# Assessing biodiversity, forest condition and the effects of management in the Northern Forest: Protocol development and field trial in the Adirondack Park

**THEME FOUR**: **Biodiversity and Protected Area Management**

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- Our research demonstrated the effectiveness of the NPS Inventory and Monitoring (IM) Program as a basis for monitoring short and long-term changes in forest structure and function across a diversity of future management objectives. Furthermore, we were able to use the protocols we modified from the IM Program to assess the effects of an intense harvest focusing on beech-regeneration in influencing forest composition.

# Project Summary

- With changes in ecological and socio-economic factors shaping the Northern Forest, ecological monitoring is needed to ensure continued forest health. We designed a monitoring system based on two existing protocols and trialing this protocol in the Adirondack Park (AP). Our goal was to provide a protocol to inform adaptive management, and to better understand changes in health of the Northern Forest in response to multiple agents of change. Our objectives were to: **1**) adapt the monitoring protocols of the NPS Inventory and Monitoring (IM) Program and USFS Forest Inventory and Analysis (FIA) Program to detect changes in patterns of focal taxa and abiotic indicators; and **2)** test our conceptual framework by evaluating the effects of an intensive harvest of American beech (*Fagus grandifolia* Ehrh.) on forest structure.
- We established 29 sampling plots in areas intensively harvested for beech removal and in standard partially-harvested stands. In each plot we sampled 14 ecological indicators including measurement of stand structural class, canopy closure, snag abundance, coarse woody debris, tree condition, tree regeneration, understory diversity, amphibian species diversity, and invasive exotic plants. Our findings suggest that three years post-harvest, the removal of beech did not result in a widespread change in the makeup of the forest compared to similar, previous harvest stands. The findings of our study have been disseminated through our partner organizations, with a peer-reviewed article currently under revision.
- In general, our modified monitoring protocol provides sufficient information to allow managers to address a diversity of questions relating to different objectives. We believe that the NPS IM monitoring protocol represents a valuable standardized addition to existing forest monitoring programs being conducted across the Northern Forest. Of specific value is the fact that this monitoring protocol not only address forest structure as it relates to silviculture (the target of existing FIA plots), but also includes a focus on aspects of overall biodiversity likely to be sensitive to continued habitat change.

# Background and Justification

A core component of developing a forest monitoring protocol for adaptive management is the identification of ecological indicators against which to measure change. As the proposed protocol will monitor ecological integrity (i.e., a general measure of composition, structure and function across multiple temporal and spatial scales under a wide array of possible management options, indicators should be comprehensive enough to assess composition, structure and function across multiple spatial scales.

# General criteria for selecting indicators include:

1. Readily interpreted
2. Sufficiently sensitive to changes in environmental conditions that they will exhibit a measurable change within a time-scale appropriate to monitoring efforts
3. Readily measured using standardized techniques

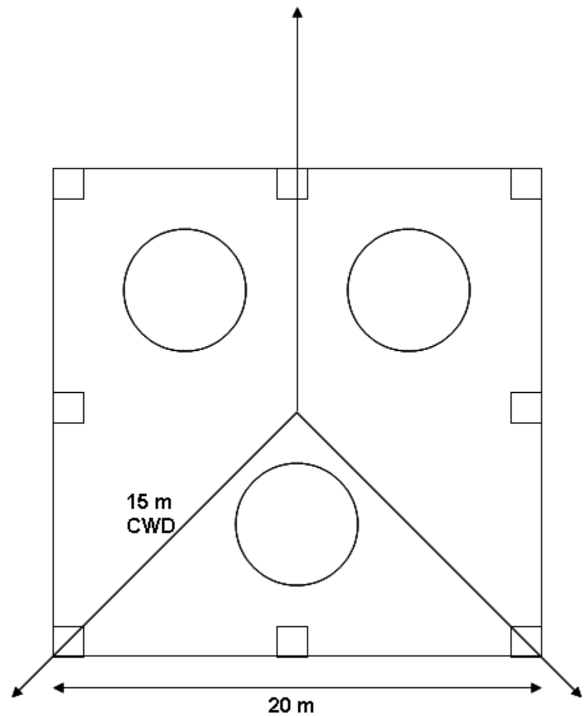
# Validating concept

- To test the monitoring protocol we compared forest structure and function in stands intensively harvested for removal of American beech, with previously harvested stands

# Methods

- Forest sampling plots adapted from the monitoring protocols of the NPS IM Program and USFS FIA

# Plot design




National Park Service Northeast Temperate Network forest monitoring plot layout used in monitoring forest health (reproduced from Tierney and Faber-Langendoen 2009). Nested 2-m radius regeneration microplots are shown as black circles, 8 1-$m^2$ vegetation quadrats as small rectangles, and 3 15-m long coarse woody debris transects as arrows extending from the center of the plot.

# Metrics used to quantify ecological integrity on the Shingle Shanty Preserve and Research Station, Long Lake, NY.

| Metric type | Metric | Aspect of study from which data were gathered | Method of deriving metric |
|---|---|---|---|
| Structure | Stand structural class | 20x20m square plots | Single classification based on the entire plot. Basal area (BA) of live trees calculated for poles (10-25.9cm dbh), mature (26-45.9cm) and large trees (≥46cm dbh). |
| | Snag abundance | 20x20m square plots | Calculated as the number of snags per 20x20m plot converted to snags/ha (snags per plot/0.04). Log base 10 (X + 1) used for analysis. |
| | Abundance of coarse woody material (CWM) | Three 15-m transects per plot | CWM converted to $m^3/ha$ using the following formula for each transect:<br>CWM $m^3/ha = ((\pi^2/(8*\text{transect length in meters}))*\Sigma\ \text{diameter}^2$ in cm of all CWM on transect<br>Averaged across the three transects in each plot. |
| | Live tree volume | 20x20m square plots | Tree volume for each live tree (>10cm dbh) in a stand was calculated as:<br>Individual tree volume = $(\pi*dbh2*h_c)/80{,}000$<br>Where $h_c$ = is an estimate of stand height adjusted for the canopy position of the tree (for dominant trees, $h_c = 1.1$ stand height, for codominant and open-growth trees $h_c = 1$, for intermediate and sub-canopy trees $h_c = 0.8$, and for over-topped trees $h_c = 0.5$).<br>Volume of live trees $m^3/ha$ was calculated as the sum of all live plot tree volumes/0.04. We also calculated the volume of F. grandifolia in each of the harvest types. |
| Composition | Tree condition | 20x20m square plots | % total crown was recorded for all live trees in the plot. Mean crown for all trees and for F. grandifolia was compared between the two harvest types. |
| | Indicators of deer browse | Three 2-m radius circular microplots | Mean ratio of seedlings in lowest height class (15-29.9cm) to taller seedlings (all other classes) was assessed from the average ratios for individual tree species classified as highly preferred deer browse. |
| | Plant diversity | Eight 1-$m^2$ quadrats | Simpson's indices calculated for the combined percent cover of plant species across the eight quadrats in each plot. |

# Results/Project outcomes

- The general characteristics of the 29 plots sampled varied both within and between the two treatments (beech removal and previous harvest).
- Stand structure based on initial assessment in the field fell into four of the five available categories used by NPS (no stands were characterized as woodland). These included 10 plots categorized as mosaic, i.e., containing two structural classes each of which covered >25% of the plot; 10 multi-aged plots, representing mature forest with a clear canopy and mixed-aged understory; 7 early-successional plots; and 2 even-aged plots with a single cohort of trees dominating.
- The beech removal treatment included six of the early successional plots with the remaining plots in this stand being multi-aged (N = 2) and mosaic (N = 2).

# Comparison of mean attributes (± std. dev.) of structural and functional metrics measured in previously harvested and beech removal stands in the Shingle Shanty Preserve and Research Station.

| Metric | Previously harvested | Beech removal | t-statistic* | P-value |
|---|---|---|---|---|
| **Structural metrics** | | | | |
| **Basal area $m^2$/ha of mature trees (26-45.9cm)** | 10.728 ± 6.025 | 6.891 ± 4.084 | 2.028 | **0.053** |
| **Basal area $m^2$/ha of poles (10-25.9cm dbh)** | 7.910 ± 3.488 | 6.276 ± 2.970 | 1.325 | **0.200** |
| **Snag abundance/ha** | 46.05 ± 41.05 | 35.00 ± 21.08 | -0.444 | **0.660** |
| **CWM $m^2$/ha** | 77.007 ± 52.980 | 105.893 ± 98.502 | -1.035 | **0.310** |
| **Live tree volume $m^3$/ha** | 79.058 ± 48.697 | 62.072 ± 49.584 | 0.887 | **0.383** |
| **Live F. grandifolia tree volume $m^3$/ha** | 37.403 ± 26.921 | 14.232 ± 9.536 | 2.617 | **0.014** |
| **Compositional metrics** | | | | |
| **% total crown** | 86.846 ± 6.831 | 89.913 ± 4.729 | -1.264 | **0.217** |
| **% total crown F. grandifolia** | 86.263 ± 6.594 | 88.740 ± 6.329 | -0.974 | **0.338** |
| **Plant species diversity (Simpson Index)** | **0.872 ± 0.067** | **0.837 ± 0.071** | **1.301** | **0.204** |

Outreach efforts

- Results disseminated through partner organizations
- Final peer-reviewed publication

# Implications and applications in the Northern Forest region

- Our protocol provides sufficient information to allow managers to address a diversity of questions relating to different objectives.
- We believe that the NPS IM monitoring protocol represents a valuable standardized addition to existing forest monitoring programs being conducted across the Northern Forest.
- Of specific value is the fact that this monitoring protocol not only address forest structure as it relates to silviculture (the target of existing FIA plots), but also includes a focus on aspects of overall biodiversity likely to be sensitive to continued habitat change.

# List of products

- 29 forest plots suitable for long-term monitoring in the region
- Established monitoring protocol suitable for a wide variety of forest monitoring applications in the Northern Forest
- Peer-reviewed publication in revision (resubmission by December 2012)