td><strong>Beaver browse</strong> – 4 out of 26 sites were impacted by beavers</td>
</tr>
</tbody>
</table>
What else contributes to survivorship?

– Plant material type?
– Health?
– Species?
– Protection materials?
– Girdling?
– Annual rainfall?
Survivorship - Bareroot

- Includes all bareroot stems (trees, shrubs, and all other variables) across all 26 monitoring sites
- 5th year bareroot survivorship = 64%
Survivorship - Balled and Burlap

Mean % Survivorship

<table>
<thead>
<tr>
<th>Year</th>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
<th>4th Year</th>
<th>5th Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>100%</td>
<td>98%</td>
<td>96%</td>
<td>91%</td>
<td>84%</td>
</tr>
</tbody>
</table>

Summary of survivorship:

- Includes all balled and burlap stems
- 5th year survivorship = 84%

Summary of survivorship:

- Overall 5th year bareroot – 64%
- Overall 5th year balled and burlap – 84%
Survivorship - Tubling

- Includes all tublings
- Tubling sample size was too small to compare 5th year results
- Tubling survivorship is most likely impacted by the size of the material – approximately 18 inches at planting

Summary of survivorship:
- Overall bareroot: 3rd year = 73% and 5th year = 64%
- Overall B&B: 3rd year = 96% and 5th year = 84%
- Overall 3rd year tubling survivorship – 60%
5th Year Tree Health and Plant Material Type

Bareroot

- Healthy: 61%
- Moderate: 24%
- Unhealthy: 15%

Balled and Burlap

- Healthy: 40%
- Moderate: 27%
- Unhealthy: 33%

- Balled and Burlap stems have a greater percentage of unhealthy stems than bareroot stems.
- If the 33% of unhealthy balled and burlap stems are destined for mortality survivorship will = 51%
- If the 15% of unhealthy bareroot stems are destined for mortality survivorship will = 49%

Summary of survivorship:
Overall 5th year bareroot – 64%
Overall 5th year balled and burlap – 84%
## Survivorship – 3\(^{rd}\) Year by Species and Plant Material Type

<table>
<thead>
<tr>
<th>Bareroot - Species</th>
<th>Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speckled Alder</td>
<td>100%</td>
</tr>
<tr>
<td>Black Ash</td>
<td>100%</td>
</tr>
<tr>
<td>Choke Cherry</td>
<td>100%</td>
</tr>
<tr>
<td>Green Ash</td>
<td>95%</td>
</tr>
<tr>
<td>Silky Dogwood</td>
<td>94%</td>
</tr>
<tr>
<td>Shrub Willow spp.</td>
<td>93%</td>
</tr>
<tr>
<td>Basswood</td>
<td>93%</td>
</tr>
<tr>
<td>Red Osier Dogwood</td>
<td>88%</td>
</tr>
<tr>
<td>White Pine</td>
<td>86%</td>
</tr>
<tr>
<td>Swamp White Oak</td>
<td>85%</td>
</tr>
<tr>
<td>Boxelder</td>
<td>79%</td>
</tr>
<tr>
<td>Black Willow</td>
<td>74%</td>
</tr>
<tr>
<td>Red Maple</td>
<td>74%</td>
</tr>
<tr>
<td>American Elm</td>
<td>71%</td>
</tr>
<tr>
<td>Silver Maple</td>
<td>69%</td>
</tr>
<tr>
<td>Cottonwood</td>
<td>61%</td>
</tr>
<tr>
<td>Sugar Maple</td>
<td>53%</td>
</tr>
<tr>
<td>Northern Red Oak</td>
<td>52%</td>
</tr>
<tr>
<td>Hop Hornbeam</td>
<td>50%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Balled and Burlap- Species</th>
<th>Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Ash</td>
<td>100%</td>
</tr>
<tr>
<td>Red Maple</td>
<td>98%</td>
</tr>
<tr>
<td>Sugar Maple</td>
<td>94%</td>
</tr>
<tr>
<td>White Pine</td>
<td>95%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tubling - Species</th>
<th>Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Osier Dogwood</td>
<td>82%</td>
</tr>
<tr>
<td>Shrub Willow spp.</td>
<td>60%</td>
</tr>
<tr>
<td>Black Willow</td>
<td>27%</td>
</tr>
<tr>
<td>Elderberry</td>
<td>20%</td>
</tr>
</tbody>
</table>

Based on 10 stems or greater

Summary of survivorship:

- Overall bareroot: 3\(^{rd}\) year = 73% and 5\(^{th}\) year = 64%
- Overall B&B: 3\(^{rd}\) year = 96% and 5\(^{th}\) year = 84%
- Overall 3\(^{rd}\) year tubling survivorship – 60%
Survivorship - 5th Year Bareroot and Protection Materials

- Only includes tree species that were represented by all protection variables
- It appears that “no protection” had the highest survivorship
- The use of only a mat produced the highest mortality rates

Summary of survivorship:
- Overall 5th year bareroot – 64%
- Overall 5th year balled and burlap – 84%
- Overall 3rd year tubling survivorship – 60%
Survivorship - 5th Year Bareroot Dogwood and Mat Protection

- Red Osier and Silky Dogwoods were combined
- Dogwoods with no mat had a higher survivorship rate than dogwoods with a mat

Summary of survivorship:
- Overall 5th year bareroot – 64%
- Overall 5th year balled and burlap – 84%
- Overall 3rd year tubling survivorship – 60%
Survivorship - 5th Year Bareroot Maples and Protection Materials

Summary of survivorship:
- Overall 5th year bareroot – 64%  
- Overall 5th year balled and burlap – 84%  
- Overall 3rd year tubling survivorship – 60%

- Red maple, silver maple and sugar maple were combined
- Maples with no protection have a higher survivorship than maples with protection
- Maples with only a mat produced the highest mortality
Plastic Tree Tubes and Mats
Do we really need them?

Tubes:
• Fall over and get smothered
• Fill with growing grass
• Fill with sediment
• Leave plastic trash in the landscape

Mats:
• Quickly become covered by vegetation
• Are buried by sediment
• Create a home for rodents
• Leave plastic trash in the landscape
Maintenance?

Tubes with no maintenance plan often cause harm to otherwise healthy successful trees.
Plastic...

Tubes and mats used near flood prone areas and eroding banks often end up in our waterways.

So the trash just disappears?
Tube Clean Up

• The Lake Champlain Basin Program will support the first widespread clean-up effort

• Summer 2014 the Intervale Conservation Nursery planting crew will work for 7 weeks attempting to remove 25,000 tree tubes in Addison County (2 Tons of plastic!)

• Between 2001 and 2007 more than 100,000 tree tubes (8 Tons of plastic!) were installed in Addison County alone
If tubes are incorporated in a planting plan there needs to be a plan and a mechanism for removal in the future.
Survivorship - 3\textsuperscript{rd} Year Girdling

- 7\% of all stems showed signs of girdling
- 85\% of stems that showed signs of girdling were alive
- 9\% of stems with no tube showed signs of girdling
- 2\% of stems with a tube showed signs of girdling
- Maples and dogwoods had the highest incidence of girdling
- 10\% of maples with no tube showed signs of girdling
- 12\% of all dogwoods showed signs of girdling
### Annual Precipitation and Survival

<table>
<thead>
<tr>
<th>Planted Year</th>
<th>Bareroot Survivorship</th>
<th>Rainfall April 1 to June 1</th>
<th>Annual Precipitation Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>86%</td>
<td>7”</td>
<td>41.34</td>
</tr>
<tr>
<td>2008</td>
<td>68%</td>
<td>5”</td>
<td>48.85</td>
</tr>
<tr>
<td>2009</td>
<td>82%</td>
<td>7”</td>
<td>39.30</td>
</tr>
<tr>
<td>2010</td>
<td>63%</td>
<td>5”</td>
<td>39.78</td>
</tr>
</tbody>
</table>

- Average expected rainfall April 1 – June 1 = 7 inches
- Average annual is 40.00 – 49.99
- Rainfall appears to impact establishment and survivorship

*Overall bareroot survivorship 3rd Year – 73%*
Survivorship Summary

**Bareroot**
- 73% survivorship - 3rd Year
- 64% survivorship - 5th Year
- 15% Unhealthy
- Trees with no mat or tube have the highest survivorship – 73%
- Trees with only a mat have the lowest survivorship – 40%
- Dogwoods with & without a mat have similar survivorship - dogwoods with-out a mat have a 3% higher survivorship
- Maples with out a mat and tube have the highest survivorship – 67%
- Maples with only a mat have the lowest survivorship - 21%

**Balled and Burlap**
- 96% survivorship-3rd Year
- 84% survivorship - 5th Year
- 33% Unhealthy

**Tubling**
- 60% survivorship (3rd Year)

**Overall Averages**
- 65% survivorship (5th Year)
- Species survivorship is variable, early successional species tend to have the highest survival
- Girdling impacts 7% of all stems
- Rainfall amounts appear to have an impact on survivorship