Assessing Wetland Compensation in the Lower Fraser River

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Collaboration with Rob Knight and Brad Mason (Community Mapping Network), and the BC Conservation Foundation

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Background

• No-Net-Loss & Policy for the Management of Fish Habitat (DFO)
• FREMP – Fraser River Estuary Management Program
• FREMP-BIEAP Habitat Atlas and the Community Mapping Network
Objectives

• Determine if compensation projects are achieving no-net-loss
• Consolidate and build upon existing FREMP-BIEAP Habitat Atlas
• Make current study results publicly available through the Habitat Atlas
• Publish findings of this study and make recommendations for future and current habitat compensation projects.
Field Methods

- 39 of 96 marsh compensation projects surveyed
- 54 individual sites
- 7 reference sites
Field Methods

• Area measured using Trimble Geo 7x GPS device
• Vegetation sampled using 1m² quadrats
• Each species identified, % cover estimated, origin reordered (native, exotic, invasive), Wetland Indicator Status recorded.
• Maximum stem height of sedge species measured
Methods - Assessment

1. Proportion of Target Habitat Established
2. Proportion of Native Plant Species
Methods - Assessment

- Poor: 0 – 64%
- Fair: 65 – 84%
- Good: 85 – 100%
1. Proportion of Target Habitat Established

Target Area at Creation: 200 m²

Mudflat = 34 m²

Marsh = 166 m²

83.0%
2. Proportion of Native Species

<table>
<thead>
<tr>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 51%</td>
<td>52 – 67%</td>
<td>68% +</td>
</tr>
</tbody>
</table>
Background
501 sqm of unvegetated intertidal mudflat were lost as a result of foreshore filling in 1991. Notes from 1996 state that compensation marsh benches were constructed, however no vegetation had been planted. Natural colonization was noted, but existing plant growth was described as ‘sparse.’ Marsh and riparian plantings were recommended, however no remedial action was undertaken, as there was no legally binding agreement between the proponent and DFO. Habitat compensation goal = 627 sqm of marsh habitat.

Description
Site is a 248 sqm embayed marsh with an armoured riprap foreshore. The backshore of the site is bordered by both concrete wall and riprap dike, both supporting the BC Parkway trail above. Public access is deterred due to a metal fence surrounding the site. Log booms have been installed along the marsh foreshore, but are angled inwardly (perhaps broken), likely offering little protection to the site.

Currently 70% of the site is dominated by mid-to high marsh vegetation (target habitat), dominated by Juncus balticus, Carex lyngbyei, Potentilla anserina and Lycopus sp.. Low marsh habitat (Community 2) represents 14% of site area, and occurs along the foreshore where soil loss and erosion is most prevalent. Community 2 is dominated by Juncus articulatus, Hypericum scouleri, Crassula aquatica and Lilaeopsis occidentalis. The remainder of the site is covered by log debris, which has accumulated along the site backshore.

Marsh productivity is being impacted by log debris and erosion. Log debris currently accounts for 16% of site area, and will continue to reduce vegetative cover due to smothering and grounding unless addressed. Erosion is occurring along the riprap edge of the marsh, as well as within the unvegetated intertidal portion of the marsh, where a coarser substrate is now exposed due to soil loss. The log boom, which is currently funneling wave energy into the center of the marsh due to improper angling, is likely the primary cause of this soil loss. A lack of planting (and subsequent lack of soil binding by roots) has likely also contributed to erosion of habitat.

Morphological Features
Site is a flat marsh bench with exception to lower, eroded areas. Some erosion is occurring along the foreshore edge of the marsh, as well as within the unvegetated intertidal portion in the center of the marsh, where a coarser substrate is now exposed due to soil loss.

Impacts & Stressors
Log debris is a significant stressor to the backshore of the site, accounting for 16% of the site area. The embayment shape, and lack of functional log boom protection increase site susceptibility to further deposition. Carex lyngbyei appears to be reduced in height by waterfowl grazing.

Wildlife Sightings/Evidence
Evidence of waterfowl graze in areas with more palatable species (e.g. Carex spp.).

Adjacent Land Use
Residential development with BC Parkway trail at top of dike (N), Fraser River North Arm (S) and train trestle (E).

Threatened Plant Species (Provincial/Federal)
None.
Invasive Species

Three invasive species were sampled in target habitat: Lythrum salicaria, Phalaris arundinacea and Iris pseudacorus, totaling a mean % cover of 9.1 +/- 11.3.

Community Descriptions

<table>
<thead>
<tr>
<th>Community</th>
<th>Area (m²)</th>
<th>% of Total Area</th>
<th>% Unvegetated Ground, CI (95%)</th>
<th>% Log Debris, CI (95%)</th>
<th>Wetland Indicator Status</th>
<th>n</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>173.0</td>
<td>69.0</td>
<td>4.3 +/- 9.3</td>
<td>1.3 +/- 3.4</td>
<td>1.43</td>
<td>7</td>
<td>Marsh habitat (target habitat)</td>
</tr>
<tr>
<td>2</td>
<td>36.0</td>
<td>14.5</td>
<td>72.7 +/- 14.2</td>
<td>None</td>
<td>1.21</td>
<td>3</td>
<td>Vegetated mudflat along foreshore</td>
</tr>
<tr>
<td>3</td>
<td>39.0</td>
<td>15.7</td>
<td>None</td>
<td>100</td>
<td>n/a</td>
<td>n/a</td>
<td>Log debris accumulation zone. No vegetative cover.</td>
</tr>
</tbody>
</table>

Dominant Species

<table>
<thead>
<tr>
<th>Community</th>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Origin (N/T/E/I)</th>
<th>Wetland Indicator Status</th>
<th>Mean Absolute % Cover</th>
<th>CI (95%)</th>
<th>n</th>
<th>Relative Dominance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Baltic rush</td>
<td>Juncus balticus</td>
<td>N</td>
<td>2</td>
<td>42.6</td>
<td>31.8</td>
<td>7</td>
<td>30.3</td>
</tr>
<tr>
<td>1</td>
<td>Lyngbye's sedge</td>
<td>Carex lyngbyei</td>
<td>N</td>
<td>1</td>
<td>20.7</td>
<td>20.7</td>
<td>7</td>
<td>22.1</td>
</tr>
<tr>
<td>1</td>
<td>common silverweed</td>
<td>Potentilla anserina</td>
<td>N</td>
<td>1</td>
<td>11.7</td>
<td>5.4</td>
<td>7</td>
<td>14.6</td>
</tr>
<tr>
<td>1</td>
<td>horehound</td>
<td>Lycopus sp.</td>
<td>U</td>
<td>1</td>
<td>11.9</td>
<td>4.9</td>
<td>7</td>
<td>12.6</td>
</tr>
<tr>
<td>2</td>
<td>jointed rush</td>
<td>Juncus articulatus</td>
<td>N</td>
<td>1</td>
<td>4.3</td>
<td>3.5</td>
<td>3</td>
<td>22.9</td>
</tr>
<tr>
<td>2</td>
<td>western St. John's-wort</td>
<td>Hypericum scouleri ssp. scouleri</td>
<td>N</td>
<td>2</td>
<td>3.7</td>
<td>3.5</td>
<td>3</td>
<td>19.4</td>
</tr>
<tr>
<td>2</td>
<td>pigmyweed</td>
<td>Crassula aquatica</td>
<td>N</td>
<td>1</td>
<td>3.5</td>
<td>3.7</td>
<td>3</td>
<td>18.5</td>
</tr>
<tr>
<td>2</td>
<td>western lilaeopsis</td>
<td>Lilaeopsis occidentalis</td>
<td>N</td>
<td>1</td>
<td>3.7</td>
<td>3.6</td>
<td>3</td>
<td>12.9</td>
</tr>
</tbody>
</table>

Origin Class Proportions (Based on % Cover in Target Habitat)

- Exotic
- Invasive
- Native (non-threatened)
- Native (threatened)
- Unknown Origin
<table>
<thead>
<tr>
<th>Criterion</th>
<th>Target Percent</th>
<th>Actual Percent</th>
<th>Success</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Proportion of Target Habitat Established</td>
<td>100*</td>
<td>27.6%</td>
<td>Poor</td>
<td>Only 28% (173 sqm) of the initial goal is functioning as viable marsh habitat. This can easily be increased to 34% (212 sqm) by removing the buildup of log debris and planting to native species. The paired site (01-003-A) currently contains no functioning marsh habitat, but an embayed marsh could be created to increase total compensation area. To achieve the habitat compensation goal of 627sqm, a total of 454 sqm of marsh will have to be restored or created.</td>
</tr>
<tr>
<td>( % of area goal)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Proportion/Relative % Cover Native Species</td>
<td>72.8</td>
<td>76.0</td>
<td>Good</td>
<td>Invasive species only represent 8% of vegetative cover. Native species represent a higher proportion of vegetative cover than average of neighbouring reference sites REF-11-001 and REF-02-001.</td>
</tr>
</tbody>
</table>

**Recommendations**

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Priority Rank (1 Low - 5 High)</th>
<th>Action Required</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Debris</td>
<td>5</td>
<td>Remove log debris and plant with native vegetation. Consider replacing log boom structure to mitigate log debris.</td>
<td>Approximately 16% of the site is covered in log debris with the majority of it building up along the backshore. The embayment shape of the site allows log debris to build up and get stuck at the back of the site. A structure to mitigate future buildup of log debris would be advisable.</td>
</tr>
<tr>
<td>Invasive Species</td>
<td>3</td>
<td>Control <em>Iris pseudacorus</em>.</td>
<td><em>Iris pseudacorus</em> occurs in small clumps and could be easily controlled.</td>
</tr>
<tr>
<td>Low Target Habitat Success</td>
<td>5</td>
<td>Increase area of marsh habitat through mitigation.</td>
<td>Only 28% (173sqm) of the initial goal is functioning as viable marsh habitat. This can easily be increased to 34% (212 sqm) by removing the buildup of log debris and planting to native species. Planting of the vegetated mudflat is an option, however, the vegetated mudflat may indicate other stressors preventing growth (such as waterfowl grazing, elevation - too low, wave action, hydrological processes); therefore, planting this zone may have a higher chance of failure.</td>
</tr>
</tbody>
</table>

**Monitoring**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Priority Rank (1 Low - 5 High)</th>
<th>Action Required</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Results – Compensation Success

- **Proportion of Target Habitat Established (Criterion 1)**
  - Poor: 10%
  - Fair: 25%
  - Good: 65%

- **Proportion of Native Species (Criterion 2)**
  - Poor: 5%
  - Fair: 15%
  - Good: 50%
Results – Compensation Success

33%
Results – Proportion of Native Species Across the Fraser River

\[ y = -1.3491x + 85.752 \]
\[ R^2 = 0.3751 \]
\[ P < 0.001 \]
\[ N = 54 \]

\[ y = -1.8075x + 97.287 \]
\[ R^2 = 0.8817 \]
\[ P < 0.01 \]
\[ N = 7 \]
Results – Lyngbye’s Sedge Dominance

<table>
<thead>
<tr>
<th></th>
<th>Compensaton Sites</th>
<th>Reference Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyngbye’s Sedge Dominance (%)</td>
<td>29%</td>
<td>56%</td>
</tr>
<tr>
<td>N</td>
<td>54</td>
<td>7</td>
</tr>
</tbody>
</table>

P = 0.021
Results – Waterfowl Grazing

Lyngbye’s Sedge max. height (cm)

<table>
<thead>
<tr>
<th>Waterfowl grazing evidence observed</th>
<th>Waterfowl grazing evidence not observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>99cm</td>
<td>122cm</td>
</tr>
<tr>
<td>N = 18</td>
<td>N = 27</td>
</tr>
</tbody>
</table>

P = 0.039
Results – Wetland Indicator Status

1: Obligate Wetland

5: Obligate Upland
Results – Wetland Indicator Status

- **y = 24.583x - 22.097**
  - \( R^2 = 0.2961 \)
  - \( P < 0.001 \)
  - \( N = 54 \)

- **y = 31.485x - 30.31**
  - \( R^2 = 0.5157 \)
  - \( P < 0.001 \)
  - \( N = 7 \)

**Relative Percent Cover Exotic Species**

- Compensation Sites
- Reference Sites

**Site Wetland Indicator Status**

<table>
<thead>
<tr>
<th>Site Wetland Indicator Status</th>
<th>Compensation sites</th>
<th>Reference sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**P = 0.049**
Invasive Cattail

Typha angustifolia (Invasive)

Typha latifolia (Native)

Typha x glauca Cattail (Hybrid)
Invasive Cattail
Recommendations

Current and Future Compensation Sites

• Extend monitoring time
• Adjust monitoring and adaptive management dependant on West to East gradient
• Increase monitoring of Lyngby’s sedge during initial years of establishment
• Consider waterfowl grazing protection
• Ensure appropriate elevation and soil material
• Control Lesser Cattail (*Typha angustifolia*)

Legislative

• Upgrade *T. angustifolia* to INVASIVE
• Ban *T. angustifolia* from garden shops
Conclusion

- **Only 33%** of marsh compensation in complete compliance
- Compensation habitats are important, but there is room for improvement
- Provide feedback by completing online survey at: [www.surveymonkey.com/r/SNB9FYZ](http://www.surveymonkey.com/r/SNB9FYZ)