Using Forest Inventory Data to Assess Changes in Minnesota’s Northeast Moose Habitat

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Moose Habitat in Minnesota

Figure 1: Moose Habitat Zones in Northern Minnesota. Primary habitat zone data (circa 2010) courtesy of Minnesota DNR Data Deli. Secondary habitat zone adapted from Moose Advisory Committee (2009).
Figure 2. Northeast moose survey area and sample plots (cross hatching) flown in the 2013 aerial moose survey (DelGiudice 2013).
Moose Population Trend

(DelGiudice 2013)

Estimated moose

\[ r^2 = 0.8401 \]
\[ P = 0.0005 \]
What is causing the decline?

• Low levels of adult survival and calf recruitment
  – Disease?
  – Parasites?
  – Predation/Hunting?
  – Climate change?
  – Habitat change?
Statewide Harvesting Trend

Data Source: Pulpwood (USFS, Northern Research Station), sawtimber and fuelwood (MN DNR surveys).

Taken From: Minnesota’s Forest Resources 2012
## Volume of timber harvest from Superior National Forest

<table>
<thead>
<tr>
<th>Federal Fiscal Year</th>
<th>Volume Harvested (MBF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 00</td>
<td>66,633</td>
</tr>
<tr>
<td>FY 01</td>
<td>71,408</td>
</tr>
<tr>
<td>FY 02</td>
<td>56,509</td>
</tr>
<tr>
<td>FY 03</td>
<td>46,507</td>
</tr>
<tr>
<td>FY 04</td>
<td>55,147</td>
</tr>
<tr>
<td>FY 05</td>
<td>48,590</td>
</tr>
<tr>
<td>FY 06</td>
<td>32,445</td>
</tr>
<tr>
<td>FY 07</td>
<td>27,930</td>
</tr>
<tr>
<td>FY 08</td>
<td>32,330</td>
</tr>
<tr>
<td>FY 09</td>
<td>50,163</td>
</tr>
<tr>
<td>FY 10</td>
<td>49,851</td>
</tr>
<tr>
<td>FY 11</td>
<td>40,152</td>
</tr>
<tr>
<td>FY 12</td>
<td>50,907</td>
</tr>
</tbody>
</table>

Note: 1 cord = 500 Bd ft

SNF harvest data courtesy of Tim O’Hara, Minnesota Forest Industries, Duluth, MN
Forest Inventory and Analysis Program

- Inventories began in 1930s, and include estimates for 1977 and 1990, in addition to annually updated 5-year estimates starting with the 1999-2003 FIA cycle.

- Data used to project forest conditions 10 to 50 years or more into the future.

- Serves as key data for policy development and investment analysis...for economic development, forest management, and resource protection, etc.

- Used to evaluate status and trends in:
  - forest area, species, size, and health of trees;
  - total tree growth, mortality, and removals by harvest;
  - wood production and utilization rates;
  - forest land ownership.
FIA in Northern Minnesota

- 1,258 permanent sample plots within the primary moose habitat zone.
  - Includes 4 subplots covering 0.0415 acres per subplot
- 1/5\textsuperscript{th} of plots measured each year
- In 2011, 224 plots fell on non-forested conditions:
  - Non-forested land (92),
  - Open water (132),
  - Not sampled (37)
Forestland Ownership

Primary Moose Habitat Zone
- National Forest: 64%
- Private: 14%
- State: 12%
- County and Municipal: 10%
- Other: 0%

Forestland Acres = 2,773,798
84.7% Forested

Secondary Moose Habitat Zone
- National Forest: 6%
- National Park Service: 2%
- Private: 38%
- State: 37%
- County and Municipal: 16%
- Other: 1%

Forestland Acres = 5,554,128
46.6% Forested
Forest Age distribution within the primary moose habitat zone (2005 vs. 2011)
### Comparing Moose Population and Forest Inventory Data

#### Table 1: Moose population estimates and corresponding FIA estimates of forestland in the 0-10 year age-class, acres disturbed by harvest, wind, weather, fire, flood (includes beaver damage), human, and unknown causes, and acres of open water.

<table>
<thead>
<tr>
<th>Moose survey year</th>
<th>Moose population estimate</th>
<th>Acres 0 to 10-year old forestland</th>
<th>Acres 0 to 10-year aspen-birch-willow</th>
<th>Harvested acres</th>
<th>Acres harvested and/or disturbed</th>
<th>Open water</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>---</td>
<td>227,632</td>
<td>129,527</td>
<td>91,503</td>
<td>352,299</td>
<td>394,589</td>
</tr>
<tr>
<td>2004</td>
<td>---</td>
<td>236,889</td>
<td>136,712</td>
<td>89,629</td>
<td>343,311</td>
<td>405,490</td>
</tr>
<tr>
<td>2005</td>
<td>8,160</td>
<td>250,817</td>
<td>140,855</td>
<td>91,651</td>
<td>303,238</td>
<td>427,147</td>
</tr>
<tr>
<td>2006</td>
<td>8,840</td>
<td>241,238</td>
<td>126,853</td>
<td>89,405</td>
<td>236,019</td>
<td>393,319</td>
</tr>
<tr>
<td>2007</td>
<td>6,860</td>
<td>236,149</td>
<td>113,228</td>
<td>81,747</td>
<td>180,647</td>
<td>389,109</td>
</tr>
<tr>
<td>2008</td>
<td>7,890</td>
<td>241,834</td>
<td>117,737</td>
<td>67,467</td>
<td>126,584</td>
<td>386,185</td>
</tr>
<tr>
<td>2009</td>
<td>7,840</td>
<td>209,084</td>
<td>101,818</td>
<td>58,966</td>
<td>123,015</td>
<td>351,370</td>
</tr>
<tr>
<td>2010</td>
<td>5,700</td>
<td>206,087</td>
<td>106,983</td>
<td>71,346</td>
<td>194,748</td>
<td>349,247</td>
</tr>
<tr>
<td>2011</td>
<td>4,900</td>
<td>203,766</td>
<td>107,976</td>
<td>71,468</td>
<td>236,007</td>
<td>348,271</td>
</tr>
<tr>
<td>2012</td>
<td>4,230</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>2013</td>
<td>2,760</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
Comparing Moose Population and Forest Inventory Data

• Estimates of changes in potential feeding habitat area do not coincide precisely with the steep decline in the moose population.

• A period of time (lag) would be needed for the moose population to respond to changes in its habitat.
  – Moose depend on body mass gained, and hence food availability, from the preceding summer to survive the winter.
More explanation regarding assumed lag response times

• We assumed a 1 year expected response time to changes in area of young forestland and aquatic feeding habitat recorded by FIA.
  – For example, to determine the effect of forest conditions from 2005 on the moose population with an assumed response time of 1 year, we compare FIA data from 2005 with moose population data from 2006.

• For changes in harvested and disturbed forestland area, we assumed a longer response time.
  – For example, the time required for disturbed areas to develop into young forest and serve as a food source for moose will vary depending on forest type and type of disturbance.
  – We assume that aspen will produce abundant suckers 1 or 2 years following harvest/disturbance (Bates et al. 1991). We further assumed an additional year for these suckers to become small saplings, and the technical passing of another year between the FIA field season and the January moose survey.
  – Hence, for comparisons of the moose population with FIA estimates of area disturbed and/or harvested, we assumed an overall response time of 4 years.
Correlation analysis verifies the existence of a shared relationship.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Moose population estimate</th>
<th>0 to 10-year forestland (acres)</th>
<th>0 to 10-year aspen-birch-willow</th>
<th>Harvested + disturbed acres</th>
<th>Open water (acres)</th>
<th>SNF harvested volume (MBF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moose population</td>
<td>1.0000</td>
<td>0.9425</td>
<td>0.7787</td>
<td>0.9321</td>
<td>0.9344</td>
<td>0.8829</td>
</tr>
<tr>
<td>0 - 10-year forestland</td>
<td>0.9425</td>
<td>1.0000</td>
<td>0.7925</td>
<td>0.9252</td>
<td>0.9341</td>
<td>0.8598</td>
</tr>
<tr>
<td>0 - 10-year aspen-birch-willow</td>
<td>0.7787</td>
<td>0.7925</td>
<td>1.0000</td>
<td>0.7109</td>
<td>0.9324</td>
<td>0.8548</td>
</tr>
<tr>
<td>Harvested + disturbed acres</td>
<td>0.9321</td>
<td>0.9252</td>
<td>0.7109</td>
<td>1.0000</td>
<td>0.9359</td>
<td>0.8131</td>
</tr>
<tr>
<td>Open water (acres)</td>
<td>0.9344</td>
<td>0.9341</td>
<td>0.9324</td>
<td>0.9359</td>
<td>1.0000</td>
<td>0.9042</td>
</tr>
<tr>
<td>SNF harvested volume</td>
<td>0.8829</td>
<td>0.8598</td>
<td>0.8548</td>
<td>0.8131</td>
<td>0.9042</td>
<td>1.0000</td>
</tr>
</tbody>
</table>
Regression analysis quantifies the shared relationship between moose numbers and habitat variables.

- Does not address causality
Regression Analysis

Moose numbers vs. Volume harvested from SNF

\[ R^2 = 0.78 \]

\[ n = 9 \]

Moose numbers vs. Acres of young aspen – birch – willow

\[ R^2 = 0.61 \]

\[ n = 8 \]
Regression Analysis

Moose numbers vs. Area of open water

R² = 0.87

n = 8

$R^2 = 0.87$
Conclusions/Discussion

• This analysis suggests that habitat limitations may be playing a role in the observed moose population decline...directly or indirectly.

• Given the substantial loss in total area of summer feeding habitat, it is possible that Minnesota’s Moose population is experiencing pressure due to food resource limitations.
Suggestions/Questions?

• Re-examine the historical response of moose populations to forest age and age class distributions and associated disturbance... such as fires, harvesting, and loss of wetlands and other aquatic habitat.

• Examine the potential of additional disturbance on the landscape to benefit the moose population.

• Further examination of how moose use recently burned, harvested, or otherwise disturbed areas may help to establish the nature of the relationships indicated here.
References


• Miles, P.D. 2011. EVALiDatorPC (Version 5.01.02) [Software]. Newtown Square, PA: USDA Forest Service, Northern Research Station. URL: http://apps.fs.fed.us/fiadb-downloads/datamart.html


Steps in using FIA Data in Analysis

1. Import the X,Y coordinates from the FIA PLOT table to a GIS.
2. Attach spatially explicit attribute data to each plot.
3. Bring the modified PLOT table back into the FIA – Access data base, and update the COND table for each plot.
4. Use FIA–EVALIDator interface to make estimates for area of interest.

(Lister, Miles 2009)