

# Effects of Forest Type and Stand Characteristics on Seasonal Abundance of Forest-floor Invertebrates

## Theme #4: *Biodiversity and Protected Area Management*

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Insects and spiders varied significantly by forest stand composition and age, as well as temporally throughout the season and nocturnally/diurnally. The plantation spruce stand had the highest abundance of insects, consisting mainly of carabid ground beetles – since these were mainly nocturnally active they may be less available to birds than other nocturnal predators.

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<http://www.nsrcforest.org>

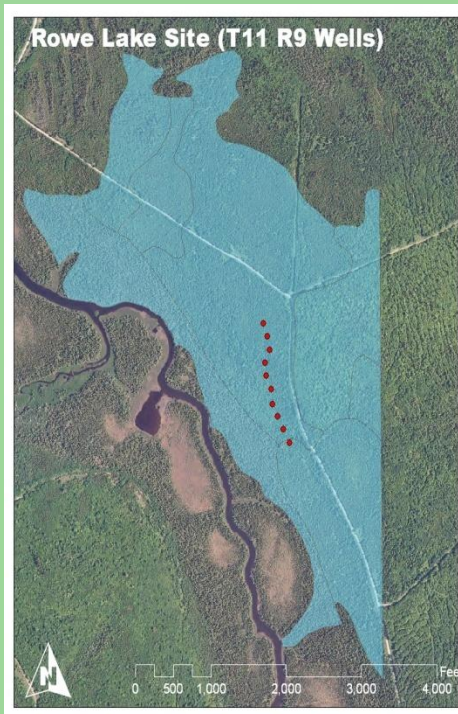
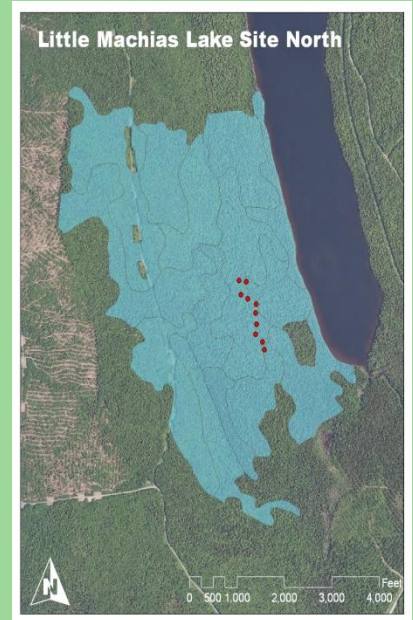
# Project Summary

To improve our understanding of the effects of forest management on invertebrates as food for vertebrates, we sampled the differences in abundance of arthropod taxa at the habitat level within four stands in Maine commercial forests: even-age spruce plantation (30 years), even-age natural regeneration (30 years), mature spruce (>80 years since last harvest) and mature hemlock (>80 years since last harvest). During late April through early August, arthropod abundance was determined using pitfall traps and branch sampling. Since arthropod abundance does not equate to food availability, food use of ground foraging and foliage gleaning birds was determined through the use of crop and fecal sampling. There were significant differences in arthropod temporal and habitat abundance between forest stand types, with spiders highest in natural regeneration, ground beetles highest in spruce plantation and ants highest in mature spruce. We found a lower abundance of spiders within the spruce plantation. After a peak the third week of May, there was a significant seasonal decline in spiders overall. Small ground beetles (Carabids) were highest in diurnal samples while large ground beetles were highest in nocturnal samples. In bird crop and fecal samples, moth and butterfly larvae, beetles and spiders appear to be the most commonly used food items. Since invertebrates form the base of most forest vertebrate food webs, an understanding of how forest management practices may impact the abundance and availability of food can be used to implement strategies that mitigate the impacts of silviculture on habitat quality for terrestrial vertebrates. Facing possible changes in tree species composition in the Northern Forest due to both invasive species and climate change, this study provides a baseline of the arthropod-bird food web within four important northern forest habitat types. Furthermore, since each of these forest habitats either persisted through or were the result of the last spruce budworm outbreak, this community ecology study may inform best management practices for the impending budworm outbreak.

# Background and Justification

- Few studies have focused on community ecology in a managed forest, comparing plantations to post-budworm stands to mature stands
- Seasonal variation in food availability has been infrequently studied
- Few studies have compared food use to food availability within the northern forest
- Climate change may affect the phenology and abundance of both trees and arthropods at the boreal-deciduous ecotone

- Four study sites that allowed us to compare both age and tree species composition
- 1) Rowe Lake → a 30-year since harvest natural regeneration stand
- 2) Westfield → a 30-year since harvest spruce plantation
- 3) Little Machias Lake South → an 80-year since harvest spruce stand
- 4) Little Machias Lake North → an 80-year since harvest hemlock + tolerant hardwood stand



Study sites (clockwise from top left): 30-year spruce plantation, 80+ year hemlock-yellow birch, 80+ year spruce, 30-year natural regeneration



# Methods

## Vegetation Measurements

- Tree species composition by size class
- Ground cover by flora, woody debris, and abiotic cover
- Canopy Closure

## Food Availability Sampling

- April-August repeated sampling
- Ground and Shrub-dwelling Arthropods
- Pitfall traps, beat-sheet method, and branch sampling



## Food Use Sampling of Birds

- Crop and fecal sampling for arthropod remains
- Two Guilds: ground-foragers and shrub gleaners



## Arthropod Identification

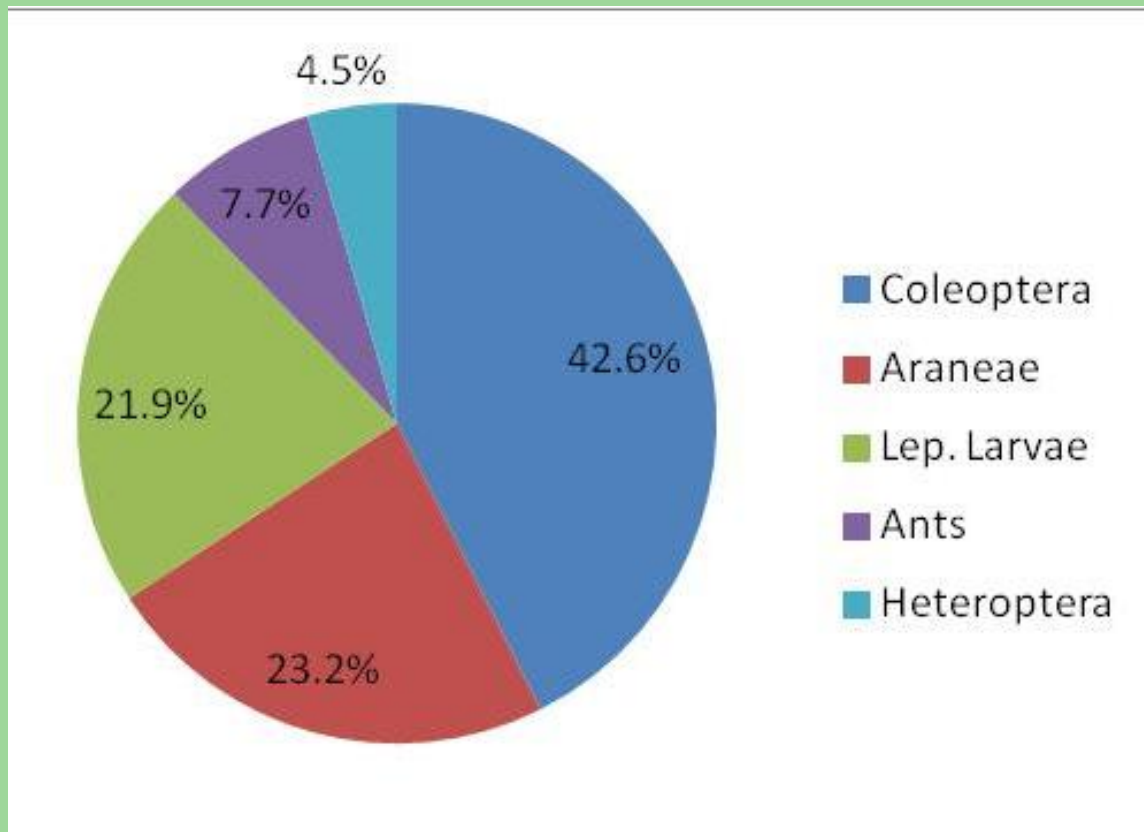
- Food availability samples identified to class, order, or family ( $n \approx 33,000$ )
- Food use samples identified to class, order (incomplete)





## Results: Food Use

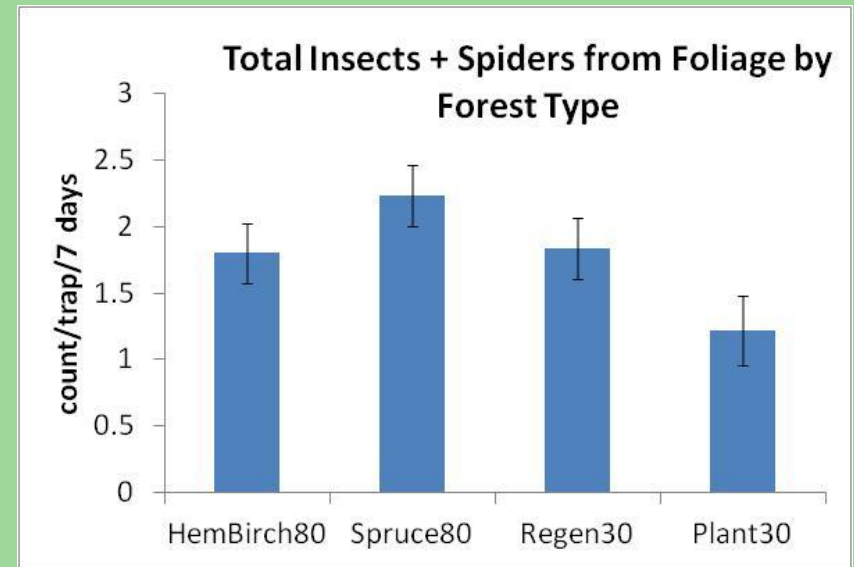
- Hermit Thrush nestlings (n=43) consumed, in order of abundance of all food items identified, beetles, spiders, caterpillars, ants, and some true bugs.



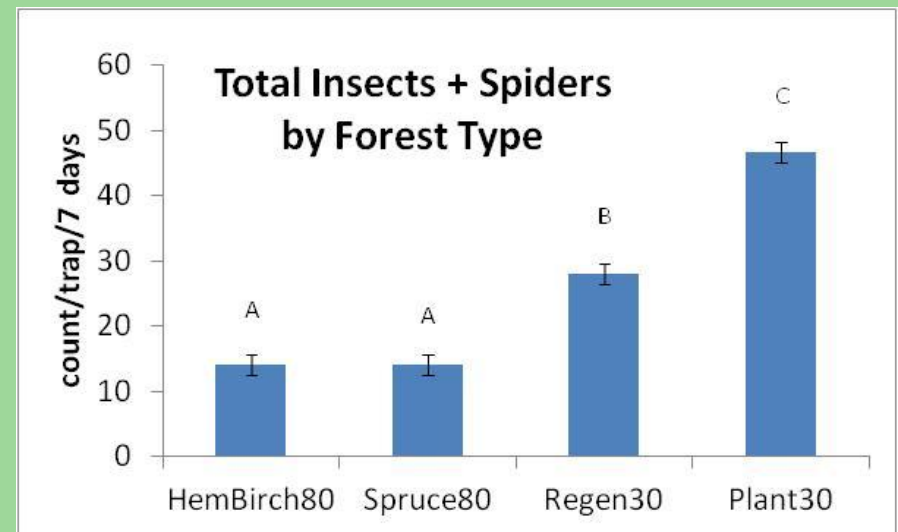
# Results: Overall Food Availability

## Total Abundance of Insects and Spiders by Habitat Type

- Foliage Samples – Old Spruce higher than young spruce plantation
- Ground Samples – Spruce plantation highest, 30-year regeneration second, both old habitats lowest



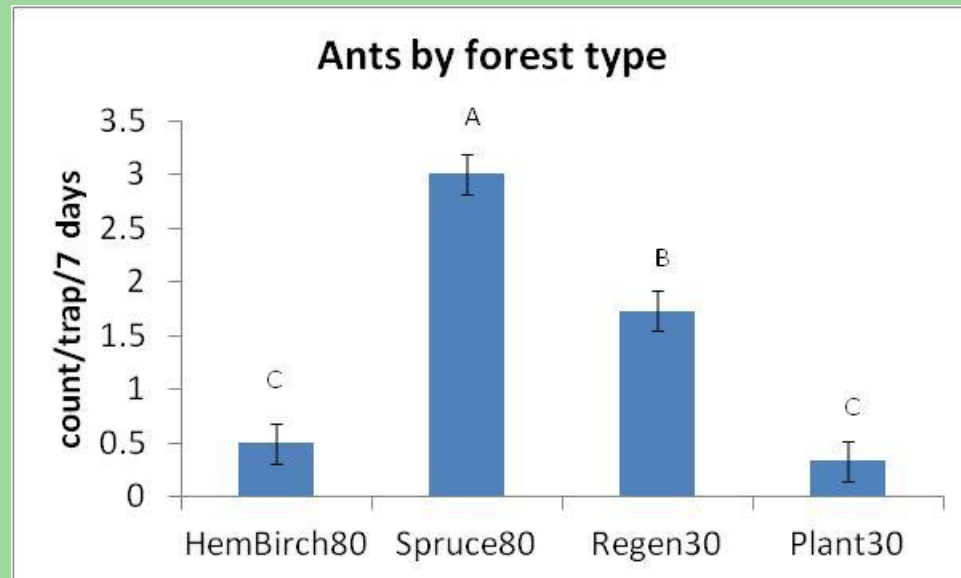
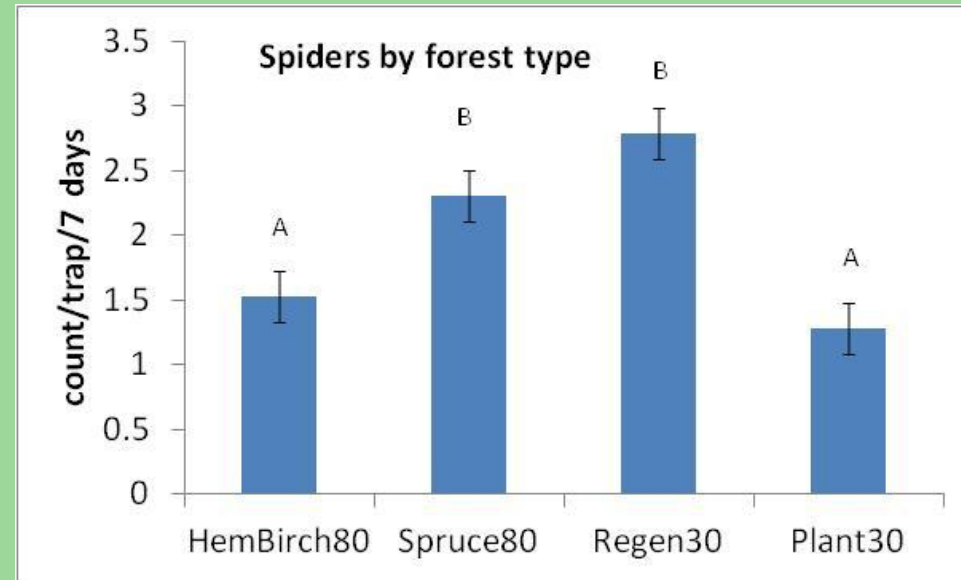
Foliage samples (above); ground samples (below)



# Results: Food Availability by Major Taxa

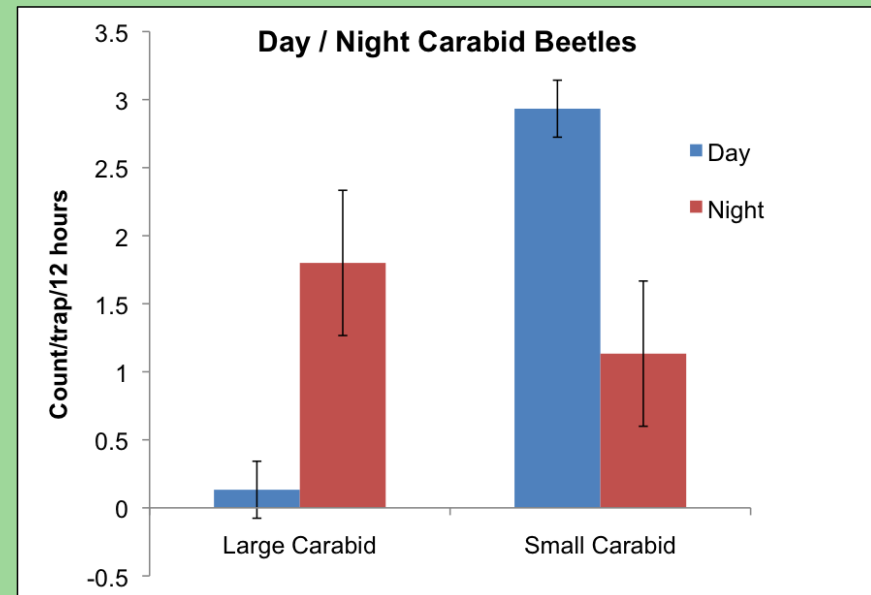
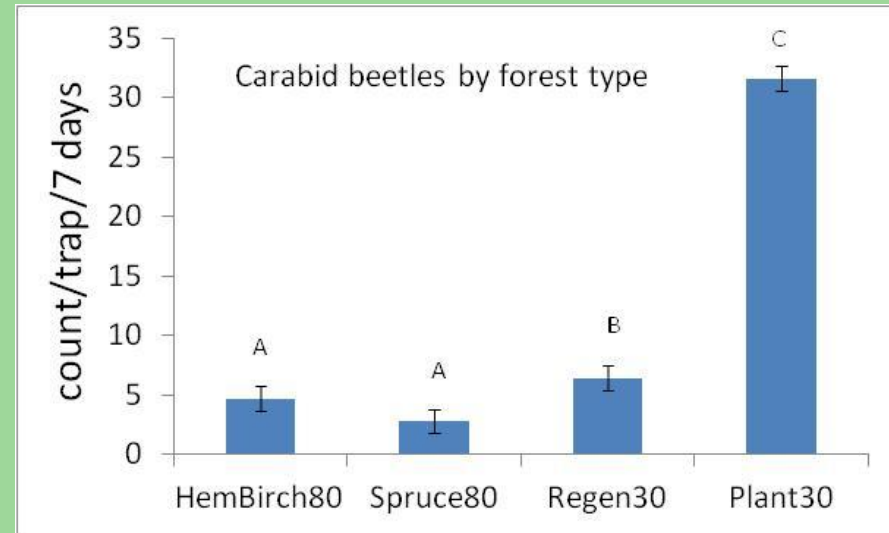
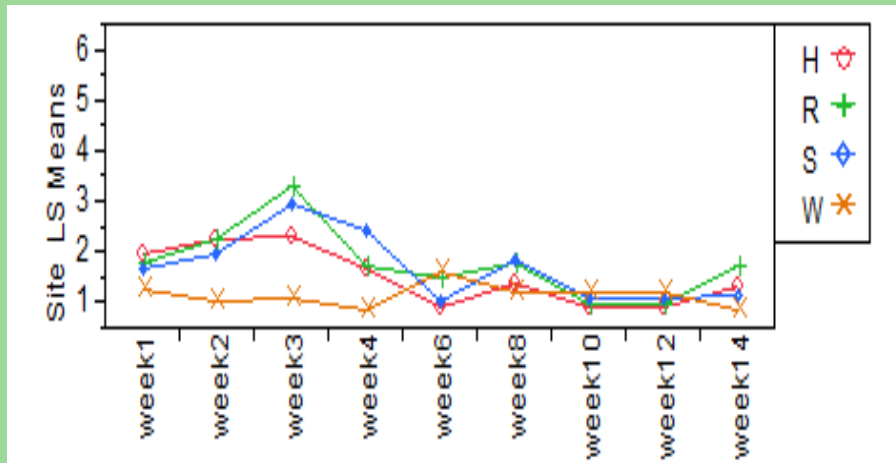
Spiders: Higher in old spruce and 30-year regeneration than old hemlock/yellow birch and spruce plantation

Ants: Highest in old spruce, next most abundant in 30-year regeneration, and lowest in old hemlock/yellow birch and spruce plantation



# Temporal Variation in Food Availability

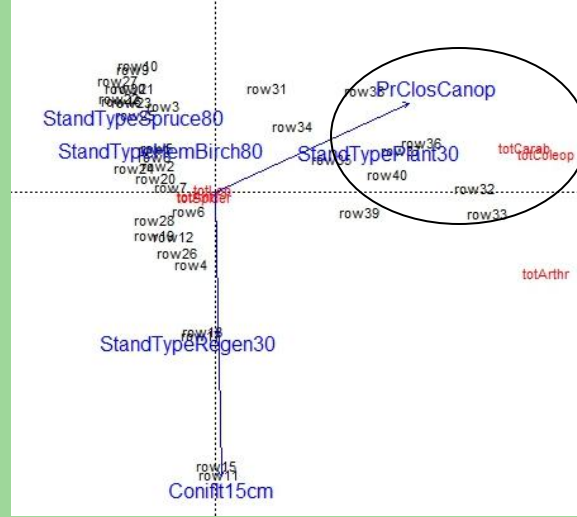
- Diurnal/nocturnal arthropod availability: There were many more ground beetles in plantation plots than all other stands (top right); Large carabids (bottom right) were mainly nocturnally active, and thus, though numerous, were likely less available as bird food.
- There was significant seasonal variation in arthropod abundance, most notably a peak in spiders in May (below) and a peak of carabids in August.



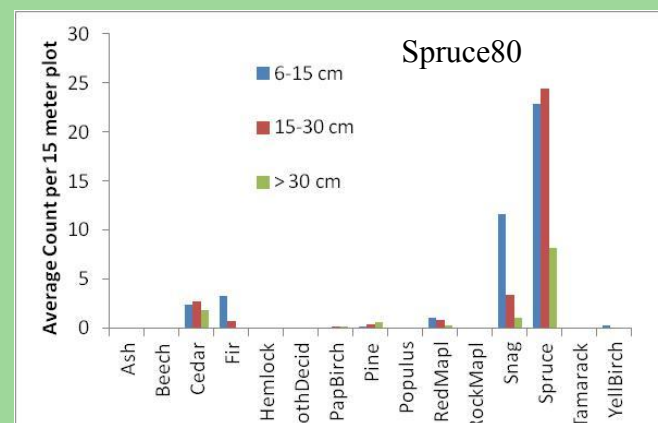
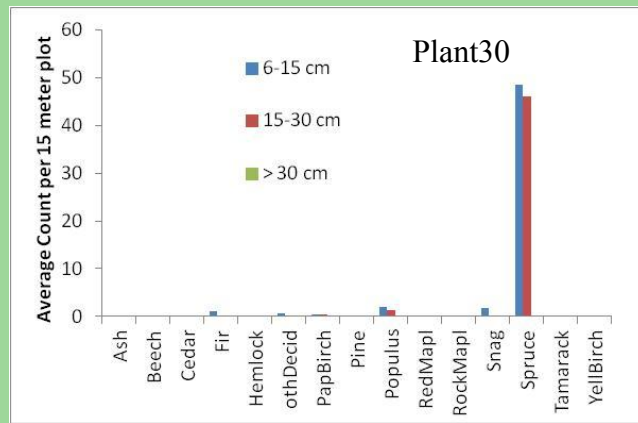
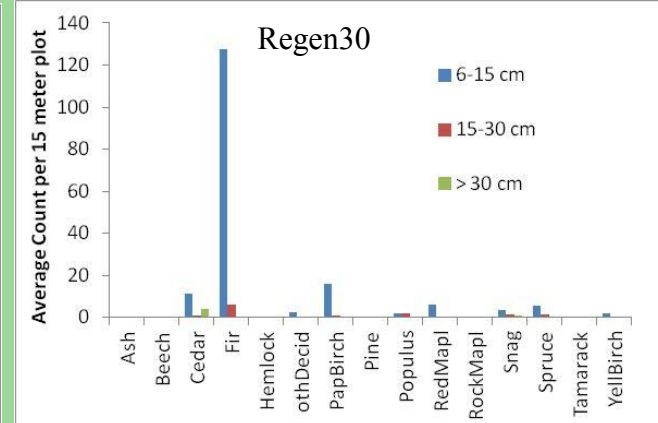
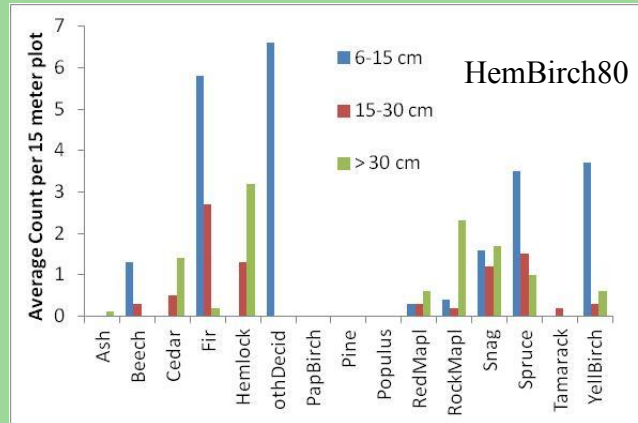
# Stand Characteristics

(top) An ordination plot illustrates that beetle abundance was correlated with canopy closure and the spruce plantation

(bottom right) Species and size class diversity illustrated by average count of 14 tree species and snags in 15 m plots



Beetle abundance was positively correlated with high canopy closure and the spruce plantation site



# Outreach

- Shared final report with local foresters and Seven Islands Land Management Company
- Undergraduate presentations at UMPI “University Day” and the Northeast Undergraduate Research and Development Symposium (NURDS) – won best poster award, March, 2013
- Invited seminar to the University of New Brunswick Biology Seminar, February, 2012

# Implications and applications in the Northern Forest region

- Differences in arthropod abundance and temporal availability between stands of different age and management history may affect predator composition within different stands
- Temporal peaks in food availability (currently during third week of May) may shift earlier with climate change
- Future declines in tree species due to threats from invasive species (e.g. Hemlock), or climate change (e.g. Spruce) may affect arthropod abundance
- This study of management approaches that followed the 1970's budworm outbreak may inform best practices following the next budworm outbreak

## Future directions

- There is the potential to re-assess arthropod abundance in one or two of these study sites after forest management activities. For example, the spruce plantation had every third row removed in 2014, and the managing forester has welcomed future re-measurement of arthropods. The Hemlock-Birch stand was selectively cut in 2012, leaving all hemlocks greater than 27" DBH.
- We have been adapting published DNA barcoding protocols to identify arthropod species from pieces recovered from fecal samples. Species-level information provides a more complete understanding of predator-prey relationships, and temporal patterns of food abundance.



# List of products

## Conference Presentations

Belair, S., D. Sheffield, D. Plissey, and J. Johnston. 2012. The Effects of Forest Type on Arthropod Abundance and Food Use by Birds. Northeast Undergraduate Research and Development Symposium, University of New England, March, 2012. \*won a 'best poster' award to S. Belair

## Seminars

Belair, S. 2013. The Effects of Forest Type on Arthropod Abundance and Food Use by Birds. University Day one-hour Presentation, University of Maine at Presque Isle, April, 2013.

Johnston, J.C. 2012. Variation in Food Availability and its Effect on Breeding Biology of Birds in Managed Spruce-Fir-Hemlock Forests. University of New Brunswick Biology Seminar (invited), February 3, 2012.