Week 1

Population Structure, Growth, and Recruitment Patterns in a Stand of Eastern White Pine (*Pinus strobus*) in Range Pond State Park, Poland, Maine, Following a Selective Harvest in 2006

**Study Objective:** The goals of this study are to document changes in the population structure, growth, and recruitment of white pines following a selective harvest in Range Pond State Park in relation to the goals of the RPSP forest management plan. We will examine the effects of the harvest on regeneration and growth of the white pines as this is of great interest and concern to the park authorities and the State of Maine Department of Conservation, Bureau of Parks and Lands.

**Supplementary Reading:** (access via Bio 270 Homepage)

http://abacus.bates.edu/~ganderso/biology/bio270/Ecological_Considerations_pinelab_sup1.pdf
http://abacus.bates.edu/~ganderso/biology/bio270/Pine_lab_questions_sup2.pdf

Today in lab we will first do some quick set up for the acid rain lab, namely, planting seeds in pots of soil to generate seedlings we will need for the experiment in a few weeks.

Following the seed planting, we will introduce the pine lab, its goals, relevant background, and then we will all tromp over to the Merrill pine grove and learn how to sample and measure trees for the data we need.

While we provide considerable information about the biology of white pines, it is your responsibility to read and learn about the relevant biology of pines and forests as it may apply to this project. Many suggested references are listed at the end of the lab to get you started.
Preparation for the Acid Rain Lab

Please carry out the following protocol to plant seeds for the acid rain lab. This experiment will be running in the background as we do the pine lab. For more information, see the acid rain lab.

Seed Planting (per group of two students)

1. **Materials**: Seeds from Connecticut Valley Biological Supply (clover CS 2638, radish CS 2507A, and sunflower CS2765); soil is a standard potting soil mix. Pots are 8.5x8.5 cm square (3.5 in²).

2. Check your pots for previous labeling. **S**=sunflower, **R**=radish, and **C**=clover. Try to use the pot for the labeled species.

3. Fill 9 pots with soil, then tamp the soil down with another pot to loosely compact the soil to fill the pot about ¾ full.
   
   a. **In each sunflower pot**, plant five intact sunflower seeds (no cracks in the seed coat) pointy end down with four seeds arrayed in a square and the 5th planted in the center (Fig. 1) and then cover with a layer of soil to the hip of the pot. The goal is to provide each seedling equal space in the pot. **LABEL each pot with an “S” if not already so marked.**

   b. **Radish and Clover**: In each pot, plant 12 seeds in a 3 x 4 square array (Fig. 1), gently pushing them slightly into the soil (about a seed diameter) using forceps. **LABEL each pot with an “R” or a “C,” respectively, if not already so marked.**

4. Cover each pot with a shallow layer (1 cm) of soil and gently tamp down again. About 0.5 cm of the rim of the pot should still be exposed above the soil level.

5. When all pots have been planted, place them in the labeled trays provided on the cart in lab so that they can transported to the greenhouse.

6. Watering of the plants to initiate germination and seedling growth will begin 30 days prior to the completion of the experiment (10 days for seedling establishment; 20 days for treatments).

![Figure 1. Suggested seed planting arrays to assure equal spacing. Forceps can be used to move individual seeds around to achieve equal spacing.](image)

Introduction
The white pine (*Pinus strobus*) (Fig. 2) is an important component of the northern forests including New England’s. The prevalence of white pines in New England forests has increased over the last century due to, in large measure, historical changes in the landscape related to removal, during the early settlement, of hardwood-pine forests for timber and agriculture, and the subsequent abandonment of agricultural fields. **To learn more about the changes to New England’s landscape since settlement view the excellent dioramas at the Harvard Forest website:** http://harvardforest.fas.harvard.edu/dioramas

A species capable of rapid colonization of open space (=ruderal), white pine was probably found in small stands associated with disturbances such as forest fires or gaps created by canopy thinning or blow downs. Following European colonization of New England, a long period of deforestation occurred as pastures and crop fields were carved out of the forests. However, subsequent abandonment of much of the agricultural landscape allowed the forest to regenerate, albeit in a somewhat different pattern. Ruderal species such as white pine took over much of the young forest and resulted in a much larger stands of pines than had existed previously. The regenerated forest we know in southern Maine today is a mixture of hardwood and softwood species often dominated, at least initially, by white pine. Hardwoods common in these forests include birch, beech, maples, oaks, and ash. Virtually all forest stands in this area of Northern New England are recent (<100 YO), relatively young forests that have developed on abandoned agricultural land.

In this study we continue an ongoing Bio 270 investigation of a population of eastern white pine growing in a young (50-70 YO), early successional, mixed hardwood-pine forest along Plains Road on the northeastern border of Range Pond State Park in Poland, Maine (Fig. 3). Based on analysis of aerial photographs of the area, we have determined that the forest in this area was previously harvested sometime in the 1950’s while the land was still in private ownership. The park was established in 1970, and since that time (and probably since the last harvest) there have been no forest management interventions on the site until the spring of 2006. In an effort to generate revenues to help fund state park operations, and to improve forest and habitat quality, the then Department of Conservation - Bureau of Parks and Lands undertook a demonstration forest management project that resulted in a selective harvest of white pines and other species in the area we have been studying. **The relevant portions of the management plan for Range Pond State Park are provided for you in Appendix 1.** The 2006 harvest presented an opportunity to study the effect of the selective harvest on the pine population in terms of subsequent growth of the mature stand and to evaluate the impact on recruitment and growth of seedlings.
In this study you will (1) characterize and compare “mature” white pine populations in both harvested and adjacent non-harvested areas for age, size, and spacing, and (2) characterize the seedling/sapling populations of white pine in the same areas for age, size, recruitment, and growth patterns to determine the effects of the selective harvest on these populations. If we are able to acquire a good sample of seedling/saplings, then your report will either focus on the mature population, or on the seedling/saplings. We will also quantify the hardwood understory.

Figure 3. A) 2010 aerial view of the study site along Plains Road (upper side), and B) location of study site (star) near Lower Range Pond in Range Pond State Park, Poland, Maine.

See also: Aerial photos of the park area 1949 to present for changes to landscape over time.
http://abacus.bates.edu/~ganderso/biology/bio270/RP_USGSaerial_photos.html

BRIEF PRIMER ON WHITE PINE NATURAL HISTORY
(Required reading: Lancaster and Leak, 1978 – pdf posted on Supplements page of the Bio 270 website – short; read only pages 1-4 for basic white biology.)

Woody plant growth: Long-lived plants such as trees exhibit tremendous plasticity in growth form and can respond to changing growth conditions (abiotic and biotic) throughout their lives. In woody plants we recognize two growth axes: primary growth, which occurs at the apical meristems (branch tips and stem leader) and adds height to the plant and length to branches, and secondary growth, which occurs at the lateral meristems and adds girth to the stem and branches. In areas of the world such as ours, with distinct winter and summer seasons, each year a new layer of wood is produced – familiar to most of you as growth rings – whose density and cell size are very sensitive to local growing conditions. This fact makes trees of temperate latitudes excellent historical records of climate conditions over time.
Recruitment strategy: *Pinus strobus* is a *ruderal* species, that is, it is an early colonizer of disturbed sites; white pine is usually one of the first species to grow on abandoned agricultural land and newly opened *gaps* in the forest. A gap is an area in which a tree, or many trees, may have died, or fallen, or have been cut, leaving a clear area open to the sky. Gaps provide a place for many shade intolerant herbaceous and woody plants to grow. Assuming there is some seed fall every year from the pines, those seeds that fall into gap areas receiving adequate light and moisture will be most successful in germination and subsequent establishment. You may see patches of older, larger seedlings at the study site that established and grew in such gaps. Because white pine is shade intolerant, it is unusual to see pine dominated stands comprised of more than 2 age cohorts.

Typical growth characteristics: White pine is a long-lived species and may attain ages of 200+ years. Typically, during the first 5-6 years in New England, pine seedlings grow slowly, attaining 30-35 cm total height. In New England, a white pine growing in good light conditions (~50% full sun) requires 8-10 years to reach 1.37 m (4.5 ft) in height; foresters call this point *breast height* and use it as a standard benchmark for size measurements. Following this period of relatively slow growth, a tree with adequate access to light enters a period of rapid growth (average 30-35 cm height growth per year) and development that lasts until the onset of reproduction at the age of approximately 20-25 years. However, depending on local density of trees, competition for light may drive primary growth to be far greater (over 1 m per year if crowded), resulting in stands of tall straight trees with live foliage restricted to the upper 1/3rd of the stem. White pines that grow up under a mature, light limiting canopy will be heavily *suppressed*, exhibiting very slow primary growth (< 5 cm per year) and reduced secondary growth (think Charlie Brown’s Christmas tree).

Growth plasticity: The growth form (think silhouette) and appearance of white pines is heavily influenced by population density and competition for/availability of light. White pines growing alone in the open, without being shaded, may do relatively small annual increments of primary growth (20-30 cm/year). Unlike suppressed trees, lack of competition for light allows these trees to channel more energy into secondary growth, branch development, and leaf growth, i.e., they make more solar collector structures to support photosynthesis. They usually appear to be short and stout, with a globose growth form, and frequently have multiple stems arising from near the ground. Branches are long-lived and may extend over the entire length of the stem. Each year, most of the *primary growth* occurs in the first few weeks of the growing season at the apical and branch tip meristems. In contrast, secondary growth (stem girth, branch girth) occurs throughout the season.

White pines growing in higher density stands compete intensely for light, water, and nutrients. Under these conditions, the competition for light at the canopy level drives primary growth at the expense of secondary growth leading to tall, straight-stemmed (rarely multiple) trees. Due to limits on light penetration through the canopy, lateral branches on stems in dense stands tend to die early, a process called *self-pruning*. Because white pine growth form is so responsive to its local growing conditions, we say it exhibits *plasticity*, and it is this aspect of its biology that forest managers take advantage of in promoting uniform growth in managed stands.

Shade intolerance: White pines are shade-intolerant and respond strongly and positively to light (Lancaster and Leak, 1978). On abandoned agricultural land, or following forest removal from logging or other disturbance, White pines may seed-in densely. They grow well in open, well-lit conditions, but, because the cohort can be very dense, they shade one another laterally as the cohort increases in height. This shade encourages both rapid primary growth (height) and self-pruning; below canopy level, lateral branches die back on the lower 2/3rd of the stem due to reduced light availability (except for
In the margins of a stand where they receive full sun.) Understory individuals in these crowded stands may be strongly suppressed and unable to persist. Along roads and trails you will observe pines with fully developed limbs on the open side, but very weak branch development on the side facing the stand’s interior.

**Growth suppression and release:** White pine can establish (germinate and persist) in shade. If the canopy is closed, these small pines exhibit features of **suppressed growth:** reduced primary growth (a few centimeters per year maximum) and vastly reduced secondary growth (spindly branches, poor needle formation; see Bormann, 1965). If the shading is removed soon enough by thinning the overstory trees, the suppressed trees are **released,** and, after a period of metabolic adjustment, may achieve normal growth rates. Shading is usually due to a dense canopy of an older cohort of other softwood and hardwood tree species comprising the canopy. Forest managers argue that without proper management and periodic thinning harvests, white pine is incapable of naturally establishing multi-age populations.

**Competition and natural thinning:** In a mixed-species stand, pines might have been the initial colonizers of a previously open site. Then, more shade-tolerant hardwood species such as beech and maple may have established under the pines. Over time, the rapid growing, shade-tolerant hardwoods join the canopy, and also comprise the lower layers because they can tolerate shade. In stands where hardwoods form a significant portion of the canopy, they may eventually out-compete the pines. In pine dominated stands, pines may establish in high densities (typical of our study site). As the pine grow and begin to compete for resources, natural thinning occurs which reduces the population density and over time, results in changes to the spatial distribution of the population. Pines stands tend to naturally thin over time and change from an initially clumped spatial distribution, to being more random, and ultimately, in old growth stands, may achieve a more uniform spatial distribution.

**Determining the age of pines:** Paramount to understanding growth rates (increase in size per year) of any organism is having a basis for estimating time, preferably as an individual’s age (Fig. 4, 5). Woody-stemmed plants mark the passage of time by annually producing a new layer of **xylem** tissue at the lateral meristems (secondary growth meristems). Xylem, as you will recall, is the water transport tissue in plants. What we call **wood** is the accumulated dead, heavily lignified, xylem tissue in a tree or other woody plant. New xylem and **phloem** (the nutrient conducting tissue) are produced annually at the lateral meristem of trees: phloem to the exterior and xylem to the interior. Over the course of the growing season, the mean diameter of new xylem cells decreases dramatically (Fig. 4). The width of an annulus, or growth ring, is a measure of a tree’s **annual increment of secondary growth.** The net result is the distinctive pattern of rings, or **annuli,** seen in cross sections of tree stems. The standard technique for aging a tree is to take a core sample from the stem and count the number of annuli from center to the outside edge (Fig. 5). White pines (and other conifers) offer a second record of age: each year the apical meristem produces a new whorl (ring) of branches. This occurs not only at the top of the stem, but also at the branch tip meristems. Thus, the age of the stem and individual branches may be estimated by counting the number of branch whorls each presents. Moreover, if a tree has lost its top, age can be determined by counting branch up the stem and then out a branch near the break point.
Figure 4. Micrograph of pine xylem showing changes in xylem cell diameter over the growing season to form a growth annulus.

Figure 5. Characteristics of the Eastern White pine useful for study of age and growth.
FIELD SAMPLING: LOGISTICS AND TECHNIQUES

A REMINDER ABOUT DRESSING FOR WINTER FIELD CONDITIONS:
To confirm rumor, this exercise is nearly ALWAYS done in knee-deep snow - PLEASE DRESS APPROPRIATELY – wear multiple layers of clothes to stay warm. Gaiters (we have about 20 pair) and waterproof pants for your legs are especially helpful as are wool socks with wool felt-insulated boots (e.g., SORELS). You MUST have a PARKA, scarf, and warm hat, and warm gloves. If you have questions about appropriate clothing, please ask an instructor. If you have snowshoes, bring them. Snowshoes can also be checked out from the Bates Outing Club. REMEMBER: You can always take clothing off, but you can't put on what you didn't bring. The vans will be parked close by and will have hot drinks, food, and heat for warming up. We also have lots of disposable hand/foot warmers.

A. EQUIPMENT

1. We will provide transportation, field equipment, hand warmers, and nourishment.
2. Your team should bring: Pencils, lab instructions, a calculator, enough warm and dry apparel (plus extras!) to keep you happy in the bitter cold for 3 hours, and binoculars if you have them (since we have only a few pairs).

B. FIELD PROCEDURES

Teams of ecologists will work together to carry out the surveys of parts of the white pine stand: a harvested zone and a nearby non-harvested zone that will be our control. We will go over the sampling plan in lab and practice the sampling techniques near Merrill Gym the first day in lab. Teams will be assigned tasks at that time to make data collection as efficient as possible. At the field site, we’ll distribute equipment bags to each team, and briefly review the sampling plan and techniques. Instructions for each task are provided below. Waterproof data sheets will be provided in the field bags. It is essential that you understand the data collection procedures before you begin. When your team’s tasks are completed, please help others to complete their tasks to minimize our exposure time outside. Each group will also record observations they’ll use to write a description of the study site. Because this is a large, collaborative effort, it is vitally important that each ecologist does their utmost to measure and record the data accurately, and legibly, in a manner consistent with that of your colleagues. Be alert for oddball data that make no sense, e.g., a tree of age 14 that measured 275 m in height. More likely it was 2.75 m in height. Use common sense and stay alert. At the end of the day double-check the numbers to make sure that they all make good sense.

1. SITE DESCRIPTION (see Appendix 2)

Field ecologists must communicate the location of the field site and what the study site is like physically and biologically. The specific location latitude and longitude can be determined using a GPS unit in the field, or closely approximated using online sources such as Google Earth or MapQuest. To describe the physical and biological features of the site, you will answer a series of questions once we’re on the site. Appendix 2 is a sample data sheet for recording some characteristics of the site. Waterproof copies will be provided for the fieldwork. You should add other characteristics that are relevant to the study objectives. You might also bring a camera to help record the site characteristics photographically for later reference.
2. SAMPLING PLAN: HARVESTED AND NON-HARVESTED MATURE PINE POPULATIONS

a. CIRCULAR PLOT SAMPLING: An efficient method for replicate sampling of stationary organisms such as plants is to survey individuals within small defined areas we call plots, which are typically round or rectangular (e.g., quadrats). You will be sampling within round plots measuring 9.8 m diameter (radius = 4.9 m) and 75 m² area (Fig. 5). We will randomly select locations for transects (straight lines) oriented parallel to Plains Road and along these your sampling team will systematically sample plots located on 15 m centers. Our goal is for each sampling team to survey 5-6 plot positions within either the harvested or non-harvested zones in the stand. The “harvested” plots are randomly located along transects within the same area we have been sampling since 2005 just adjacent to Plains Road (Fig. 3a). We purposefully avoid transitional areas (e.g., where dense forest may give way to larger gaps, or areas where the species mix changes dramatically) and border areas near the roads because these factors would introduce variability into the data that would make a final interpretation difficult. The “non-harvested” plots are located further to the southwest (toward the lake) in an adjacent area that was not included in the selective harvest of 2006; this plot will function as the control; the forest here reflects pre-harvest stand conditions for purposes of comparison. We’ll thus compare the population characteristics of the white pines in the two zones to determine how the population structure, growth, and recruitment may have changed as a function of the harvest in 2006.

b. DATA COLLECTION – MATURE POPULATION: Each plot center will be marked by a wire flag. Each plot is one replicate for density calculations. Each group of 6 students will sample 5-6 plots during the lab and then the data will be pooled. The data collection protocol that follows will be practiced on campus prior to the field trip. Data sheets will be provided for each specific task. Completely fill out the top of each data sheet, making sure to note your team’s lab day and your team members’ names.

For each plot the teams will:

1. Determine the boundaries of the plot by holding a 4.9 m rope over the flag and slowly rotating 360° (if snow, stomp the perimeter boundary as you go) noting and tagging those trees that will be included in the plot sample.

2. Pin an ID tag at 1.37 m off the ground (BH) on each live white pine tree that is at least 5 cm stem diameter at BH, in the plot; any tree whose stem center falls within the plot is counted as in the plot. We will hereafter refer to these trees as “mature trees”. White pines should be coded as WP on the data sheets. Hardwoods (HW) will be lumped together because there are relatively few large individuals of any given species, and most are saplings. Hardwoods will be tagged and included in the sample only if their height is at least half the local canopy height.

3. Count the number of mature pines tagged in the plot and record under Mature Pine Density (#stems/75 m²). If there are no mature pines in the plot, record a zero. These data will be used to determine the density of trees in each stand.

4. DETERMINE THE AGE (yr): The age of each tagged white pine tree will be determined primarily by counts of annual branch whorls. Care must be taken to find branch scars on lower portions of older stems where branches may have been lost. Take the average of two independent counts on each tree and then add 5 years to account for early growth.
that has subsumed by the stem. NOTE: The age annulus of a tree is “recorded” at the cessation of growth in the fall. For trees in our samples, therefore, growth associated with the present calendar year has not yet occurred. Thus, age by whorl counts or growth rings must use the previous calendar year as the reference point for age when we do the analysis.

5. MEASURE STEM DIAMETER AT BREAST HEIGHT (DBH): Stem diameter is a function of secondary growth (accumulation of xylem, or wood) at the perimeter of the stem. To standardize this measurement, we measure the diameter of the stem at breast height (BH) = 1.37 m above the ground. Wrap the DBH tape around the stem at the level of the tag and measure and record the diameter to the nearest 0.5 cm. Do not measure stem diameter of trees less than 5 cm DBH.

6. MEASURE STEM HEIGHT: Tree height (the result of primary growth) is measured vertically from the base of the trunk to the tip of the topmost stem leader, or to the stem midpoint and then doubled. Since direct measurement is impractical, we will measure tree height by the percent slope triangulation method (see Appendix 3) using a device called an Abney level, a type of inclinometer. If part of the stem has broken off, do not measure the height – simply make a note on the data sheet that it was “topped.” Record height to the nearest 0.1 meters.

7. MEASURE NEAREST NEIGHBOR DISTANCES (NND): Spacing of trees, measured here as the average distance to a white pine tree’s nearest neighboring living white pine trees, provides information about the tree’s local “neighborhood” and possible sources of competition for resources (e.g., light, nutrients, water). We will use this measure to assess whether or not the spacing of white pines has changed as a result of the selective harvest. For each tagged pine, measure the distances - stem center to stem center – to the two nearest live, white pines of at least 1.37 m height (Fig. 6). Note that some of these neighbors may fall outside of the plot – that’s OK. NND will be reported in the data file as the average distance to the two living nearest neighbor white pines.

Figure 6. Circular plot sampling scheme. WP = white pine, HW = hardwood. Nn1 = closest nearest neighbor WP; Nn2 = second closest nearest neighbor WP.
c. HARDWOODS AND HARDWOOD SAPLINGS:

1. Hardwoods of at least one half the general canopy height should be tagged and should be measured for DBH and height (highest point of the tree’s crown). Hardwoods should be coded as HW for the species.

2. For hardwood seedlings/saplings, visually bisect the plot such that there is an equal number of hardwood saplings in each half. Count the number of stems rooted within one half of the plot (all species combined) that meet or exceed BH (1.4 m) and record under HW Density (#stems/37.5 m²).

d. WHITE PINE SEEDLINGS AND SAPLINGS (SNOWPACK DEPENDENT): Sampling of seedlings is difficult in winter due to the snow cover. If snow pack depth is low (< 30 cm), do the following for each plot:

1. Position your 1 m² rope quadrat on the plot center with the side parallel to Plains Road (see Fig. 6).

2. Determine the age of each one based on branch internode counts working from top to bottom along the stems (Fig. 7). Make sure to clear any snow around the base of the tree so as to find the lowest branches and branch scars.

3. Measure total stem height to the nearest 0.5 cm using the folding ruler.

4. Count the number of seedlings/saplings within half of the plot following the same instructions as in c.2. above and record under Pine Seedling Density (#stems/37.5 m²).

Figure 7. Example of HEIGHT measurement and annual internode segments to be counted for AGE on seedling white pines referenced to sampling year 2016. In 2016 sampling, the uppermost stem internode would have grown during the 2015 growing season. The age of the tree in this example would be 10 years.
C. DATA COMPILATION AND DISTRIBUTION:

Before leaving the field site, each team must completely fill out the data sheets and,

1. Make sure your full names, the date, and sampling area are fully identified on ALL sheets.
2. Check your sheets for missing information, errors, or missing data, and fix them.
3. Collate your team’s completed data sheets together.
4. Hand in your data sheets to Greg before leaving the vans.

We cannot stress how important it is that the data be recorded legibly and accurately. Invariably there will be issues with the data that cannot be remedied unless we can track down the data takers and get clarification. IF the data are not collected carefully and properly, the data analysis will be less robust and your lab reports will be more difficult to write.

About the data files: Greg will enter all the data into an Excel file called Pines2016.xls and a Prism file named Pines2016.pzf. The Prism file will contain some data collected in previous years, as well, that may be needed for certain analyses. The Excel data file contains complete records for all white pine trees and hardwoods within the two plots. All data are reported as metric values. Each file will be posted to the class website under the Supplements links (http://abacus.bates.edu/~ganderso/biology/bio270/270supplements.html).

PROTECTING YOUR DATA FILES: We strongly suggest that you BACK UP your data files on your Paris network drive OR, better, an external Cloud-based drive such as Dropbox or Google Drive that can be shared by you and your partner. Following each work session always save a copy of the most recent work to your back up site.

During the course of the analysis you will often need to manipulate the data to get it in a form needed to graph or do statistical tests. Excel is a good program for storing the basic data file and for manipulating the file to get groups of data organized for analysis. The data can then be copy/pasted to Prism for running tests or making graphs.
Appendix 1: Range Pond State Park Forest Management Prescription
December 19, 2005. Mark Miller

PROPERTY OVERVIEW - Description of the property as a whole

Range Pond State Park, located in the town of Poland, includes extensive frontage on Lower Range Pond, shoreline and wooded trails, and undeveloped forestland. The tract contains pine and hardwood forests, forested and shrub swamp wetlands, and perennial and intermittent streams.

The Park was established in 1975 to create a major day-use facility for the Lewiston-Auburn area. Two new playgrounds, a group meeting structure, and handicapped accessible facilities were constructed in 2002. No timber harvesting has occurred since prior to Park acquisition.

The property is an extremely popular summer destination for swimming and picnicking, and is visited by walkers and hikers year-round. The site has 4 miles of foot trails and old forest roads, a large central parking area, seasonal ranger quarters, and covered group outdoor meeting facilities. An authorized snowmobile trail crosses the park, as do several unauthorized ATV trails.

In 2005 the Range Pond tract was designated as a lead tract for the BPL Demonstration Forest Project. Harvesting will demonstrate exemplary forest practices and increase public understanding of forest ecology, resource management, and conservation topics. Specific goals of the Forest Demonstration Program include:

- Demonstrate scientific forest management and conservation practices
- Improve, restore, and regenerate forest stands, and speed development of desired future conditions.
- Design timber harvests to complement further park development and recreational opportunities
- Financially support the Parks general fund budget

Of the tract’s 740 total acres, developed park facilities occupy approximately 30 acres. Wetlands and riparian features account for about 45 acres. The remaining 665 acres are forested (90 percent of total acreage). The forest is comprised of four primary forest types: Pine-Oak forests on sand plains, Mixedwood stands on slopes and uplands in the east, Early Successional forest on old pastures and bums in the south, and Riparian forests on lowlands. Worthley Brook crosses the property in the southeast, with several associated small intermittent streams. Trees average from 45 to 75 years old, with areas of younger, older and multi-aged growth. Some areas to the south were partially harvested around 1970, the most recent cutting on the tract.

Insect/Disease:

Pine in dense stands has sparse and weak crowns, with competition mortality of small stems, the result of overcrowding and drought stress. Overstory fir to the east is over mature and in decline. Scattered dead oak trees are sometimes found on dry or droughty sites, the result of gypsy moth damage in the 1980s. No other significant problems were observed, with most trees currently healthy and relatively vigorous.

Wildlife:

The Park has diverse habitat for both upland and aquatic species. Large, vigorous oak is found across many parts of the property, providing plentiful acorns (mast). Beech is a less common mast species, and
heavy producers are uncommon. The Park includes almost two miles of undeveloped shoreline along Lower Range Pond. Its border of large pine provides perch and nest habitat for raptors. A bald eagle nest, mapped as Essential Habitat, is located on an island in Lower Range Pond. A portion of the protected nesting habitat impacts the northern portion of the property. There are no Old Growth or Late Successional stands on the tract, although some large pine and hardwood in the east are approaching mature size. Wooded and shrub swamp wetlands are found in several locations, with pocket swamps and vernal pools found in depressions (kettle holes) to the south.

Land Use/Water:
In 1999 specific water resources rights were leased to Poland Spring Bottling Company on a 5.9-acre parcel. Two wellhead pump stations and an underground pipeline were installed on this parcel in the southwest portion of the property. As a part of this signing agreement Poland Springs constructed two playgrounds, a _ group meeting structure, and handicapped accessible facilities.

Recreation/Visual:
The principal recreation activities are swimming and picnicking along the Range Pond shore. The 600-car parking lots fill on hot summer afternoons, and group facilities are reserved early in the season. Four miles of foot trails and old forest roads cross the Park, which receive light but steady year-round use by walkers, hikers, cross-country skiers, and mountain bikers. Trail marking, maintenance, and visitor use level varies. There are no camping facilities. Visually sensitive areas include all park facilities, the pond shoreline (visible from the pond or Frenchman Beach), and the long undeveloped forest frontage of Plains and Empire Roads. Few other areas are viewed or frequented by the public.

Education/Demonstration
Bates College uses a portion of the property along Worthley Brook to study water quality. The property has close proximity to the Lewiston-Auburn area, as well as numerous local schools.

Soils/Geology:
Soils are1typically deep, well to excessively-drained sands and loams derived from glacial outwash. Sand plains underlie most of the north and west, with kettle holes and eskers to south. Uplands and short areas of steep slope are found to the east. Areas of restricted drainage or low water table border streams and wetlands. Logging could occur in most areas during any season but spring break-up.

Engineering/Surveying:
Most property boundary lines are generally evident, although some have not been painted for many years. Old red or orange paint is present on the southeast line. Metal tags mark the Poland Spring line to the west. The north and south boundaries are Plains Road and Route 122. The northeast line was recently surveyed, flagged, and blazed. A small portion of the tract extends north of Plains Road; north and west portions of that boundary are unclear. Park and public roads provide ready access to most of the property, although heavy hauling on park roads should be restricted until frozen or very dry conditions.

Landscape Assessment:
The landscape surrounding the park is characterized by industrial and residential development, interspersed with small private woodland ownerships. The Poland Springs bottling plant abuts the Park immediately to the southwest, and the Jolly Farmer landscape products processing facility to the southeast. Rural residences border the Park to the north. The surrounding landscape includes two golf
courses, a private campground, numerous residences, and multiple small, undeveloped woodland tracts. Lakes, developments, and public highways hinder the movement of species to the east and west. Habitat connectivity north to south is fair.

Other Concerns:
The Maine Natural Areas Program (MNAP) database identifies no sensitive habitats or Exemplary Natural Communities on the site. MNAP did document a single sighting of a spotted turtle (State Threatened) in 2000 near the outlet of a stream at the NW end of the park. The 1998 Maine Forest Biodiversity Project inventory assessed Range Pond but did not recommend it as a potential ecological reserve.

**PRESCRIPTION SUMMARY (from the management plan)**
Harvesting is planned for approximately 480 acres, or 65 percent of the total park area. Portions of stands 1, 2, 4, and 5 will be treated. The overall silvicultural goals of the harvest are to:

- Improve the growth, vigor, and future timber value of pine, oak, and maple
- Remove declining and at-risk trees
- Maintain and expand multi-aged forest conditions
- Protect and improve wildlife habitat values

Stands will be managed to speed the development of large trees, long-lived species, multi-aged structure, and other late successional characteristics. Where such conditions already exist, management will perpetuate them. Areas where recreation, aesthetic, or biological values would be negatively impacted by harvesting will be reserved from management.

Harvesting will include thinning of the smaller trees (individual tree selection), removal of small patches (group selection), and retention of large patches (group retention). Individual tree selection, or low thinning, chooses trees for harvest to improve the composition and growth of the overstory. This type of harvesting will cover 354 acres, or 74 percent of the harvest area. Group selection patches range from 10 trees to 0.2 acres, and are designed to provide growing space for seedlings. These will cover 81 acres, or 17 percent of harvest area. Group retention harvesting will cover 42 acres (9% of harvest area), and has the objective of establishing or encouraging new seedlings while maintaining functional components of the prior stand. All trees to be cut will be marked under the supervision of a professional forester. Where young fir threaten to dominate oak and pine seedlings they will be crushed during logging, as practical. Post-harvest control of invasive honeysuckle will be needed.

Access Needs:
Seven wood yards will be needed, three east of Empire Road (one either side Worthley Brook and one near the north boundary), two west of Empire Road (on either side of the Park entrance road), one in the group lot to the northwest, and one in an old clearing north of Plains Road. The central yard east of Empire Road will be constructed as a future day use parking lot for the forest demonstration area. All other yards will be temporary, kept as inconspicuous as possible, and reseeded after use. A temporary crossing structure is needed to protect the historic stone culvert over Worthley Brook. The current maintenance yard will be expanded for one wood yard, and will require realignment of that maintenance spur to accommodate log trucks. A short truck spur is needed for a new yard south of the entrance road (300-400', using an existing hiking trail). The northwest yard will use the existing group picnic area parking lot (winter use only), and will be resurfaced with fresh gravel after use.
Education/Demonstration:

New interpretation displays are planned at two locations: at the existing group meeting structure, and at a new day-use lot east of the entrance gate. Information kiosks will be constructed at each trailhead. A new interpretive trail in the east will link with the existing trail network. Interpretive themes include private small woodlot management, early successional wildlife habitat, water quality protection, and Best Management Practices (BMPs). Partnerships with local education groups will be pursued.

Recreation:

All harvesting will be done so as to retain the forest’s visual character as seen from trails and roads. Most park visitors will be aware of the forest demonstration primarily through the new trailhead and information display. Harvesting will be lighter near trails, and substantial concentrations of logging slash will be disposed out of view of trails and roads. Following operations wood yards and roadsides will be cleared of debris and seeded to a wildlife mix.

Wildlife:

Bureau of Parks and Lands (BPL) Wildlife Guidelines will be followed during harvest planning and layout, including leaving existing den tree and snags, providing new future wildlife trees, and protecting raptor nests. Mast production will be encouraged in oak stands. Some large diameter logs will intentionally be left for small mammals and amphibians. Multi-aged management will strive to develop a mid-canopy habitat layer for songbirds. Riparian area management zones (RZs) will be established along waterways (averaging 330' along Lower Range Pond, 75' along streams and wetlands). These are areas where wildlife management is dominant over other uses. Any timber harvesting will retain wildlife trees, practice multi-age management, and be lighter near the water feature. Equipment exclusion zones will be established next to water bodies (minimum 35' width, increasing with slope). Special provisions will be taken to protect spotted turtle habitat, including low intensity timber harvesting, winter operations, using BMPs for sediment control, and following "Forestry Habitat Management Guidelines for Vernal Pool Wildlife in Maine" near vernal pools and pocket swamps. Consultation with the Inland Fisheries and Wildlife regional biologist will occur before harvesting takes place in the affected portion of Stand 1. The low intensity harvesting, winter timing of the harvest and the harvest operation not being visible from the nest will result in minimal impact on the Essential Habitat.

Reserve Areas:

The 1998 Maine Forest Biodiversity Project inventory did not recommend Range Pond as a potential ecological reserve. The suitability of this park as an Ecological Reserve is limited by small acreage and incompatible adjacent uses (industrial, residential, development). Areas reserved from management total 67 acres (10 percent of forested acres). The comparatively light harvesting that will take place in managed areas will likely have minimal effects on species diversity, dispersal, and viability. In some ways harvesting will disrupt natural successional development of these stands, but in many ways harvesting will promote late successional features.

Landscape and Connectivity:

The park will retain its role in the landscape as a moderate-sized "island" of intact forest within a matrix of development and small, forested tracts. Management will improve many of the forest's ecological values. Logging trails and canopy gaps associated with the proposed harvest will be of small scale and temporary duration, and should result in only a minimal loss of connectivity for a small group of effected species.
### STAND PRESCRIPTION AND MANAGEMENT RECOMMENDATIONS
(Note: This prescription includes our study site on Plains Road – see map that follows)

<table>
<thead>
<tr>
<th>Stand #</th>
<th>Species</th>
<th>%</th>
<th>Treated Ac:</th>
<th>Total Acres:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WP</td>
<td>55%</td>
<td>384</td>
<td>410</td>
</tr>
<tr>
<td></td>
<td>RO</td>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RM, AS</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HE, WB, PP</td>
<td>&lt;5%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Size:** Small sawtimber  
**Age:** 45-65  
**BA (5"+):** 132  
**Regeneration:** Adequate  
**Species:** WP, RO, RM, BF  
**Height:** 2-8 feet  
**Site Quality:** II (90%), III (10%)

**Remarks/Stand History/Non-timber concerns:** This single large and variable stand comprises over sixty percent of the property's forested acreage. Immature pine and hardwood are found on generally flat sand plains and rolling uplands, with inclusions of older pine, hemlock, and wet soils. Eastern areas originated following pasture abandonment around 1950. Others originated following harvesting around 1940-50. A small area east of Worthley Brook was partially harvested around 1970. Trees have good stem form and fair to good vigor. Scattered dead oak is the result of gypsy moth mortality around 1980. Dense pine areas are suffering from pine decline. Invasive honeysuckle is present along old woods roads to the east. The MNAP spotted turtle sighting was in the northwest portion of the stand. Several roads and trails cross or border the stand, as do Worthley Brook and several wetlands and small streams. An unauthorized ATV trail east of Empire Road has two illegal stream crossings that are causing sedimentation, and which should be corrected as a part of operations. The Poland Springs water lease site in the far southwest corner of the stand will be reserved from timber management.

**Management Objective/Prescription:** Improve composition, stand stature, and vigor. Begin to develop mid-canopy habitat for songbirds by providing additional light to established seedlings. Protect older trees, snags and potential cavity trees, especially in areas near water features. Release old apple trees in the east. Harvest large-crown pine along Plains Road to reduce winter road icing as per Town request. Reduce understory fir where oak and pine are present. Prevent expansion of invasive honeysuckle. Preferred species priority: WP, RO, RM, HE, PP, then, any straight stems. Nine percent of the stand will be excluded from harvest for wellhead protection, lakeside buffers, or visual sensitivity.

**Activity:** Operations within the Essential Habitat in this stand will follow the recommendations of the MDIFW regional biologist. In addition, all superstory white pine within the riparian zone along the shoreline of Lower Range Pond will be retained for perching, roosting and potential nest sites. On 85 percent of harvest area use individual tree selection low thinning to remove low quality and low vigor pine and hardwood, plus most white birch and aspen. On 15 percent use small group selection in areas of low vigor, poor form, or mature trees (10 trees to 0.1 ac.). Create early successional wildlife habitat demonstration in aspen patches. Develop a wood yard across from the Park entrance gate for trailhead parking. Plan skid trails to for future hiking trails, and link to the existing trail system. Lighter harvest along roads, trails, and near streams and turtle habitat. Crush fir seedlings where more desirable species are present or likely to establish. Aggressive post-harvest honeysuckle treatment will be required to prevent its spread (Roundup or Garlon herbicide foliar or cut stump treatment during mid to late summer following or preceding harvest). Hand pulling in spring can control light populations.
Residual Stand:
Type: H3B  
Species: WP, RO, RM, HE, AS, WB, PP 
Size: Saw timber  
. BA (5"+): 85-100  
Remarks: Harvest should protect established pine and oak seedlings.

**Next Activity:** Monitor for honeysuckle sprouting and new seedlings for 3 years. Next harvest: 2015-20 Individual tree and group selection harvest to release and establish regeneration.

**Note (GA):** This last remark (my bold) is very important in terms of the future activity in the stand. This first cut in 2006 was designed to promote establishment of seedlings of all the long-lived species, but especially of the white pines. By planning a future thinning cut in 10 years or so, they act to create a multi-age stand and give even more room and access to the canopy to the young pines now growing in the understory, and to promote even more seedling establishment.
Note: The map is not completely accurate – the no-harvest area does not abut Plains Road near our study site as is evidenced by the skidder tracks around the stand. What is marked as “Plains Road” down the middle of the NE arm of the area is the old railroad grade now used as a trail.