

Propagation Manual

Bur Oak (*Quercus macrocarpa*)

Volunteer Leadership Team

Bur Oak Proof of Concept Project Team



A mature healthy bur oak growing in an ideal wetland environment.

Acknowledgments

This manual has been possible due to the abundant sources of reliable information available including papers, technical documents, and information willingly shared by people having relevant training and experience. The scientific research done by Natural Resources Canada, Canadian Forest Service has resulted in a number of published papers that provide a wealth of information on bur oaks. The Great Trees of New Brunswick by David Palmer and Tracy Glynn has some inspiring information about bur oaks. There is also a lot of additional information on the internet.

Background

The bur oak is a native tree species in New Brunswick that formerly grew in considerable numbers in the lower Wolastoq (St. John River) valley and on the shores of Grand Lake. There are some surviving groves and roughly 2000 mature trees and saplings in the province according to a survey done from 1996 to 2000¹. Human activity has taken its toll on the tree but efforts are underway to ensure that bur oaks have a future in New Brunswick². Such efforts include the Bur Oak Conservation Standards Planning Group, the reforestation projects undertaken by the Nashwaak Watershed Association, and the bur oak work currently being done by the Nature Trust of New Brunswick.

Manual Objectives

The objective of this manual is to document the information needed by interested growers to propagate bur oaks successfully. The manual has been compiled in support of the Nature Trust of New Brunswick (Nature Trust) bur oak pilot project. The pilot project is to determine if individuals working together can help restore the bur oak in New Brunswick by growing seedlings from local acorns and planting them on Nature Trust preserves. Although results will vary, this manual aims to present the steps that, if followed, should result in success for committed growers regardless of their prior training and experience.

Conceptual Framework for the Bur Oak Proof of Concept Project

This approach is to collect local acorns, germinate and nurture them, and plant the resulting seedlings on protected Nature Trust preserves. This strategy should help save the imperiled bur oak DNA found in southern New Brunswick and increase the bur oak population to a more sustainable level. Planting on land that will not be developed is a key part of the strategy.

¹ Donnie A. McPhee and Jude A. Loo. Past and Present Distribution of New Brunswick Bur Oak Populations: A Case for Conservation, *Northeastern Naturalist*, 16(1)85-100, 2009 pp 91.

² David Palmer and Tracy Glynn. *The Great Trees of New Brunswick*, 2nd Edition, Goose Lane pp 127

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Growing Cycle

The chart below shows a typical growing cycle starting with acorn collection through to the out planting of seedlings in permanent locations, and finally the support and monitoring process leading to self-sufficiency. It summarizes the required tasks and associated timelines. Detailed information is provided below for each of the tasks identified in the table.

	Task	Timing	Notes
1	Pre-Collection Organization	August	Pre-planning is important as growers need to be ready to perform their roles without delay when acorns are ripe.
2	Collect Acorns	September (first two weeks)	Based on continual observation starting in late August
3	Acorn Viability Testing	Immediately after collecting	
4	Acorn Preservation Prior to Dormancy Control Process	Immediately after viability testing	In the case of option #1, this ends on or about October 31 In the case of option #2, this ends on or about December 31
5	Dormancy Control Option #1 Natural Method	Option #1 – November 1	
5	Dormancy Control Option #2 Refrigerator Method Stratification	Option #2 – January 1	This phase is also referred to as cold stratification
6	Sowing acorns in Air Pruning Grow Boxes	May 1	
7	Germination	Second week of May to mid-June	Germination rates (%) should be very high but it does take several weeks for most of the acorns to germinate.
8	Nurture Seedlings	All summer	
9	Preparation for out planting	Planting day minus one	
10	Transplant Seedlings	October/November	
11	Monitor Seedlings	May following year	This is an annual ongoing obligation

1. Pre-Collection Organization

Timeline

All planning, equipment (such as air pruning grow boxes, stakes, browsing protection etc.), volunteer commitments, task assignments, and acorn collection targets must be determined and documented before August 31st.

Procedure

1. Determine how many seedlings will be grown in the current year. This depends on financial resources (such as costs of stakes, construction of air pruning grow boxes, browsing protection, grass control matting, and rodent protection), volunteer resources, available planting sites and the natural level of seed production. Each harvester should be allocated a maximum number of acorns to collect so that over-harvesting is avoided.
2. Identify the seed trees (groves) from which acorns could be harvested and provide location coordinates to the assigned harvesters.
3. Ensure that the target seed trees are bur oaks. It is very important to ensure that acorns being collected and nurtured are in fact bur oak acorns and not Northern Red Oak or English Oak. It is suggested that amateur growers study bur oak identification materials carefully so as many characteristics such as leaves, bark, acorn shape and size, location, and tree profile are used to confirm that target trees are bur oaks. This confirmation activity should be started as part of the planning and organizing phase. The paper³ written by Mary Ann Riley [Species Profile of the Bur Oak](#) and the [The Great Trees of New Brunswick](#) (Palmer/Glynn) provide useful information allowing for accurate tree identification.



Figure 1: The dominant cap is a good indication that this is a bur oak acorn (left) as the northern red oak has a smaller cap. This cap (right) is typical of the bur oak.

4. Check in late August to determine the potential quantity and quality of acorns that might be harvested (it varies from year to year) and adjust collection plans and assignments accordingly.

³ Mary Ann Riley, “Species Profile of the Bur Oak” Kemptville College, page 1

5. Document the plan and share it as appropriate so all volunteer and Nature Trust staff team members are in the loop.

Notes

1. Pre-planning is important as growers need to be ready to perform their various tasks, including harvesting acorns, without delay and without much notice.
2. Harvesting of acorns should be limited to the number of trees to be grown for a specific year plus 15 % to allow for certain factors such as seed viability.
3. Multiple sources of acorns are preferable to a single grove so that future genetic diversity is increased. Acorns from groves may be superior to acorns from isolated (lone) trees.⁴
4. Individual harvesters should be assigned the task of monitoring their seed source groves so that collection can start as soon as there is evidence of acorn maturity.
5. Harvesters should be well briefed on the physical indicators that suggest that the acorns are ready to be collected. Indicators that the acorns are ready to pick include squirrel activity, falling acorns, colour, etc. It must be stressed that the collection window of opportunity is very narrow and huge numbers of acorns can be taken by squirrels in a very short period of time.

2. Collect Acorns

Timeline

September (the collection activity could peak about mid-month)

Procedure

1. Assigned harvesters should observe their assigned site every day or so starting in early September. Check the ground beneath mature trees to see if branch tips have appeared on the ground below the trees. They indicate that squirrels have started to harvest.
2. Select and pick the acorns based on size and condition especially if there are lots of good ones to choose from.
3. After going home, harvesters should lay the acorns out with good air circulation so they can dry a bit.
4. Count, bag and label the collection location and turn in the acorns to the individual responsible for testing.

Notes

1. All collections should be labelled carefully so long-term tracking (commonly referred to as “batch control”) can be done (name of harvester, site location, date of harvest, weather conditions, number of acorns collected). Batch control starts at this point.
2. Batch control should be maintained from the collection data to the out planting phase. The Nature Trust might want to know where each batch came from, and should be able to trace back as varied outcomes are encountered. We will certainly want to be able to assess which approaches and seed locations work best for us in practice.
3. Acorn collectors should not strip every last acorn from a collection site especially in years having low acorn production. In spite of having been given a maximum number to collect, the

expectation is that collectors will use their own judgment and collect fewer if they encounter low acorn yields.

4. Care must be taken to distinguish between red oaks and bur oaks. They may co-exist in some collection areas. During the viability testing phase, it will be important to examine the acorn caps as this should help to confirm their species. If doubt remains, have the acorn studied by someone else.
5. Obviously imperfect acorns should not be collected. Punctured acorns are not suitable for collection, Dried-out (brown) acorns should be avoided if possible.
6. Stepladders may be useful to reach some of the low hanging acorns (for safety reasons they must be supported by someone other than the harvester). Never stand on the top “step” of a stepladder. A hook-ended stick could be used to pull a branch down gently to a more accessible height. Care must be taken to avoid damage to the small branches.

3. Acorn Viability Testing

Timeline

September immediately after harvesting

Procedure

1. Carefully inspect each acorn to cull punctured acorns
2. Flotation test: put all acorns in a pail of water for 24 hours. The ones that are still floating after that time should be discarded as they are not viable.

Notes

1. Note that Bur oaks have a high germination rate so if some non-viable acorns go on to the next phase it is of little consequence.



Figure 2: Acorns drying after the float test.

4. Acorn Preservation Prior to Dormancy Control Processes

Timeline

September, immediately after harvesting

Procedure

1. Remove caps. They should come off easily without use of tools.
2. Place acorns in medium sized Ziploc bags with a batch card indicating their source, collection date, harvester and other data that will then be available for future analysis and problem solving (for example, to determine source of germination failure). Add a mixture of potting soil, peat moss, sand and some vermiculite. Mix acorns and this soil mixture. Leave the zip locks unzipped.

3. Slightly moisten soil mixture.
4. Place bags in a cool dry place. Unheated outbuildings or garages are good locations.
5. Ensure that mice or squirrels cannot get access to the acorns. Heated locations are not ideal and should be avoided.
6. For the acorns that will undergo the natural dormancy control process (option #1) on November 1, proceed with option #1 process as described below.
7. For the acorns that will be cold stratified in the refrigerator (option #2) at the end of November, bring the acorns inside into a cool basement. This prevents them from freezing. They must not be allowed to freeze.
8. At the end of December proceed with the cold stratification process for the acorns that are intended to undergo the dormancy control process in the refrigerator (option #2).

Notes

1. Given climate change and consequent weather extremes, growers may want to diversify their approach. One way to do that is to divide the acorns into two groups and process one group using Option #1 and the other group using Option #2.

5. Dormancy Control - Option #1 Natural Method

Timeline

November 1 (before the ground freezes)

Procedure

1. Prepare a garden box (raised bed) that can be protected from tunnelling and squirrel damage.
2. Count the acorns and document the number to enhance the full recovery of the acorns in the spring (add to batch information card).
3. Place individual acorns about 1 inch deep and 3 inches apart in the soil. Cover them lightly with a bit of earth. This approach should ensure that the acorns do not freeze during the winter. For more information, consult Henry Kock [Growing Trees from Seed](#)⁵.
4. Mulch with straw covering the top surface at least 4 inches deep. Mulch around the sides of the garden box with leaves.
5. Cover the top with chicken wire so squirrels cannot get to the acorns.

Notes

1. In this manual, we reserve the term “cold stratification” or “stratification” exclusively for the process using the refrigerator. The “natural process” described below is the process used by nature.
2. Germination may start during the winter for some of the acorns in the raised bed (usually in the form of a white tap root). If so, treat the tap roots with care in the spring and proceed with the process. Premature germination seems to be harmless and limited.
3. Overwintering is simply a process by which nature sets the germination clock for the acorns. Exposure to cold temperature for a certain amount of time triggers the germination process. That mechanism ensures the acorns begin germinating in the spring but not prematurely.
4. Mark the storage location clearly so all the acorns can be recovered easily the next spring.

5. There are physical variations of the approach described above. The common theme of successful approaches is that they avoid freezing the acorns. Some experimentation might be useful but not in years when acorn production is low.



Figure 3: Left: These acorns have just reached the end of their fall storage and are ready to be placed in a raised bed in the garden for the winter. The raised bed will be well insulated as the acorns are not meant to freeze. Squirrel protection is necessary. Right: This is a premature tap root well developed by the end of October. It was subsequently wintered in the raised bed and did not seem to have been adversely affected.

5. Dormancy Control - Option #2 Refrigerator Method (Cold Stratification)

Breaking Seed Dormancy at Home

“In the natural world, seeds that fall in suitable habitat will break dormancy naturally and receive appropriate moisture and protection. Scientists have developed various methods to mimic nature’s ways. Breaking seed dormancy by using stratification, a cold, moist treatment period, is one of them.”⁴ Refer to Appendix D of this manual for more information on woody plant seed treatment.

Timeline

January 1

Procedure

1. Check to ensure that the growing medium in the zip lock bags is slightly moist.
2. Close the zip lock bags.
3. Place the bags in the crisper drawer of the refrigerator.

⁴ Henry Kock, Growing Trees from Seed - A practical guide to growing native trees, vines and shrubs, 2nd Edition Revised and Expanded, Firefly Books, 2016, page 23

4. Ensure that the crisper temperature stays within the range of 35 degrees F and 39 degrees F. The acorns must not freeze . The acorns are never to be stored in a freezer.
5. Check from time to time to see that the acorns are not too dry and that there is no mold.

Notes

1. Stratification is a process of pre-treating seeds in order to simulate natural conditions that seeds would experience in the soil over winter. Pre-treating seeds helps them “break dormancy” and initiate the germination process⁵. Refer to www.prairie.nursery.com for more information.
2. Pre-treatment by keeping the seeds in cold dry storage helps increase germination rates by imitating a natural dormant winter period.
3. Germination may start for some portion of the acorns during the cold stratification process. If so, treat the tap roots with care and proceed with the process. The germination state is first evidenced by tap root growth, not stem growth which is a different process.
4. Seeds must retain dormancy to prevent germination during an autumn warm spell and then being destroyed when winter comes.
5. All temperate plants have hormones that prevent leafing out during a warm spell between September and March. This resting phase is called dormancy.
6. Stratification is a way of mimicking nature.

In addition to the two approaches described above, there is another effective method for those having access to a greenhouse that will be heated for the full course of the winter. It is described briefly in Appendix A.



Figure 4: This acorn demonstrates aggressive growth of the tap root by the end of November. It is ready to start the “cold stratification” process in the crisper drawer of a refrigerator.

⁵ www.prairie.nursery.com

6. Setting out in Air Pruning Grow Boxes

Timeline

May 1

Procedure

1. Prepare air pruning grow boxes by ensuring there is sufficient soil and that the boxes are weed free.
2. Soil mixture should be 35 – 45% topsoil, compost 15 – 25%, and peatmoss 30 – 40%. The compost material could be shellfish based. The pH level should be about 5.4.
3. Locate the boxes so they get full sunshine.
4. Elevate the boxes about 6” off the ground so lots of air can get underneath where the ¼” galvanized bottom screen is.
5. For Option #1, extract the acorns that wintered in the raised beds outside being very careful not to damage any early tap root growth.
6. For option #2, collect acorns that were cold stratified in the refrigerator. These too may have early tap root growth. Early tap root growth is not a problem as long as the fragile root is handled with care.
7. Plant acorns (root side down) in the air pruning grow box 1” deep and about 12 per square foot of surface area. Cover lightly with soil mixture.
8. Cover air pruning grow box with protective screening (to keep squirrels out).
9. Update the batch control records – sowing date, number of acorns planted etc. It is important to know how many acorns were planted in the air pruning box so that the germination process can be monitored.



Figure 5: Left: two cubit foot boxes under construction and ready for planting at the beginning of May. Note the chickenwire covers that prevent animal damage to the seedlings. Right: The underside of a 4' x 2' air pruning grow box with a 1/4" galvanized mesh to introduce high levels of oxygen which in turn causes the suspension of tap root growth when the tap roots are at an optimal point.

Notes

1. This would normally be done about May 1st. There will be frost after that; however the earliest stem growth will appear only a week or so after setting out and as growers will have ready access to the grow box they are tending, they can cover them easily on frost nights.
Air pruning is an effective method for avoiding the seedling becoming “pot bound”. Plants that are pot bound may not survive very long. Air pruning results in higher-than-normal levels of oxygen which is detected as the root gets close to the bottom wire screen. This causes suspension of the taproot growth at a convenient length (say 15”). Provided the seedling gets out planted that same season, the root growth will resume. Note that the tap roots do not get tangled in the air pruning boxes in spite of being planted close together. Consequently, it is not difficult to extract them from the box without damage when ready for out planting.
2. The first three years with bur oaks is all about getting great tap roots⁶.
3. The grow box should have at least 12” of soil depth but no more than 15”. See Appendix B. Boxes that are too heavy to lift may cause issues.
4. Covering the grow boxes during May and early June is likely only necessary when there is a frost warning.

7. Germination

Timeline

May – with initial sprouts appearing about two or three weeks after sowing in the air pruning boxes

Procedure

1. Continue to be vigilant making sure that soil does not dry out and that predators do not get into the growing boxes.
2. Inspect daily to see when the first shoot appears.
3. Mark shoots as they appear with small wooden stir sticks to facilitate weekly count.
4. Determine the number of incremental shoots each day and mark them with wooden stir sticks.



Figure 6: Left: Acorns planted May 1st showing shoots emerging 20 days later. Middle: Stir sticks have been used to both protect the sprouts and to make periodic inventory counts easier. Right: One month after planting, seedlings are 2" high.

⁶ Donnie McPhee, interview with Frank Camm 2022 07 19

Notes

1. Ultimate germination rates should be very high (90%+) but it does take several weeks for all the acorns to germinate. Dormancy control, whether natural or simulated (cold stratification), seems to make it likely that some acorns may delay germination until after the likelihood of a last killing frost.
2. It may take about two or three weeks after sowing before the first shoots appear. Germination is a gradual process and it may take six weeks before all viable acorns germinate.
3. As they sprout, bur oak shoots could be mistaken for debris or the red flowers of red maple (*Acer rubrum*).
4. Germination rates approximate a bell curve with a few coming early followed by a very productive middle period and finally a slow period at the end of the process. Several days with no new stems is an indicator that germination is most likely complete.

8. Nurture Seedlings

Timeline

All summer

Procedure

1. Place air pruning grow box in maximum sunlight.
2. Do not allow the soil in box to dry out especially during hot summer periods. If watering is required it should be done in the early morning or evening.
3. Keep the grow box cover in place at all times. Squirrels are very attracted to the half-rotted acorn long after the shoot has appeared and will rip out seedlings to get to the acorn. The spent acorn will tempt them well into September.
4. Fertilize with a water-based fertilizer that has very little nitrogen. The objective is to encourage root growth rather than shoot or leaf growth. Be careful not to over fertilize as plants should acclimatize to the natural conditions they will encounter in the wild. Fertilize twice a summer: once in early June and once in mid-July. Do not fertilize after July 31.
5. Weed regularly to eliminate competition and to help ensure that when the seedlings are extracted from grow boxes they come out easily without interference by weed roots.

Notes

1. Note that the leaves attain a surprisingly large size relative to the seedling stems.



Figure 7 : Seedlings seven weeks after planting

9. Preparation for out planting Seedlings

Timeline

Planting day minus 1 (mid-October to early November)

This is done when the seedlings show signs of approaching dormancy i.e. leaves are turning brown or falling. Extraction from grow boxes should be done the night before the out planting. It should not be done during the heat of the day or in bright sunlight. The seedlings should remain in the grow boxes until the very last minute so the risk of drying out is minimized.

Procedure

1. Determine which batch(s) of seedlings (based on acorn source) are appropriate for the planting site that will be used. Deliberate DNA diversity is a good thing so planting from several local source groves is desirable.
2. Visit the planting site(s) with a small team a week in advance to select the individual seedling locations. Stake (3/8-inch or 10 mm rebar makes the best stake) and flag each location, and install a cylinder of protective chickenwire 12" in diameter and 36" high. The rebar stake should stabilize the wire.
3. Locate the best individual sites for seedlings keeping soil and light conditions, as well as competition in mind. These individual sites should be selected at least one week in advance so that due diligence can be given to this important siting task.
4. Once planting locations have been selected and staked, if possible, record each location on Avenza digital mapping software and insert appropriate digital labels that will be meaningful for future analysis.
5. As the seedlings must never dry out, it is best to extract the seedlings from the grow boxes the evening before out planting. Disturbance duration must be minimized.
6. Make sure that the seedlings are dormant (the leaves should have fallen or be turning brown) before extracting from grow box.
7. Remove the end of the air pruning box if it was designed to allow the end to come off easily. This design makes it easier to remove



Figure 8: This acorn has a very robust tap root which is straight (not root bound) and about 12" long. This specimen came out easily as the root stopped just short of the ¼" galvanized screen bottom of the air pruning box. While there is a nice above ground seedling, at this stage, the important outcome is a root that is at least twice as long as the stem. Note the acorn still seems to be intact. Even at this stage it is still attractive to rodents.

individual seedlings without damage. When extracting seedlings from the grow boxes do not damage the tap root or the tap roots of adjacent seedlings. A gardening trowel or a cedar shingle shim may help with this part of the process. Take every seedling and discard only really bad specimens (extremely short stem or poor tap root). A great tap root is what matters most at this stage so as long as the root is good, the seedling should be selected for out planting.

8. Gently remove the soil while ensuring that the tap root is not damaged.
9. Bundle seedlings loosely with a twist tie. Each bundle should contain 5 or 10 seedlings. This makes for easier counting and distribution to the planting teams.
10. Place the bundles in the pail so they collectively lean gently against the side.
11. Gently cover the roots with soil and moisten it if necessary. Make sure they never dry out. Be concerned with both tap roots and the many lateral roots.
12. Secure the pail in a squirrel proof location for the night.
13. Collect tools for out planting such as pails, gardening trowels, shovels, gloves.
14. Remind volunteers of personal gear requirements (such as water, lunch, boots, raincoat etc).
15. All volunteers should be equipped with high visibility vests (planting seedlings in October or November will most likely be during hunting season in New Brunswick).

Notes

1. A pail for each planting team preloaded with the correct number of seedlings may be the most effective way to ensure that all seedlings are planted as planned.
2. Certain planting sites may require a “Permit for Watercourse and Wetland Alteration” depending on the proximity of the sites to a wetland. The permit application process will be completed by the NTN staff for NTN nature preserve planting events.
3. Keep the seedlings moist in a 20 liter pail with soil covering all the roots. Never let the roots dry out.

10. Transplant Seedlings

Timeline

October/November

Procedure

1. Recruit planters. Volunteer commitment is important as seedlings will be prepared to suit the size of the planting group. Any leftover and unplanted seedlings will lead to an increase in mortality rate.
2. Create planting teams consisting of experienced planters as well as volunteers planting bur oaks for the first time. List team members by name.
3. Review verbally the detailed planting instructions found in Appendix C of this manual.
4. Plant the trees as instructed.
5. Ensure that every pre-staked planting site receives a seedling and if not, remove that stake and flag.
6. Count the trees planted and correct planning documentation as required.

7. Do a quality assurance process to make sure all seedlings were planted properly.
8. Ensure that the site is inspected after the planting exercise has been completed. All tools should be collected, all individual seedlings should be inspected, and all debris (pre-existing and new) should be collected.



Figure 9: Planting day! A very satisfying part of the annual cycle.

Notes

1. Refer to Appendix C “Tree Planting Guide”.
2. Ideally planting events will coincide correctly with the frontal weather expected i.e. it would be good to have rain the day after the planting event especially if carrying water for large numbers of seedlings is impossible or impractical. As is likely the case.
3. Reschedule planting day if a hot spell is forecast.
4. Teams may consist of one hole-digger, one or two planters, and another individual who specializes in the installation of browse protection . Every participant should be encouraged to plant some trees and to get experience with all the tasks required to plant the trees.
5. Be sure all flagged stakes have a seedling planted.
6. Holes need to be 18 inches deep so tap root is vertical and straight.
7. Ensure that the root collar (just above the acorn if still attached) is at the same grade as the surrounding soil i.e. no basin to retain water as this may harm, rather than help, the seedling.
8. Replace earth around root gently. Do not stamp down the restored soil.
9. Install rodent guard.
10. Install chicken wire so it can be elevated easily as the tree grows. Thread the rod through the holes but do not wire it tight.
11. Get GPS readings for the epicenter of the planting area or each individual seedling whichever is practical.
12. Grass and weed control. Consider matting if grass could be a competing factor.
13. Root and rocks – eliminate them or move the individual site stake.

11. Monitor Seedlings

Timeline

Spring and fall (at least twice each summer)

Procedure

1. Review electronic maps and inventory data.
2. Inspect every seedling.
3. Count any dead seedlings and note their location.
4. Generally, assess the health of the surviving trees.
5. Correct any issues pertaining to the anti-browse protection and the rodent coils.
6. Collect any garbage.
7. Remove screening and stakes from the dead trees if no infill planting is planned for that grove.

Notes

1. This is an ongoing process but a process that should be explicitly planned for as part of the overall annual plan and budget.
2. The first inspection should be in the spring at a time when the seedlings could be expected to be producing leaves and new shoots. Assessing survival rates before leaves develop is unreliable.
3. Grove records should be updated and dead seedlings should be replaced if possible.
4. All inspection report data should be included in the permanent record for each planting location. During the first summer after out planting special attention should be paid to weed control, browse protection etc.
5. Inspection includes elevation of chicken wire cages as the trees grow and adding supplementary stakes as required.
6. Remove anti-browse screens and stakes when the saplings are about 2.0 meters tall.
7. When seedlings reach a height of 1.5 meters, they are considered to be “saplings”⁸.

Appendices

Appendix A: An Alternate Greenhouse Approach to Seedling Development

There is a third option for those who have access to a heated greenhouse. English oak (*Quercus robur*) acorns were collected in September, left in a plastic bag for a few weeks until there were signs of tap root development and then sowed in plastic cups in a heated greenhouse. The greenhouse is heated (about 15 degrees Celsius) and there is a fan to simulate outdoor air movement. Grow lights are also used. They continued the germination process over the next few weeks, with the image below taken in December. One would expect Bur Oak performance to be very similar. This picture was taken at the end of December.



Figure 10: English Oak (*Quercus robur*) grown in a heated greenhouse by Tony Henderson.

Appendix B: Growing Box Design and Bill of Materials (One Box)

Note: this is just one approach. The key is the screen bottom for air pruning, the depth of the box for tap root purposes, and the rodent control. See Section 6 above for pictures.

The small boxes the project built were two feet long, one foot wide, and almost one foot deep. Two cubic feet of soil plus the wooden box itself likely weighs about 80 pounds. Anything larger will be difficult to move around if that's necessary.

The air pruning bottom is $\frac{1}{4}$ " by $\frac{1}{4}$ " galvanized steel screen. Box design must be based on the available screen dimensions and cut with economy in mind. The objective is to avoid having to splice this material or to have any residual too small to use on future boxes. The screen is stapled to the bottom and there should be $\frac{1}{4}$ " battens nailed around the perimeter and likely a couple across the box width. There is nothing else to impede the circulation of oxygen.

The chicken wire cage is very important in preventing squirrels from ripping out the seedlings to get the decomposing acorns. Space for future growth is key here and there should be at least 12 inches of

vertical growing space. The cages must be squirrel proof but easily removed by box stewards to do periodic tasks like weeding.

When deployed, the boxes need to sit off the ground on blocks at least 3.5 inches high.

Item	#	Dimensions
Long side	2	1 x 7 ¾ x 24
Long side	2	1 x 3 7/8 x 24
Short side	2	1 x 7 ¾ x 10
Short side	2	1 x 3 7/8 x 10
Corner post	4	2 x 2 x 11 1/2
Hardware cloth (1/4" galvanized screen)	1	12 x 24
Strips to anchor the hardware cloth to sides and ends at bottom edge	6	1 x ¾ x 12 2 are shortened to 9 ½" and the other two are 10 1/2" to fit
Crosspiece support	1	1 x ¾" x 12
Lid corner piece	4	1 ¼ x 1 ¼ x 12
Lid long side top	2	1 x 1 ¼ x 24
Lid long side bottom	2	1 x 2 ½ x 24
Lid short side top	2	1 x 1 ¼ x 14 ½
Lid short side bottom	2	1 x 2 ½ x 14 ½
Chicken wire or plastic netting	2	82 x 12 27 x 14 ½
Screws 2" deck or construction screws	Approx. 66 per box.	Nails are just as effective and less costly.
Hook and eye	2	

Note: one end can be unscrewed for easier seedling removal. If dressed lumber is used instead of 1" actual rough, the 1" dimensions above may be reduced to ¾" and some others may have to be tweaked as well.

Appendix C: Tree Planting Instructions

1. If individual sites have been pre-selected (the norm) use the designated site.
2. Dig a hole 15-18 inches deep (and about a garden shovel wide) conserving the earth carefully for refilling.
3. If there are significant obstructions (rocks or roots) relocate site without encroaching on other sites too much.
4. Carefully extract the seedling from the seedling pail. Make sure it is a single seedling. Re-cover the roots for the remaining seedlings in the pail as they dry out very quickly. They must be kept moist at all times.
5. Ensure the tap root is vertical and straight as it is trial fitted in the hole. It must not change direction (curl either horizontally or vertically) at the bottom as it can become pot bound even in the absence of a pot.

6. Ensure that the root collar (intersection of stem and root) is level with the surrounding forest floor. There should not be a shallow basin around the seedling to collect water as this may drown the plant.
7. Gently replace earth (having broken up clods). Replace earth gradually ensuring that there are no voids.
8. Do not compact the earth by stamping it down with one's foot. Simply gently compress the soil with hands.
9. Install mouse guard.
10. Install coconut matting or landscape fabric to inhibit weed and grass growth.
11. Weave rebar (having removed it from the ground) through the chicken wire at the seam. Four weaves should be sufficient.
12. Locate the rebar stem about 6 inches from the seedling so that the stem is in the center of the chicken wire cylinder.
13. Drive the rebar stake 12 inches into the ground.
14. If flagging or tagging instructions have been given, follow them.
15. Move to the next flagged site making sure that no neighbouring sites have been overlooked.

Appendix D: Woody Plant Seed Treatment Guide

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The table data shown below does not include *Quercus macrocarpa* (Bur oak) but does include *Quercus alba* (White Oak). Both species are classified as “white oaks” and therefore the material in the table is thought to be appropriate for Bur oak.

Table Data for *Quercus alba* (White Oak):

V, O (V, W 15, G, C 90 – 120)

Table Decode

V Viability is reduced if seed dries out

O Seed is best planted in protected outdoor seedbed. The information enclosed in brackets – () – represents an alternative to direct seedbed sowing

W Warm stratification 68 degrees F (20 degrees C), # = duration in days

G will germinate near the end of the cold stratification and should be planted soon. When root growth occurs during the warm treatment, the seed must still have cold treatment for the shoot.

C Cold stratification 35 – 39 degrees F (2-4degrees C) (but not freezing);# = duration in days