Response of tree regeneration to commercial thinning in spruce-fir forests of the Northeast

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In addition to improving forest growth &yield, commercial thinning of spruce-fir also increases the abundance of desirable conifer regeneration

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http://www.nsrcforest.org
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http://www.umaine.edu/cfru/

Project Summary

Forests support more species than any other terrestrial ecosystem on Earth. Forests also provide humans with numerous goods and services, including clean air, potable water, and wood products. Sustaining forests and the benefits they provide ultimately hinges on the forest's capacity to regenerate after disturbance (e.g., windstorm, fire, timber harvesting, etc.).

The spruce-fir forest type is important to the economy of the northeastern US. This northern conifer forest type supports multiple wood products industries, yet also provides numerous recreational opportunities for residents and non-residents alike. Of the northeastern US forest, the spruce-fir type is the most intensively managed.

Owners of northeastern spruce-fir forests interested in timber production are increasingly applying commercial thinning on their lands. Commercial thinning is traditionally used to enhance tree growth by reducing crowding, while harvesting merchantable trees for forest products. Enhanced growth of the remaining trees is driven by increases in the availability of plant resources, such as light, water, and nutrients. This transient increase in plant resources may also stimulate the establishment of new trees, a process called regeneration.

Project Summary continued

Although triggering regeneration is not traditionally an objective of thinning, understanding what responses to anticipate can help forest managers plan for future operations that renew their forests after final harvest. This knowledge is particularly valuable when sustainably managing forests dependent on natural regeneration, such as northeastern spruce-fir forests.

We used two long-term commercial thinning experiments in spruce-fir forests of Maine maintained by the University of Maine's Cooperative Forestry Research Unit to test two hypotheses: 1) commercial thinning increases the abundance of tree regeneration and 2) tree regeneration abundance increases with increasing thinning intensity. A decade after thinning, abundance of desirable conifer regeneration was 10-times greater in thinned than unthinned stands. Small conifer abundance was highest in lower intensity thinning treatments, while the abundances of larger conifer regeneration increased proportionally with thinning intensity. The abundances of broadleaf species regeneration generally increased with thinning intensity. Therefore, in addition to providing higher individual-tree growth and merchantable yield, commercial thinning in northeastern spruce-fir stands also increases regeneration abundance.

Project Summary continued

This response to commercial thinning has implications for the sustainability of managed northeastern spruce-fir, since commercial thinning may simultaneously improve tree growth and accumulate desirable conifer regeneration. In turn, this could shorten rotation length by reducing the time needed to develop acceptable regeneration abundance under more traditional methods for regenerating spruce-fir forests.

Background and Justification

- The spruce-fir forest type of the northeastern US and eastern Canada is ecologically & economically important to the region
- There is currently over 5 million acres of spruce-fir forest available for commercial timber harvesting in the northeastern US
- Much of this forestland could benefit from commercial thinning to reduce forest density and alleviate competition among trees
- Landowners in the northeastern US are interested in practicing this form of mid-rotation forest management more extensively
- Dominant tree species of this forest type (spruce and fir) are adapted to respond to small-scale disturbances, like thinning
- In particular, thinning likely stimulates the establishment and growth of young spruce and fir trees in the forest understory

Background and Justification continued

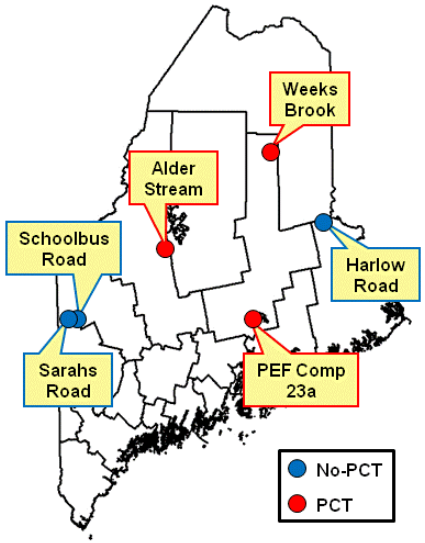
- Knowing how much regeneration to anticipate, especially that of desirable conifer species (spruce, fir, and pine), can help forest managers plan for future operations

- Understanding regeneration response to commercial thinning is important in forest types where managers rely on natural regeneration, such as spruce-fir

- Unfortunately there are few datasets available for evaluating regeneration response of spruce-fir forests to commercial thinning

Methods

- We used two long-term thinning experiments maintained by the University of Maine's Cooperative Forestry Research Unit
- One experiment evaluates commercial thinning (CT) in younger fir-dominated stands previous treated with precommercial thinning (PCT)
- The other evaluates CT in older, spruce-dominated stands with no history of thinning
- Collectively these experiments represent a wide range of spruce-fir stand conditions in the northeastern US



Locations of six CTRN sites with (red) and without (blue) a history of PCT in Maine (Unpublished figure).

Methods continued

- CTRN stands used in this study were thinned in the winter of 2000-2001
- Treatments evaluated in this study were two levels of thinning (heavy & light) plus an unthinned stand for comparison
- We intensively sampled the regeneration layers of all study sites in the summer of 2011 – approximately 10 years after thinning

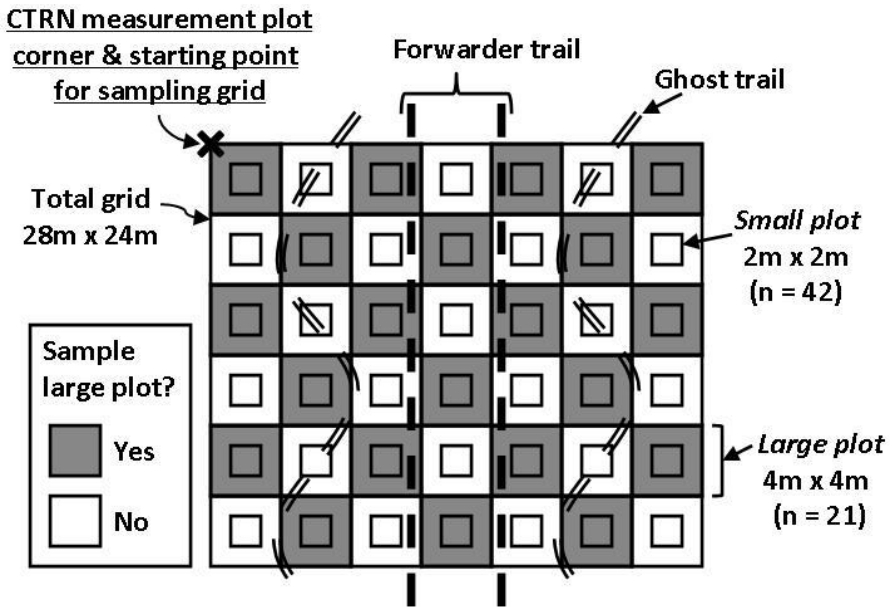
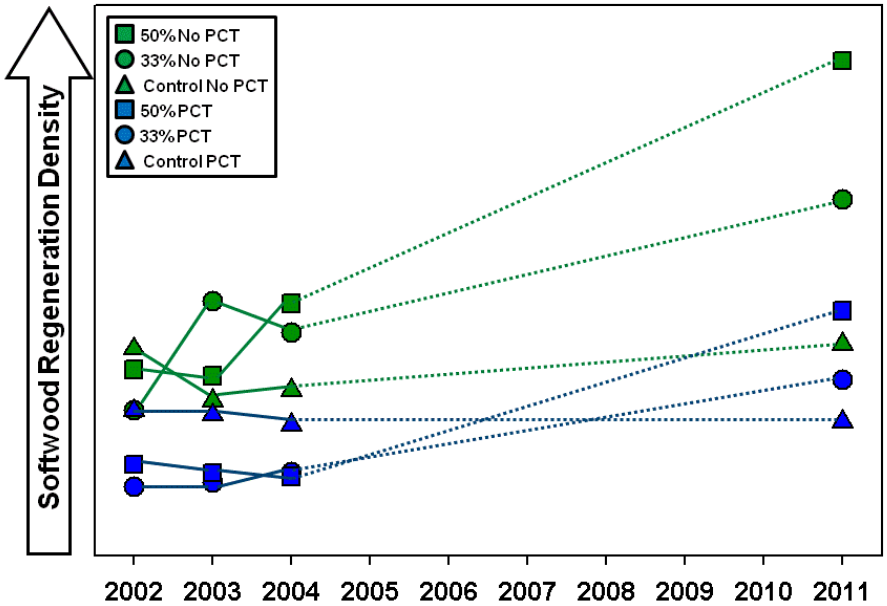


Figure depicting the design and layout of regeneration sampling plots nested within a hypothetical CTRN treatment unit. Forwarder and ghost trails refer to machine trails created by logging (Unpublished figure).

Methods continued

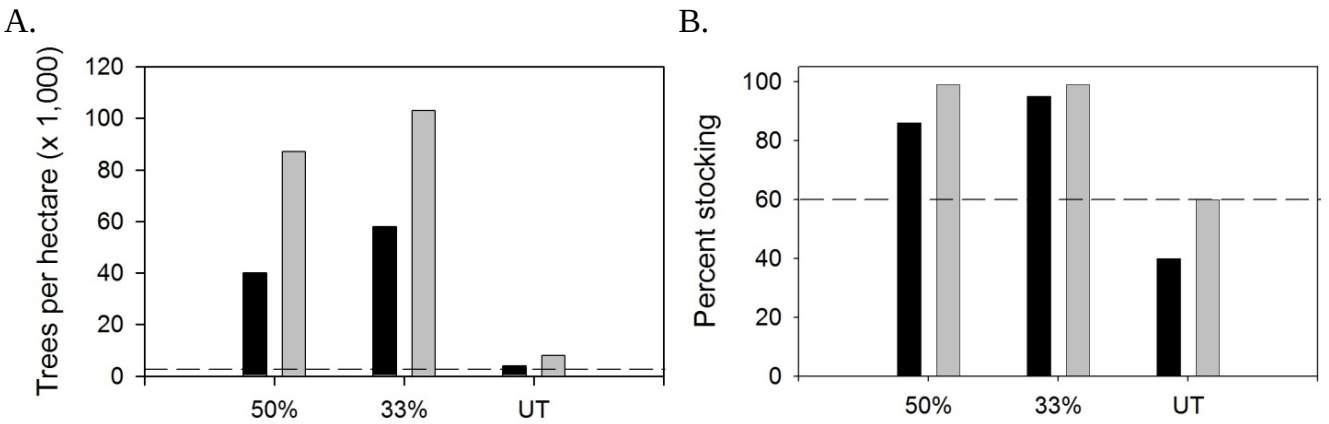
- Data collected on the status of regeneration layers of the CTRN were analyzed to test two main hypotheses:
  - 1) Commercial thinning increases the abundance of tree regeneration
  - 2) Tree regeneration abundance increases with increasing thinning intensity



Hypothesized responses in regeneration abundance (stem density) during the first decade following two levels of commercial thinning (33% and 50% for light and heavy thinning, respectively) and a control for both PCT and non-PCT stands of the CTRN. Solid lines for 2002-04 represent actual data and dotted lines represent hypothesized changes and relative differences in density among treatments at year 2011 (Unpublished figure).

Results & Project Outcomes

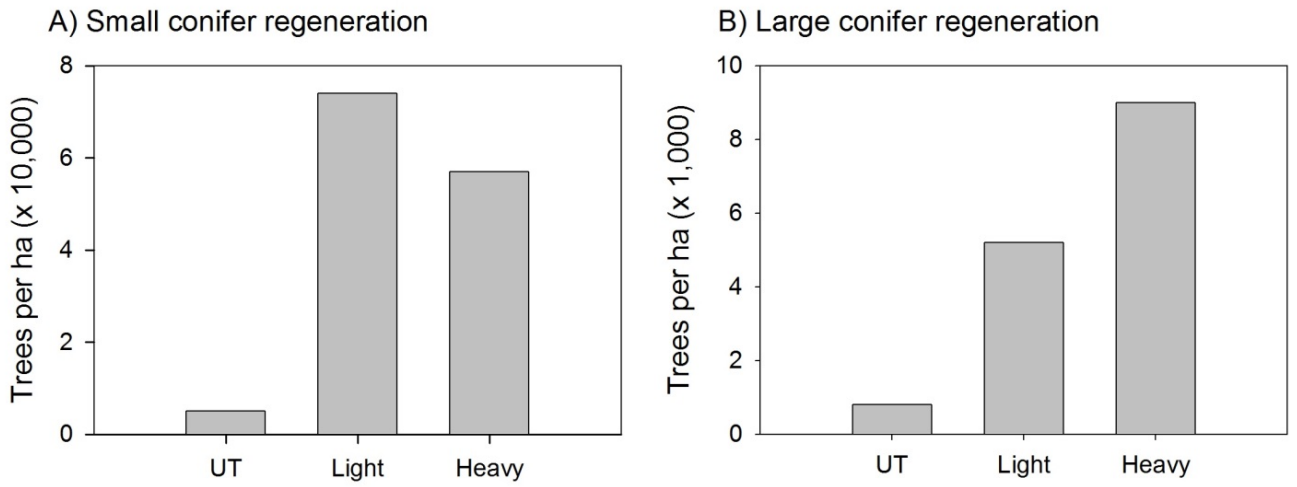
- 10 years after thinning, abundance of desirable conifer regeneration was 10-times greater in thinned than unthinned stands
- Total abundance of conifer regeneration in thinned stands exceeded regional standards of minimum acceptable abundance



Abundance (A) and percent stocking (B) of desirable conifer regeneration in fir-dominated (black) and spruce-dominated (grey) forests treated with 50% thinning (heavy), 33% thinning (light), and no thinning (UT). Dashed lines represent minimum acceptable standards for both abundance (2,500 per ha) and stocking (60%) for northeastern spruce-fir forests (Unpublished figure).

Results & Project Outcomes continued

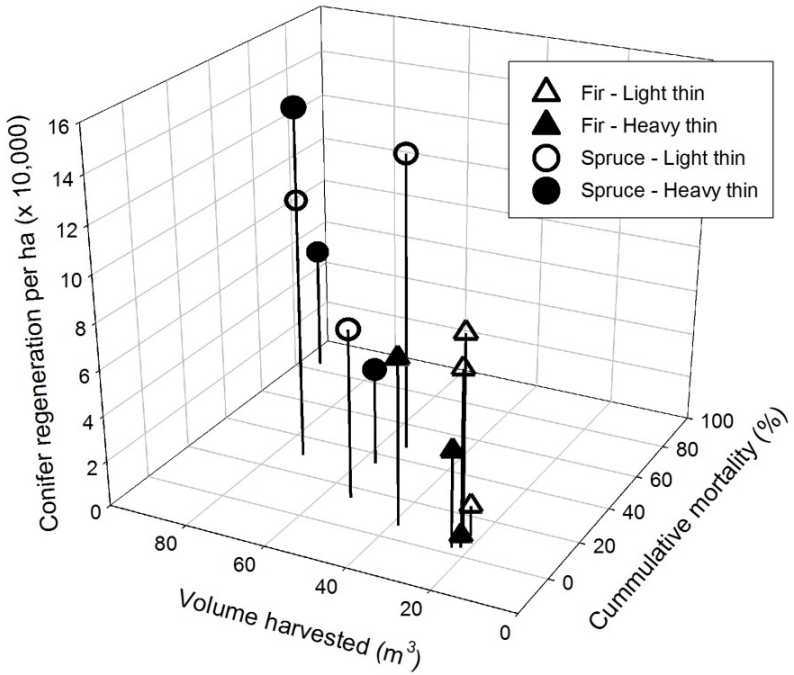
- Small conifer abundance was highest in lower intensity thinning treatments, while the abundances of larger conifer regeneration increased proportionally with thinning intensity
  - Suggesting faster growth and accelerated regeneration development as thinning intensity increased



Abundance of small (A) and large (B) conifer regeneration across both experiments of the CTRN (Unpublished figure).

Results & Project Outcomes continued

- Conifer abundance was greater in older, spruce stands (no-PCT) than younger, fir stands (PCT)
  - Mainly due to higher initial abundance, higher wood volume harvested and greater mortality of canopy trees since thinning in older, spruce stands

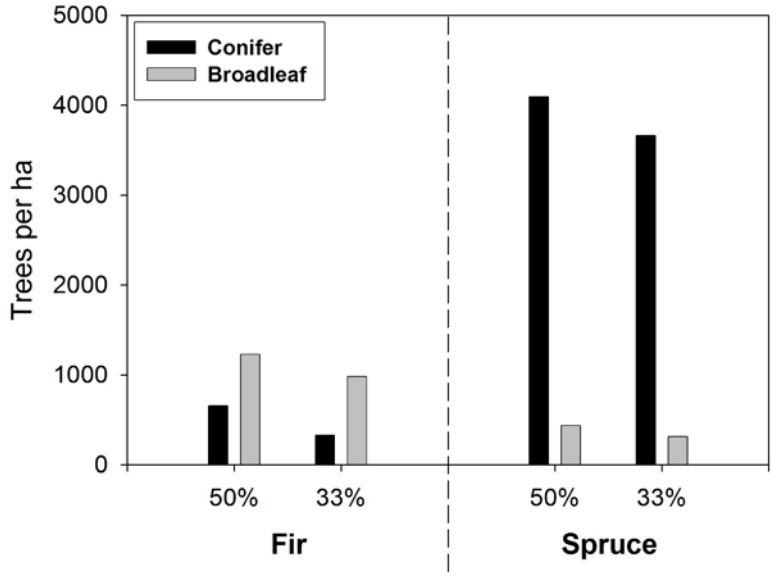


Conifer regeneration abundance in relation to volume removed during thinning and cumulative mortality since thinning under light and heavy thinning in fir and spruce stands of the CTRN (Published figure, Olson et al. 2014).

Results & Project Outcomes continued

- Broadleaf species regeneration also increased with thinning intensity & developed into a significant component after 10 years

- 10 years after thinning, abundance of large broadleaf regeneration was greater than that of large conifer regeneration in younger, fir stands, while large conifers were far more abundant in older, spruce stands



Comparison of large conifer and large broadleaf regeneration abundance 10 years after light (33%) and heavy (50%) thinning in fir and spruce stands of the CTRN.

Results & Project Outcomes continued

Outreach

- Interim results have been presented in several annual reports of the Cooperative Forestry Research Unit (CFRU)

- Findings have also been presented to forest managers during CFRU workshops

- Results were also presented at the 2012 Eastern Canada-USA Forest Science Conference and 2013 Society of American Foresters National Convention

- Results were recently published in the Canadian Journal of Forest Research – a respected forest science journal with wide readership in the northeastern US

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ARTICLE

Commercial thinning stimulates natural regeneration in spruce–fir stands

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Implications & Applications in the Northern Forest Region

- Not only does commercial thinning (CT) enhance growth and yield of the northeastern spruce-fir forests, it also increases the abundance of desirable conifer regeneration
- Therefore, CT of similar spruce-fir stands may also be used to accumulate desirable conifer regeneration prior to a final harvest
- Furthermore, CT may help in sustaining long-term productivity of spruce-fir forests of the northeastern US
- This response to CT may also occur in other northeastern US forest types dominated by shade-tolerant species (e.g., sugar maple)
- Broadleaf species regeneration also increased under thinning
- Broadleaf control measures (herbicide or mechanical treatments) may be warranted where broadleaf competition with conifers is deemed undesirable

Future Directions

- Monitoring of regeneration development beneath a thinned canopy after the first decade
  - How do different levels of thinning affect conifer height growth?
  - What effect does thinning intensity have on broadleaf species?
  - Which regeneration reaches the canopy first, conifers or broadleaf species?

- Assessment of direct (logging damage) and indirect (growth after release) impacts of a final harvest on regeneration initiated by CT
  - This is particular critical since many conifers do not sprout and past research has shown that damage can set back conifer development by several decades

- Monitoring of forest development after final harvest of a stand previously treated with CT
  - How does this compare to unthinned stands that are clearcut and stands regenerated using recommended approaches (e.g., shelterwood methods)?

- Evaluate treatment options for controlling broadleaf species, both before and after a final harvest

List of Products

Peer-reviewed publications

- Olson, M.G., S.R. Meyer, R.G. Wagner, and R.S. Seymour. 2014. Commercial thinning stimulates natural regeneration in spruce-fir stands. Canadian Journal of Forest Research. 44(3): 173-181. doi:10.1139/cjfr-2013-0227

Other publications

- Olson, M.G., S.R. Meyer, R.G. Wagner, and R.S. Seymour. 2013. In: Cooperative Forestry Research Unit: 2012 Annual Report, B.E. Roth (Ed.), 95 p. Response of tree regeneration to commercial thinning in spruce-fir stands of Maine: first decade results from the Commercial Thinning Research Network. p. 19-23.

- Olson, M.G., S.R. Meyer, R.G. Wagner, and R.S. Seymour. 2012. In: Cooperative Forestry Research Unit: 2011 Annual Report, B.E. Roth (Ed.), 111 p. Response of tree regeneration to commercial thinning in spruce-fir stands of Maine: first decade results from the Commercial Thinning Research Network. p. 20-24.

List of Products continued

Conference presentations

- Olson, M.G., S.R. Meyer, R.G. Wagner, and R.S. Seymour. Tree regeneration ten years after commercial thinning in spruce-fir stands of the northeastern US. 2013 SAF National Convention, Charleston, South Carolina, October 23-27, 2013.

- S.R. Meyer, Olson, M.G., R.G. Wagner, and R.S. Seymour. Response of softwood regeneration to commercial thinning in two northeastern spruce-fir stand types: 1st-decade results from the Commercial Thinning Research Network in Maine. 2012 ECANUSA Forest Science Conference, Durham, New Hampshire, October 2012.