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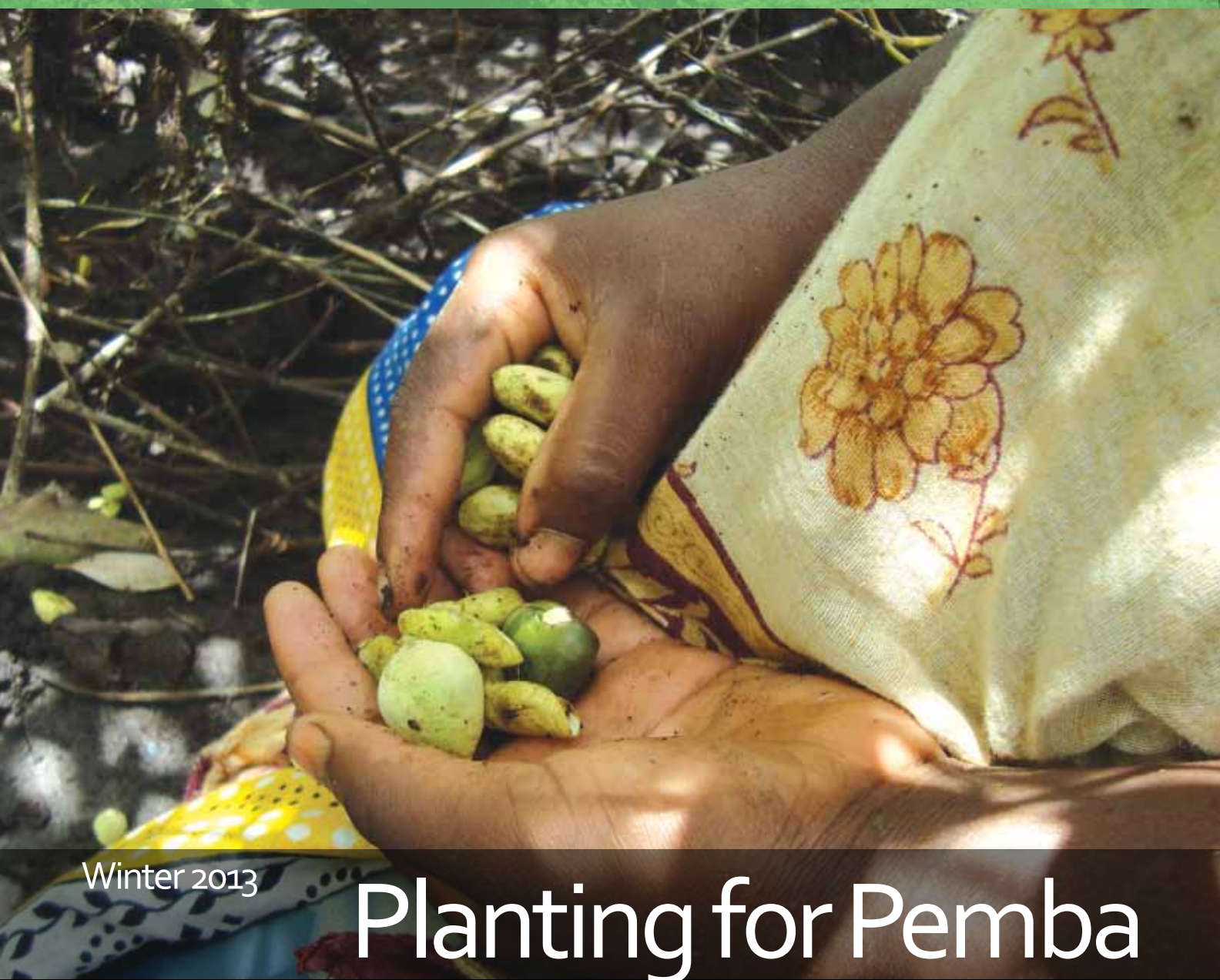

Winter 2013

Planting for Pemba

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A glance back in time

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Cover photo: Woman sorting seeds for planting in a community nursery, 2009 Pemba Tanzania

Photo courtesy of CFI (Canadian Forests International).

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Biochar and its potential in Canadian forestry

By Sean Thomas

Throughout the boreal forest region and indeed much of Canada, fire is the primary natural "disturbance agent" — the means by which older forest stands are naturally replaced by younger stands. The situation immediately after a fire can appear quite unpromising: charred remains of canopy trees and loss of understory vegetation, including regenerating trees. However, an observation familiar to many foresters is that post-fire stands "green up" remarkably quickly. A few years after a moderate-intensity fire, understory vegetation is generally thick and future canopy trees are growing vigorously.

A number of processes contribute to post-fire regeneration and rejuvenation. Many tree species show adaptations to survive fire events (e.g., thick insulating bark, high belowground storage), or to regenerate by seed following fire (e.g., the serotinous cones of Jack Pine). In addition, nutrients previously stored in living parts of trees have been released into the system, and soil temperature is increased by a reduction in litter. However, something much less obvious also contributes to post-fire forest rejuvenation: namely, a phenomenon that has been termed the "charcoal effect". In experiments in the 1990s in Scandinavia, additions of charcoal to soils were shown to increase nitrogen uptake and growth of some trees, and result in a proliferation of understory vegetation. Some fern species would only establish where charcoal was present. An initial hypothesis of the main mechanism responsible was the capacity of charcoal to absorb growth-inhibiting phenolic compounds associated with the leaf litter of certain understory species, in particular Ericaceous shrubs (blueberries and their kin). Early research also showed that charcoal strongly impacts a variety of soil processes, resulting in increased litter decomposition rates, increased soil pH, and increased availability of nitrogen and cations such as calcium and magnesium.

In the last few years research interest on charcoal in soils has veritably exploded. A major motivation stems from the long persistence of charcoal in soils. Wood chips added to soil decompose within a few years, and the half-life of larger logs is often only 20-25 years. In contrast, 90%+ of charcoal remains present for at least 100 years, and a large portion is likely to be present for 1000 years or more. This longevity is of great interest in terms of carbon "sequestration". Charcoal is >95% carbon, and diversion of organic waste material from agriculture and forestry into charcoal on a large scale could in theory be an important mechanism to remove carbon from the atmosphere and store it in a form that will remain put for a long period of time. Unlike other proposed types of carbon "capture", addition of charcoal to soils has considerable potential to have additional beneficial effects that have nothing to do with climate change. The term that has emerged for charcoal intended for use as a soil amendment is "biochar" (Fig. 1), with the "bio" referring to its biological source. Biochar as a climate mitigation strategy has recently been promoted by the likes of Al Gore, James Hansen, and James Lovelock.

Biochar basics

Complete combustion of wood, as occurs under high oxygen conditions, produces wood ash as an end product. Wood ash is generally very alkaline (pH 9-13), and depleted in lighter elements such as nitrogen. Although there are cases in which wood ash has been used for agricultural liming, it is generally not beneficial as a soil amendment to enhance tree growth. Pyrolysis is the thermal decomposition of biomass under low oxygen conditions; it is a chemical reaction that one would recognize as a kind of smoldering fire. Although simple to initiate, pyrolysis is a complex chemical process. The main chemical products of wood pyrolysis include syngas (composed of hydrogen gas, carbon monoxide, and a variety of gaseous carbon compounds, especially ethylene and methane), pyrolysis oils (heavier organic molecules that are liquid at room temperature), and charcoal. Wood vinegar, consisting of recondensed water and water-soluble organic compounds including acetic acid and acetone, may also be produced. Pyrolysis has been around a long time as an industrial process: some types of "town gas" produced during the gaslight era were essentially pyrolysis-generated syngases.

The chemical and physical properties of biochar vary greatly depending on pyrolysis conditions, such as peak temperature, and also on the properties of the organic matter used as feedstock. Biochar can be produced at temperatures of anywhere from 250-900°C. Biochar produced at low temperatures (say <400°C) tends to retain more carbon, and have a lower pH and porosity; higher temperature biochars (say >550°C) retain less carbon and have higher pH and porosity. Some types of feedstock present problems for producing biochar useful as a soil amendment. Some animal wastes (such as chicken manure), as well as urban compost sources have quite high levels of salts (sodium chloride and others) that remain present in charred material. Construction waste material is typically mixed with metals and plastics, and can be expected to produce chars that have unacceptable levels of toxic contaminants. Contamination concerns are resulting in rapid efforts to develop consistent labeling and quality assurance for trade purposes. Biochar certification is likely to follow.

The properties of biochars that may result in a beneficial "charcoal effect" remain a topic of considerable research interest. A number

of mechanisms are now thought likely to contribute to beneficial effects on plant growth. Biochar generally bears a negative charge, and serves as a cation exchange site in soils. In addition, biochar commonly has a remarkably high surface area, and physically sorbs a great variety of substances, including negatively charged plant nutrient forms such as phosphate and nitrate. The high surface area of biochar also enhances soil water holding capacity, and its low density will generally reduce soil bulk density and so enhance soil aeration and root penetration. Some properties of biochar may, however, have negative effects on plants. Freshly produced biochar may absorb mineral nutrients to such an extent that they are unavailable to plants, suggesting a need to "prime" biochar by adding nutrients. In addition, recent work has shown that many biochars outgas significant quantities of ethylene, a potent plant hormone with unpredictable and species-specific effects on plant growth and development.

Potential for biochar use as a forest soil amendment

In many respects it is "natural" to consider biochar as a soil amendment in the context of Canadian forestry. Charcoal is something that naturally occurs in to a greater or lesser extent in essentially all forest ecosystems in Canada. One can therefore anticipate that native plants and other organisms, in particular soil microbes and fauna, will be able to cope with some level of biochar in the soil. Adding charcoal to logged stands may better "emulate" natural disturbance. From current understanding of biochar effects on soil properties, positive effects on forest productivity would be expected in many systems. Moreover, there is a high potential to create "designer" biochars matched to specific soil types and forest communities.

What benefits are to be expected in terms of increases in forest growth and yield? At present nearly all published data are from agricultural systems. A meta-analysis (quantitatively compiling results from numerous studies) published in 2011 found that on average biochar additions resulted in a ~10% increase in crop yields in agricultural trials (almost all conducted in the tropics). However, if one considers only trials in which soils were acidic and/or coarse-textured, the gains in yield were ~20-30%. Also, there are other cases in which larger growth enhancements have been documented; moreover, growth enhancement effects can continue for many years after biochar has been added to a soil.

Research trials on tree growth responses in Canada have only been initiated in the last year or so. Pot experiments examining first year growth responses of a number of Canadian tree species were completed in my lab in October 2012 (Fig. 2). Results are currently being analyzed for peer-reviewed publication, but it is clear that results are not so clear cut: tree species vary in responses, and both positive and negative responses can occur. One possible explanation for negative effects is that early tree growth responses may be strongly influenced by ethylene emitted by biochars, but this remains speculative. Understanding the mechanisms for effects will clearly be critical to developing biochars that maximize benefits and are suited to specific tree species and soils.

Potential of biochar as a forest product

There is considerable popular interest in biochar as a soil amendment, and a range

Fig. 1. A handful of biochar. Photo by Nathan Basiliko.

of companies in the US and elsewhere are marketing biochar for horticultural use. In addition to its potential use for gardens and houseplants, biochar has a number of other important market niches. The low weight of biochar makes it particularly attractive for green roof and urban forestry applications where minimizing soil mass is important. The high capacity of biochar to absorb a wide variety of chemicals also has generated great interest in its use on contaminated soils, including industrial brownfields and on mine tailings. In an agricultural context, biochar may be best considered a substitute for lime: biochar commonly has a liming potential much greater than dolomitic limestone, and is expected to continue to reduce soil acidity over a much longer time. This specific product substitution may also be important in a forestry context: in Ontario the most common forest soil amendment has been lime added to acidified soils in sugar bush operations. Biochar has an additional potential advantage in that it can be directly valued in terms of sequestered carbon.

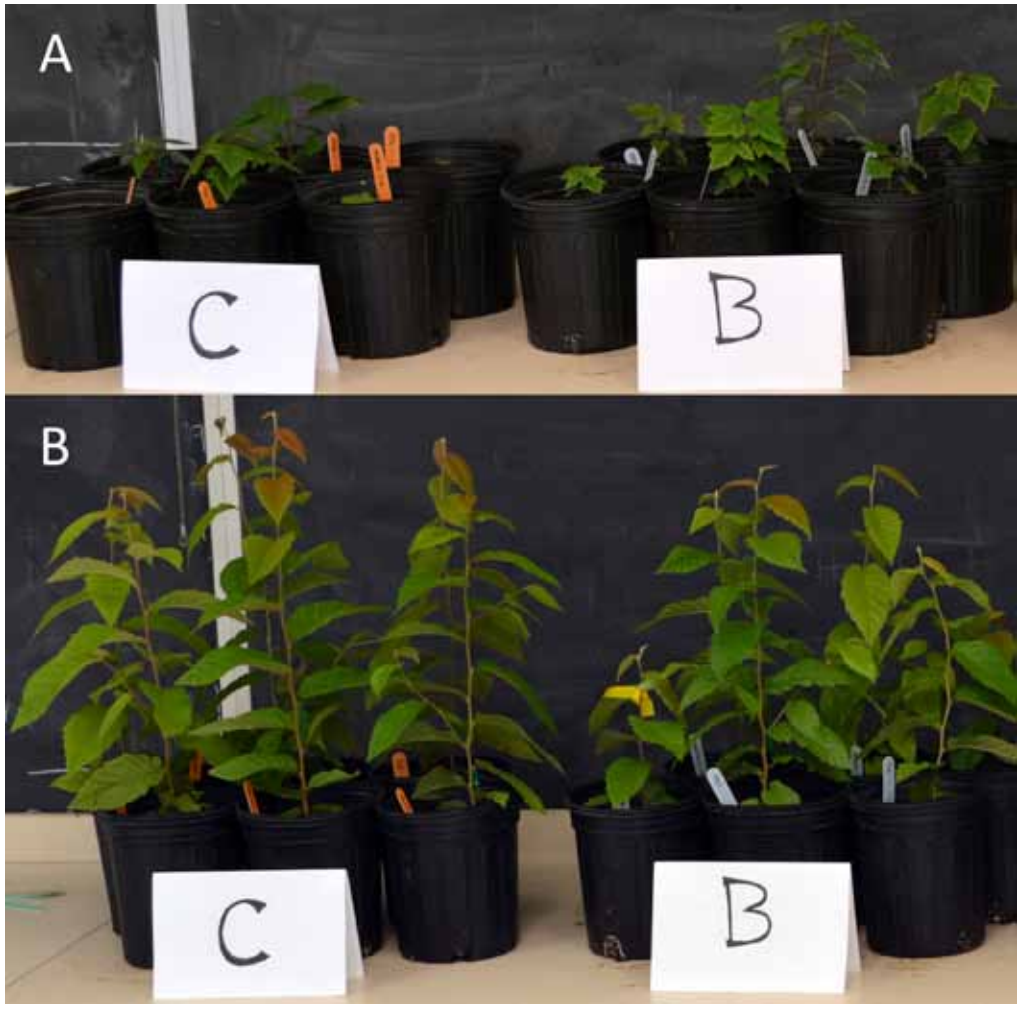

Fig. 2. Trees vary in their response to biochar additions. Comparison of growth responses to biochar of (A) red maple (Acer rubrum) and (B) yellow birch (Betula alleghaniensis) (C = control; B = biochar addition treatment, consisting of sugar maple sawdust pyrolized at a peak temperature of 525°C added at a rate of 5 t/ha. Photo by Tara Sackett.

Wood fiber is generally regarded as a superior feedstock for biochar production. Other feedstocks, in particular animal wastes and some agricultural residues, commonly result in biochars with less desirable characteristics in terms of element content and properties like porosity. Wood fiber is also likely to be more uniform and predictable as a feedstock source. Of course there are many other potential uses for wood fiber in, for example, wood composite products; however, most such applications still result in residues that could be used as a biochar feedstock.

Charcoal production is an ancient technology, and there are a variety of commercial units available geared toward production of charcoal for barbeque-type markets. Simple "retort" systems, mainly designed for on-farm processing of agricultural waste, can also be obtained. However, efficient conversion of sawmill waste, in particular sawdust and bark, to biochar, will demand high-capacity purpose-engineered machinery. Engineering emphasis to date has generally been on pyrolysis products other than biochar, in particular pyrolysis oils, which have important potential as industrial chemical feedstocks. Integrated systems that efficiently produce a set of products remain an important engineering goal.

Conclusions

Biochar is very likely to emerge as an important new aspect of the forest industry in Canada in the years to come. An obvious driver initially will be market opportunities for sawmills and other wood processing facilities to turn waste materials into new products that have an added economic value in terms of carbon credits. Use of biochar as a forest soil amendment is most likely for high-value stands subject to soil acidification, in which biochar may be a cost-effective and more permanent substitute for lime. Urban forest applications may also be important, as may intensively managed high-input systems, such as hybrid poplar. The economics of biochar will also depend strongly on the development of carbon markets and regulatory frameworks to encourage climate change mitigation.

Sean Thomas is Senior Research Chair, Forests and Environmental Change in the Faculty of Forestry, University of Toronto. Dr. Thomas's research focuses on tree functional biology and forest carbon processes, with current funded projects examining biochar impacts on tree growth and soil processes. Email: sc.thomas@utoronto.ca

Focus on Safety

By Barbara MacFarlane

Safety in Business

A word….safety.

Did you cringe? Did your mind go to your latest order by a workplace safety officer? Did you feel your bank balance shrink? Did you think about training records? Did you think about the law and how darn confusing it is to know what you're supposed to do? Did you think about an accident, a near miss?

Another word…business.

Did you think of safety at all?

On October 4th in Miramichi, New Brunswick the 3rd annual national meeting of forest safety associations took place. Representatives were present from British Columbia, Saskatchewan, Ontario, Nova Scotia, New Brunswick and Newfoundland. At such meetings, current trends and common issues are discussed and tools and solutions are shared. The most interesting thing I've noticed year after year is that no matter how different our provincial industries may seem, we are not that different after all. One common and reoccurring issue that arose again this year is how to engage industry leadership in health and safety.

To many, the term 'safety' (unfortunately) represents a cost (like an accident or a training course) or something that is apart from their daily activities (like a safety talk). However, the reality is that safety needs to be fully integrated into one's overall business. It should just be how things get done - safely. In fact, I believe that segregating safety and using terms like 'safety leadership' and 'safety culture' have only stifled what so many of us health and safety professionals are trying to do, which is to fully integrate safety to the point where it happens unconsciously.

How do we get there? The biggest step for any business owner is to recognize that safety is part of their business; whether they address it or not, it's there. As Reynold Hert of BCForestSafe said at our October 2012 meeting, "every company has a safety program, whether or not it's making or costing them money is the question". So if you are a business owner, ask yourself "does my safety program make or cost me money"? And if you answer "I'm not sure" or "I don't know" than I'll bet it is costing you.

Recognizing that safety is part of your business is one thing, recognizing how to initiate change in your business to improve on it is something else. As a business owner/manager/supervisor you have the capacity to make things happen. As Stephen Covey said "I am personally convinced that one person can be a change catalyst, a "transformer" in any situation, any organization. Such an individual is yeast that can leaven an entire loaf. It requires vision, initiative, patience, respect, persistence, courage, and faith to be a transforming leader."

A great leader is someone who champions a message and rallies, follows not with what they say but with their *behaviour*. A great leader embodies a strong and clear message such that their followers are compelled to impress and emulate them because they believe in them so deeply… and not because of what they say but because of what they do and what they stand for. Remember the business mantra that your *lowest standard will become your employees' highest expectation*.

In business and in safety it's often said that if people are not doing the little things than they are not doing the big things. So I challenge all owners, managers and supervisors to take a hard look at themselves and determine by what examples they are setting and leading by. Observe the next time you go onto the job site what people are doing (and not doing), look for those "little things". For instance personal protective equipment is an easy one; if someone is not wearing their hard hats, eye/ear protection, are they likely to follow the lockout procedure that takes 15 minutes, or that detailed maintenance program? Probably not.

The true test in this exercise is not just observing what people are doing, but how you handle it. Before you hand out a reprimand, ask yourself one final question, "what have I done as this persons' superior to encourage this behaviour"?

If you can be honest with yourself, you will find a golden opportunity within your personal accountability to become a true business leader.

Barbara McFarlane is the Executive Director for the New Brunswick Forest Safety Association. She holds a degree in Forest Engineering from the University of New Brunswick, a Certificate in Adult Education from St Francis Xavier University and is a Certified Health and Safety Consultant.

Reader's Lens

Photo by Jeremy Cameron

Photo by Scooter Clark

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Notes from the Field

A Tree Planting Misadventure

By Stephanie Page

Widow-maker: nickname used to describe a falling snag. **Snag:** a dead or dying tree.

East of the Rockies there is a stretch of Albertan forest familiar to tree-planters. After a brutal day of planting white spruce and pine in an overgrown, thorn riddled, wasp infested, three-year-old fly block somewhere between the swamps of Swan Hills and the sweet canola fields of High Prairie, we were waiting there impatiently for the helicopter to come.

The skies began to fill with dark, purple clouds. The wind was violent; we could hear branches snapping in the treeline. The thunder was chaotic; we could see lightening in the distance. The rain began to fall; we spotted the helicopter flying towards us. The pilot couldn't maneuver the wind to make the designated landing site, so he put the chopper down on the other side of the cut-block. We didn't have much time. *Time is always on a tree-planter's mind.* If we didn't make the chopper we'd have to wait out the storm on the open block. Or worse, if the sun went down before the storm let up we'd have to stay in the forest overnight with nothing but our rain gear, wet cigarettes and empty lunch bags. We ran to make time.

We ran down the muddy trail, over fallen logs, through wispy grass and into a shallow ravine towards the chopper. I didn't feel scared. I don't think anyone did. It was tree-planting business as usual. *Thunder. Lightening. Rain. Hail. Snow. Wind. Bears. Bugs. Thorns. Nettle. Waiting. Hurrying. Hiking. Sweating. Shivering. Flying. Falling. Jumping. Tripping. Bleeding. Mending. Giving up and getting up to plant again the next day.*

I heard a thunderous crack that didn't belong to the sky and my supervisor hollered, "TREE!!". I looked up from the edge of the ravine and saw the thick, sixty-foot widow-maker falling perfectly towards us. Then I felt scared.

I couldn't go left. I couldn't go right. I couldn't go forward. I only had time to throw myself backwards and brace for impact. The widow-maker slapped the ground and sent woody debris flying into the air. The last thing I saw was my friend dive into the mud and disappear beneath the trunk...

The Dogon, a Malian ethnic group, have an interesting relationship with trees. They believe the forest is alive and in flux, while villages are stagnate and fixed. Rocks move. Trees move. Animals know human intention. The forest is home to spirits and these spirits can attack. It is a force that gives *and* takes. Trees give life, but can also bring death. They prefer to trim branches than to fell whole trees. Wood is used thoughtfully and hardly ever wasted. The Dogon believe the forest replenishes itself, so they exert very little control over it and plant very few trees. Their conception of the forest is directly related to how they treat it and is in direct opposition to how I conceived of it before that sixty-foot widow-maker knocked some sense into me. (Milton, 1996)

I can assure you that when a tree falls *on you* in the forest, it makes a sound. It seems louder than thunder. It seems faster than lightening. Its presence seems so abundant that its escape from your attention seems impossible. How then, could a gigantic falling tree have remained invisible to me until I had placed myself in its trajectory?

I opened my eyes. I was covered with leaves and twigs. The largest branches had just missed me, but my friend was still buried beneath the tree.

"Where is he?!", someone yelled. I didn't know. I began to panic. Then some branches moved and he pulled himself out from under the trunk.

He stood up, patted down his body and yelled, "I think I'm okay!" Except for a busted ankle, he was.

We pulled ourselves together and made the chopper. The pilot maneuvered the storm with finesse, fought the turbulence and returned us to camp safely. I didn't feel safe though. I felt lucky.

The only reason I can write about that widow-maker as a cautionary tale of tree-planting misadventures is because time lined up perfectly, so that a potential disaster turned out to be a near miss instead. What if I had jumped forward? What if the trunk had lined up a few degrees differently to my friends body? What if my supervisor hadn't yelled out? What if we had just paid more attention?

It's interesting to think about how a tree-planter's perception of the forest influences their safety. Many of us, in our familiarity with the cut-block and its hazards, may forgot to respect the power of this environment. I failed to assess my surroundings thoroughly that day and found myself rushing towards a falling snag. I was focused on making the chopper and became inattentive. If you've been planting for awhile you're skin is probably thick and the forest may even feel like a second home. Scaring away bears, working in a volatile environment and braving a bush camp for months changes a person's understanding of discomfort and danger. When the forest is your second home and when you feel like you have control over your work environment, it becomes easy to undermine hazards on the cut-block. This season I'll be thinking about the forest a little differently. I'll be thinking about how some people perceive the forest as all powerful and relate to it more cautiously. I'll be keeping my eyes open for snags and thinking about how *lucky* we were to have escaped that widow-maker.

Milton, Kay 1996. Environmentalism and Cultural Theory: Exploring the role of anthropology in environmental discourse. London: Routedge. Pp. 106-141

Stephanie page has been planting trees for five years and currently works for Next Generation Reforestation in Western Canada. In the off-season she lives in Montreal and studies at McGill University and can be reached at stephanie.page@mail.mcgill.ca.

Notes from the Field

Those of us who have worked in silviculture know it as an industry that cultivates a unique and incredibly valuable combination of skills. Consider the conditions; unpredictable forces of nature, physical, emotional and mental fatigue and stress, community dynamics, logistics, remote locations and the repetitive nature of the work. Those who thrive in this environment may move up to management positions or develop their own contracting companies. Others pursue new endeavours, but all have developed a gamut of skills and experience increasingly recognized as having incredible value.

The next article is the first in a series that looks at amazing people of our ilk who showcase the true value of skills and experience developed over years in reforestation work. We explore and celebrate their remarkable capabilities and the diverse ways in which their experience in reforestation ultimately contributed to new and interesting directions in their lives and work.

Planting for Pemba

Tree planters empowering change in rural Africa

By Zach Melanson | Photos courtesy of CFI

Very few people have ever spent a season planting trees in the clear-cut swamps, rock cap, and mountains of our vast Canadian landscape. If they did, they would likely find it somewhat horrifying. After four planting seasons, I have become accustomed to working in remote areas, among tangles of broken sticks and swarms of blackflies. I earned good money and likely injured my body beyond repair, but the thing that kept me coming back was the people. In tree planting camps it's cliché to indulge this sentiment, but for most planters, it rings true. A friend and fellow tree planter, Laura Neals describes this experience well, "A tree planting camp operates like a community. You live together. You eat together. You work together. It's easy to connect with each other because you all share this common experience. There's a sense when you're tree planting that you're all in it together." I would argue that it is exactly this sense of *community* that links tree planters across Canada to communities half way around the world.

The story of our organization; Community Forests International, begins in the Spring of 2007, while swapping travel stories around a camp fire and ruminating on the potential for change in the world. A friend and fellow tree planter, Jeff Schnurr , shared his experience of a recent trip to a small, isolated African island called Pemba. Jeff had been living on the island for 6 months before returning to Canada to plant trees. While in Pemba, he made friends with Mbarouk Mussa Omar, a community leader who was working for a small NGO working to preserve endangered coastal regions and provide education on sustainable fishing practices. Being that Pemba is a remote Island with few tourists, Jeff the "tree farmer" had piqued their interest. Mbarouk, along with a group of local fishermen and farmers approached Jeff to help start a tree planting initiative on tracts of degraded land. Jeff was keen to help in any way he could, and began writing proposals and visiting communities, communicating with locals the possibility of growing trees for fruit, fodder and home construction.

When Jeff returned to Canada to plant trees, he shared his experience on the island with myself, and others. A small group of us decided to help, making a pact to dedicate two years of our lives to support Pembans in their efforts.

Woman planting a mango tree near Tundaua, Pemba 2008

Jeff listens as Mbarouk, Executive Director of Community Forests Pemba (CFP) speaks to community members about the tree planting project.

One of 14 low-cost nursery that Brinkma & Associates, and their planters have helped establish on the Island. Pemba, Tanzania 2012

Mbarouk speaking to villagers on the islet of Kokota about the successes other communities have had planting trees on the main Island of Pemba. 2012

Community members inspect their recent plantings of mangroves near Wete, Pemba. Mangroves are planted to help prevent erosion in inter-tidal zones and create rich habitat for many fish species. 2010

Pembans had been subsistence farming and fishing since before recorded history and pressure on their resources increased in step with population growth. Today, trees could be planted to stabilize coastlines, to improve soil quality, and provide cover on this intensely hot tropical island. Furthermore, the islanders were importing many staples from the mainland like mango, papaya, and wood poles for home construction, which could be easily grown on the island. What was missing was the initial investment in infrastructure and technical assistance to get communities growing trees.

Our goal was simple enough, start small by helping a handful of villages on the island of Pemba grow trees on community-owned land for economic and environmental benefit. We accomplished this by building low-cost nurseries in seven communities, and hiring Mbarouk and a few local experts to visit villages and provide support.

In Canada, news of Pemba spread quickly through the camp, and soon we had organized a fundraiser to help Pemban communities build nurseries and grow their own seedlings. We picked a day where planters could donate a portion of their earnings, in the form of trees, to support the project. We called it "Plant for Pemba" The premise being that for every tree planted in donation, several more would spring up on the island. Laura Neals remembers one fundraising day in particular, "It was my first year crew bossing and we had the most miserable weather. It was a torrential downpour of near-freezing rain. By four o'clock no one could feel their hands, but our day was far from over. Most of the camp planted until eight-thirty that night. It was awful, but no one complained. On that day, everyone got tough. It didn't matter how cold it was. It didn't matter how late it was. Everyone felt like they were a part of something special." Laura donated over 4000 trees that day, the equivalent of about $380 dollars; all the money she had earned. The camp followed her lead and we raised over $6000.

With the help of Brinkman & Associates Reforestation, Laura, and hundreds of other planters, CFI has grown its presence on the island, working alongside thousands of people in 14 communities. To date, Pemban's have planted 35 species of trees and over 700,000 seedlings in total. Communities engaged in these initiatives collect seed from local sources, pack the seedling containers, nurture, grow and then plant the seedlings. What makes this project stand apart is its approach; each community has full ownership and control of their nurseries and the trees they plant. They decide what trees to grow and for what purpose. CFI understands that Pemban's are the experts, and no one is better equipped to innovate long-term solutions than those within the community. By Planting for Pemba, Pemban silvicultural experts are employed and necessary funds are raised to get the projects off the ground, helping create a collaborative partnership that works toward positive social, economic and environmental change on the island. Canadian tree planters and the people of Pemba have shown us that collectively, we have the skills, resources and knowledge to care for the environment and the people who live within it.

If you are a crew boss or supervisor who would like help organizing a Plant for Pemba day, contact Zach Melanson at zach@forestsinternational.org. Also please consider donating to Community Forests International's Pemban projects. For more information please visit CFI at www.forestsintrnational.org and on Facebook, by searching community forests international.

A glance back in time: Poor decision making

Words & Photos by Raymond M. Keogh

Clonal Teak, a revolution in teak cultivation.

The year 2012 marks my official retirement date. Normally retirement is a time to highlight one's outstanding achievements and contributions. Unfortunately, as I glance back I see more shipwrecks than completed voyages. It is difficult to admit this; but my career was almost a total failure. If I seek excuses, I have few. I must place the blame on a lot of poor decision-making on my part.

The first poor decision was my choice of career. I could not have become a forester - and especially a tropical forester - at a more inopportune time in history. Throughout the period 1972-2012 deforestation in the tropics was running at historically high rates, reaching on average, 13 million ha/annum in recent years.

The second inadequate decision was to concentrate on teak. The species has been in decline over the last four decades. Although 30 million ha were under teak forests in the early 1990s, resource depletion had gone beyond the point of sustainable commercialisation by then. Logging bans had to be applied in Thailand in 1983; India in 1987 and Laos in 1989. Even in Myanmar, where commercial management has continued to the present day, the extension of teak forests has been reducing; the quality declining and the yield dropping. This reflects poor management. Little wonder, then, that the country is set to ban exports of the species by 2014.

The third ill advised decision I made was to become involved in development, yet maintain an emphasis on commercial aspects of forestry. The focus in the early 1970s was changing from industrial activities towards community, social or agro-forestry; that is: forestry for the people. As commercial activities and wood production began to be marginalised and, as donor funding shifted in line with these trends, teak as a species for development was sidelined. Counter to the norm, I continued to develop models for growth and yield in teak.

Lopsided development

In the wake of the change of emphasis from commercial to social endeavours in forestry, a major problem has become apparent. Demand for commercial high-grade tropical hardwoods, running at around 90 million m^3per year, depends largely on deforestation and degradation of natural forests. The unsustainable nature of the supply situation is known as the tropical hardwood crisis. I do not suggest that social dimensions should have been ignored; the mistake was to have created an imbalance. If any aspect of forestry is ignored, the consequences will be detrimental to the sector as a whole.

Inspection of teak, Brazil.

During the 1980s, development agencies did make a concerted attempt to combat tropical deforestation which became a highly publicised global concern. The Tropical Forestry Action Programme (TFAP) was an effort to get to grips with a problem that had reached alarming levels. However, some NGOs, claiming to represent the environmental movement, accused TFAP of irresponsibility because it considered logging natural forests. TFAP protested that its aim

Inspection of teak, Brazil.

was to shift dependency of tropical timber supply from unsustainable to sustainable practices. As a result of the disaccord, donor governments were confused about which policy to follow; they did not support TFAP adequately and the initiative sank.

It has become clear that an inordinately large area of the natural forests, running to tens of millions of hectares would be required to satisfy sustainable commercial demand for tropical hardwoods. Most of this area is totally inaccessible. Therefore, dependency on natural ecosystems alone for the supply of these timbers is not feasible.

The lack of complementary commercial high-grade hardwood plantations to take the pressure off natural forests must be addressed. But, some influential entities question any organisation that considers developing industrial plantations, especially monocultures, to solve the crisis. Monocultures are deemed to be a bad thing among these groups. As a result the donor community has been reluctant to appear to be supporting commercial plantations.

Without a concerted effort to manage natural forests in a sustainable manner on the scale required, and without creating backup commercial plantations, where is the supply to come from? The only logical answer is that - in the absence of a comprehensive workable programme - supply will continue to come from deforestation and degradation until it runs out. Then the world will have to accept that tropical hardwoods are a thing of the past.

It can be seen that tropical forestry, under the influence of development agencies and NGOs over the last four decades, has tended to focus on a select range of priorities. Unfortunately, these priorities did not embrace the comprehensive needs of forestry. The creation of tropical hardwood supply sources on the scale required to satisfy the growing market demand was neglected. Towards the end of the 1980s the real significance of lopsided policies became clear.

Unscrupulous elements could see clearly that predicted shortages of tropical hardwoods pointed to very promising returns. They discovered that teak is a unique hardwood and, unlike many other species in its category, can be grown in plantations. Its silviculture is well understood and it is a relatively rapid volume producer given the right conditions. They presented logical and seemingly watertight cases to attract investments on a large scale to new plantation schemes. Unfortunately, their main objective was to make money quickly.

Indonesia Old Teak; a sight that is increasingly rare as time passes and quality teak disappears – high quality teak of old age

A number of new companies generated exaggerated forecasts of growth for the species and combined these predictions with prices that were only applicable to the best-quality forest teak. The combination of inflated growth rates and prices produce exciting predictions about returns for investors who had little technical or financial knowledge about the species. It was regrettable that the development agencies and NGOs, which had neglected the hardwood sector had, by the late 1980s, lost their authority to provide a professional opinion to counter the deceit and in the vacuum a rash of questionable retail schemes mushroomed around the world.

Failure to regain balance

I set up TEAK 2000 (currently TEAK 21) in 1996 to combat the hardwood crisis and redress the imbalance. The organisation recognised the many barriers to success, including the need to:

- Obtain a sustained output of hardwoods from managed forests combined with new plantations on a large scale;
- Attract the high levels of long-term finance required through innovative methods (e.g. through insurance and pension funds; forest bonds and many other instruments);
- Incorporate a wide spectrum of growers into the endeavour, particularly communities working with the private sector;
- Overcome technical barriers, including the lack of:
  - Superior genetic material for plantations;
  - Flexibility in silviculture to suit different categories of growers;
  - Wide application of best-practice management techniques;
  - Optimal use of good quality land for hardwoods - without depressing food supply;
  - Production of certified high-quality end products;
- Change attitudes, particularly amongst donors, governments and NGOs in an era of environmental and social forestry in which timber production on an industrial scale was regarded with some suspicion.

The Consortium Support System (CSS) was the proposed mechanism through which TEAK 21 would develop a sustained supply-base of hardwoods for the marketplace in the long term. The components of the CSS include services (overall coordination, investment facilities, technology transfer, tree improvement and quality control) and

The future of teak in Latin America (mechanical harvesting in Brazil).

support entities (governments, international donor agencies and NGOs).

Unfortunately, TEAK 21 failed to make headway and is to be closed down. I cannot exonerate myself from this failure and readily admit - in hindsight - that I did myself no favours by persisting to persuade development organisations, despite their clear reluctance to engage. This was the fourth ill advised decision of my career.

I feel strongly that the aid agencies and many NGOs have been prevented from embracing the CSS because of a group-think mentality that is uncomfortable with timber production on a large scale, and particularly with the involvement of the private sector despite their potential in the development field. Whatever the reasons for past failures, the tropical hardwood crisis has not abated and the TEAK 21 proposals are every bit as valid today and more urgent than they were in 1996.

Looking back

I now look back and contemplate my career. After writing and speaking many hundreds of thousands of words in defence of tropical forestry and teak, I ponder on this expenditure of time and effort; my words have not changed the situation for the better. I also ponder on what I should have done with my life. The wisdom of Jonathan Swift springs to mind. I use his wisdom to illustrate an answer to my question, though I take the liberty to change some words (in italics) to suit the point.

"That few *campaigners*, with all their schemes, are half so useful ... as an honest *forester*; who, by skilful draining, fencing, manuring, and planting, hath increased the intrinsic value of a piece of land; and thereby done a perpetual service to his country."

Western Canada

By John Betts, WSCA Executive Director

WSCA 2013 annual conference to fathom forest restoration

Forest restoration is a term likely to get more use here in B.C. as we head into the uncertainties of life after the mountain pine beetle plague. It makes sense, given that whatever tactical opportunities we had to mitigate the extent of the attack are mostly over. We are now in what we might call a post-mountain pine beetle phase of forestry. It would seem provident then to think about putting things back in order.

Of course it's not that simple. The term itself is problematic. To restore means to return to some previous state. Not only is that a doubtful possibility, there is good reason to not want to put things back where they were on the landscape previous to the plague. After all, some of those conditions contributed to the present catastrophe. Nevertheless, if we are going to use the word 'restore' the question becomes, 'Restore to what'?

We need to look at the assumption that is driving the idea of restoring our forests; the beetles may have eaten themselves out of house and home. But does the collapse of their population signal the all clear when it comes to future disturbances and consequences of the plague? We already know the answer to that. It doesn't. The plague has created opportunities for fire, floods, and other bugs and blight that we are just beginning to contend with. Ecologically speaking, things are far from over. And this is to say nothing about the social and economic effects.

There is another dimension to this as well. What if the beetle plague is actually a deeper, less obvious problem announcing itself? The remarkable damage we've seen may really be an effect, not a cause. If that is the case then, that cause may not be gone and will seek other ways to express itself on the landscape. If we are planning on restoring our forests, it will do us little good in the long run to be fixing the wrong problem.

Which brings us back to just what state we want to restore our forests to. There is a whiff of hubris here, of course, in the assumption that this is something we could actually do. The beetle plague is a stunning example of the kinds of forces that can let loose on the landscape; our success in managing that was minimal. Nevertheless, any forest restoration strategy needs to imagine a future landscape that is at least more resistant to the kinds of catastrophic disturbance we have just been through. And, although it is far from ideal, any forest restoration strategy will likely have to use the resources we have available today, which are minimal.

How we attempt to manage our provincial forests has always been dependent on public policy. At this point it is critical to see what vantage point our political and public planners occupy on forest restoration by asking them what they think restoring our forests means in policy and practice. We intend to do that at the WSCA conference in February 2013 in a panel which includes leading politicians on forestry and members of the senior echelons of the ministry responsible for forestry. From that discussion we should be able to infer the scale and depth of the thinking today on what might be meant by the concept of restoring forests for the future.

Ontario Report

By Allison Hands

Ontario Forestry Association Will Explore 'Our Working Forest' for 64th Annual Conference

The Ontario Forestry Association (OFA) will be hosting its 64th Annual Conference on February 8th in Alliston, Ontario. *'Our Working Forest'*, the 2013 theme, will focus on the importance of the forest industry, the contributions that forestry makes to our economy and culture, and the opportunities that forests present to Ontarians. The OFA hopes to *restore* the image of the industry using our annual conference as an opportunity to engage landowners, forestry professionals, students and the general public. *Our Working Forest* will bring together experts from industry, academia, government, and more to discuss the state of forest products today, what to expect in the future, and what this means to all of us.

"Ontario's forests can work for all of us, providing important economic, ecological, and recreational opportunities," said Margaret Casey, OFA director and conference chair. "The message we are trying to get through is that whether you are a practitioner, woodlot owner, or any other interested individual, there are benefits to managing your forests, both on a landowner and provincial scale. While there may be differences between these two scales, there are many similarities as well."

Casey admits that the theme is slightly different than previous years. "There is a greater focus on the forest industry and finding what a working forest means to landowners in Ontario. Previous conferences have been more about science and research, including talks on the emerald ash borer two years ago." This year, OFA is planning a pre-conference session for municipal forest managers on EAB in partnership with York Region on February 7th as a way of addressing this critical issue. This will allow the OFA to focus the conference on providing new information to the public and creating a greater connection and awareness of the forest industry in Ontario.

The conference will open with a plenary session that will address 'What is the Working Forest?', and highlight the successes of a working forest in Ontario. Peter Schleifenbaum, owner of Haliburton Forest and Wild Life Reserve, will speak of his property and how he utilizes his forest land. "It will bring a unique perspective to the audience and get everyone on a good thinking path first thing."

Two streams will run concurrently throughout the day, one focusing on Ontario's Forests and the other a Landowner's Toolbox. The Ontario's Forests stream will cover topics such as forest ecology, Algonquin Park as a working forest, and even the successes of local wood products, with the goal of highlighting the value and importance of our provincial working forests.

The Landowner's Toolbox stream will focus on helping woodlot owners get the most out of their forests and include talks from those working directly in the forest such as loggers and forest consultants, giving the audience a more in-depth view of how they work. "The sessions will provide woodlot owners with information and encouragement on using professionals and the critical questions they should be asking them," Casey said.

"I really see this event as getting people to think in a positive way about the forest and its role, but also being practical for the landowners and getting them to look at the future," Casey said of the conference.

Previous years have enjoyed near capacity numbers with over 300 people, and Casey expects the same turn out again this year. Registration is limited so those interested are encouraged to register early.

The conference theme will be a leading force for the OFA in the coming year, with the goal of increasing the public's awareness of forestry in Ontario including forest ecology, careers and sustainable management of our resources. Successful programs such as Focus on Forests and Forester in the Classroom aim to reach teachers and students in engaging curriculum linked resources. For more information about the OFA, visit www.oforest.ca

International Forestry Students' Association

By Katie Gibson

An introduction

The International Forestry Students Association (IFSA) is an incredibly diverse organization that unites students of forestry/forestry-related sciences from every corner of the globe. IFSA's vision is for global cooperation among students of forest sciences in order to broaden knowledge and understanding to achieve a sustainable future for our forests, and to provide a voice for youth in international forest policy processes.

IFSA's mission is to provide a platform for students of forest sciences to enrich their formal education, promote cultural understanding by encouraging collaboration with international partner organisations and to gain practical experiences with a wider and more global perspective. Through its network, IFSA encourages student meetings, enables participation in scientific debates, and supports the involvement of youth in decision making processes and international forest and environmental policy.

IFSA also maintains excellent partnerships with international forest related organizations which include the International Union of Forestry Research Organizations (IUFRO), the European Forestry Institute (EFI), the Commonwealth Forestry Association (CFA), the Food and Agricultural Organization (FAO), the Informal Forum of International Student Organizations (IFISO), the Centre for International Forestry Research (CIFOR), and the International Tropical Timber Organization (ITTO). It works with these organizations to offer students opportunities to get involved in the professional world of forestry. These organisations are also provided with access to the largest collective potential workforce/ thinking body of forestry students.

IFSA is open to forestry students from all academic levels and offers a wide array of opportunities and activities. It coordinates social, professional and educational meetings amongst its members, arranges internship prospects, provides professional training, and allows students to get involved in international processes.

It is strictly a student-run association; all activities and meetings are solely organized and managed by students. In this sense students who take on official positions within the IFSA gain a stupendous amount of experience in being involved with such a professional, multinational organization.

IFSA organizes an annual symposium for its members which takes place in a different country each year. Students come from all over the world to take part in the memorable two week event in which they get a forestry-focused tour around the country. The most recent symposium occurred in Turkey; it will be in British Columbia, Canada in the begininning of August, 2014.

Katie Gibson is Vice President of the IFSA and can be reached at secretariat@ifsa.net.

B.C. First Nations Forestry Council

By Keith Atkinson, RPF

First Nations Forestry Council supports communities and silviculture through business and training

The First Nations Forestry Council (FNFC) understands the importance of silviculture and is excited to be involved in supporting communities through the creation of, or participation in, programs that support the best management of our lands and resources.

FNFC is in its seventh year of operation as a non-profit society supporting all First Nations in their forestry activities. We promote First Nations business opportunities in forestry, and collaborate with government on forestry programs and issues such as tenure, Forests for Tomorrow program and policy development. The FNFC is known to design programs and policies that align with First Nations and government goals, provide forestry information to First Nations communities, and works to address First Nations forestry priorities.

Current priorities include business development in forestry, health and safety around the MPB infestation and resulting fuel management and, always important to First Nations-health of the lands and resources. Our programs have included understanding the role First Nations are playing in the sector, supporting continued fuel management reduction around communities and interest in being part of the forest sector at both the operations economic development level and at the more senior policy and governance level.

FNFC is currently implementing a training program designed to produce skilled workers and independent contractors that can participate in the forest sector. The First Nations Forestry Training Partnership pilot is a Training Partnership program that we have launched this year, with the support of the Province of BC. The program is designed to train aboriginal people for jobs in the forestry sector, assisting with linking employers with these students and bridging the tremendous labour gap that the forest sector predicts for the coming decade.

Students entering the program will be applying for forest sector related training and they will align themselves with a forest industry sponsor. There are multiple streams for training as the goal is as much recruitment of forest sector workers as it is in the training. Industry sponsors are supporting the individual with their academic goals and are providing a work term placement.

This type of partnership program is designed to recruit students, to provide solutions for the forest sector labour shortage, to bridge gaps in education and skilled labour, and to build relationships between forest sector business and First Nations communities.

The FNFC is committed to assisting First Nations communities and youth interested in forestry in moving forward and contributing to the best management of our forests – we feel there is a current need for increased silviculture and restoration activities on the land and we hope to assist with the relationships and partnerships that are needed to encourage a collaborative approach to addressing this need.

Saskatchewan Report

By Vicki Gauthier

Jack Pine and June Bugs – A Deadly Combination in Saskatchewan!

Jack pine *(Pinus banksiana)* is an important tree species to Saskatchewan. Of Saskatchewan's commercial tree species, jack pine makes up approximately 17 per cent of the provincial forest types (PFT) in the commercial forest and over 38 per cent of the PFTs in an area called the Island Forests. The Island Forests in Saskatchewan are located within a transition area between boreal forest to the north and grasslands to the south (the Boreal Plains ecozone). This region marks both the southern advance of the boreal forest and the northern limit of arable agriculture (Acton, Padbury and Stushoff 1998). The area of interest is described as a sandy loam site that is prone to drought and was heavily infected with Lodgepole pine dwarf mistletoe *(Arceuthobuium americanium)* and was also disturbed by wildfire in 1995. The Lodgepole pine dwarf mistletoe has the most significant impact on the Island Forests with more than 13 per cent (26,453 ha) of jack pine infected with this parasite.

However, another pest of interest to the Island Forests was discovered in the fall of 2011: the June bug! Appropriately, this story of jack pine and June bugs begins in June of 2011. An area of land that was not sufficiently restocked (NSR) in the Island Forests was fill-planted using jack pine 412 (1+0) container stock planted at 2 m spacing. By the fall of 2011, dead seedlings had been discovered in this plantation during a routine walk through. When the seedlings were dug up to determine cause of death, it was very strange to see that the entire plug (4 cm across and 12 cm long), the radicle and all lateral roots were stripped from the seedlings (see Figure 1). As we do with all things related to dead and dying trees here in Saskatchewan, the dead seedlings were brought to our provincial forest entomologist and pathologist, Dr. Rory McIntosh. He diagnosed the damage to be consistent with the work of June beetles: the pesky *Phyllophaga* spp. (Figure 2)! Dr. McIntosh provided the following life cycle description.

The common life cycle of the destructive and abundant *Phyllophaga* spp. extends over three years. While these white grubs normally feed on grass roots, they will eat the roots of tree seedlings, especially when grass roots are scarce, as was the case in the Island Forests. In May or June the adult beetles will emerge from the soil and feed on broad-leaved hardwoods. The adults mate in the evening (how romantic) and at dawn the females return to the ground to deposit 15 to 20 eggs, one to eight inches deep in the soil. Eggs hatch about three weeks later into the young larvae that feed upon the roots and decaying vegetation throughout the summer. In the fall, they migrate downward in the soil, to a depth of up to one and a half metres, and remain inactive until the following spring. The spring can see the most damage as the larvae return near the soil surface to feed on plant roots. Seedling plugs that are J-rooted because of careless planting are often killed first. In the autumn, the larvae again migrate deep into the soil to overwinter, returning to just below the soil surface for the third spring to feed on plant roots until they are fully grown by late spring. The grubs then form oval earthen cells and pupation begins! The adult emerges from the earthen cell a few weeks later, but doesn't leave the ground just yet. The beetles overwinter and emerge the following year in May or June, when the next round of feeding, mating and egg-laying takes place.

You can see how by the fall of 2011 the larvae had already eaten the roots from the jack pine plugs in the Island Forests and left evidence in the red, dead seedlings. It is estimated that up to 250 hectares of plantation have been damaged, or approximately 270,000 seedlings. The cost of re-treating these sites could be as much as $300,000. The June bug is native to Saskatchewan and generally has a three-year cycle. We estimate that 2011 was year two of the cycle. The grubs we found this past spring indicate that 2012 is year three and, hopefully, the end of the cycle. We've got our fingers crossed that replanting these sites in the spring of 2013 will avoid major root damage and allow the seedlings to get bigger and be better able to withstand any further June beetle attack.

Figure 1: Dead Jack pine with damaged radicle. Photo by Rory McIntosh. Ministry of Environment

Figure 2: Dead jack pine with june bug. Photo by Christine Simpson. Ministry of Environment

Figure 3: June bug. Photo by Christine Simpson. Ministry of Environment

Acton, D.F., G.A. Padbury, C.T. Stushoff. March, 1998. The Ecoregions of Saskatchewan. Prepared and edited by Saskatchewan Environment and Resource Management. Canadian Plains Research Centre/Saskatchewan Environment and Resource Management. University of Regina. 205 pgs.

Vicki Gauthier is a professional forester with the Saskatchewan Ministry of Environment.

The ultimate tree planting shovel

By Ting von Bezold | Photos courtesy of Janet Dwyer

Every planter spends countless hours daydreaming ways to improve the activity of planting trees. During one such session I contemplated how to improve my planting shovel and recalled meeting a knife maker on Salt Spring Island, Seth Burton. I was imagining modifying my existing stock shovel with a handle made of Damascus steel. One of the many downfalls of today's modern planting shovel is that the handles are prone to failure. Damascus is an ancient form of steel characterized by distinctive patterns of banding and mottling, reminiscent of flowing water. Items made of Damascus are reputed to be not only tough and resistant to shattering, but capable of being honed to a sharp and resilient edge, ideal for knife making. It was just a few years prior that I had met Seth and was introduced to his exquisite hand forged knives made from Damascus. I bought one as a gift for my tree planting boss.

I soon visited Seth on Salt spring Island and sowed the idea of modifying my shovel into the ultimate planting machine. To my delight, Seth was interested. A shovel is, after all, a type of blade and the idea of making a blade that cut through tough terrain to plant trees motivated him. We decided to work on this project together.

Like a true piece of art the design didn't occur overnight. Over several months the design emerged with a blade of Damascus steel rather than the handle. As we worked, there was an unspoken understanding between us that we were going for the absolute best shovel possible. In the end the only thing we used from the original shovel was the general size and weight. The final construction is what we consider to be the best tree planting shovel made to date. In fact it is probably the most beautiful and functional shovel ever made.

The blade and ferrule was constructed out of five types of the highest quality stainless steels, forged and folded over a core of powdered tool steel. The result of this process was a single billet of metal consisting of over 200 layers. Having not made a shovel blade before, Seth drew on his considerable metal smith experience to find the combination of inert hardening and tempering that would produce a shovel blade that was both tough enough to endure repetitive striking against rock and which had high edge retention (capacity to remain sharp). After mastering the blade we moved onto designing the handle, shaft and fittings. For the shaft, we chose a wood, Cocobolo, known for its strength and weather resistance. Cocobolo has been used for centuries in knife and gun handle construction. The shaft was press fit, epoxied and pinned with a mosaic pin into the ferrule. The D-handle was constructed with a white oak core and reinforced with stainless steel. A mortis and tenon and stainless steel bolt fastened it to the shaft. The final touch was to wrap the D handle in multiple layers of carbon fibre. The last stage of the shovel construction was the grip which we formed out of stacked leather with a half inch square stainless tang and bolster.

Two hundred and fifty thousand trees later, the shovel still looks brand new and is valued at over $6000. Most standard shovels would struggle to last a single season of planting and certainly would not be considered a valuable piece of art. This shovel will last forever. Eager to try the shovel, a fellow planter Wahabu Ahmed, renowned for his 19 year tree planting career, borrowed the shovel for a month and attests:

"I got the opportunity to try this shovel at the later part of this planting season and I can say it is the best shovel I have used in my nineteen years of planting. The shovel feels solid and the blade has the best approach angle, which makes it easier to drive through challenging land such as thick grass."

Feats and achievements aside, I humbly suggest the best thing this shovel has done is cultivate a friendship that is destined to grow along with all the trees this shovel has planted. Thank you, Seth Cosmo Burton.

You can see Seth's knives at www.cosmoknives.com

Forest Health

Silvicultural Options for the Endangered Whitebark Pine

By Michael P. Murray and Jodie Krakowski

Whitebark pine *(Pinus albicaulis)*, well-known for its value to western North American high-mountain wildlife, commonly thrives in harvested forests. As the producer of the largest tree seeds in the spruce-fir zone, whitebark pine supports more than two dozen species of foraging mammals and birds, including grizzly bear *(Ursus arctos horribilis)* and Clark's nutcracker *(Nucifraga columbiana)*. The tree maintains waterflows into the dry summers by shading late-lying snow. At the highest elevations, their wind and ice battered frames contribute to spectacular timberline scenery.

An introduced fungal pathogen *(Cronartium ribicola)* known as white pine blister rust is decimating whitebark pine throughout most of its range. This canker disease has a complex lifecycle, but in general, the younger or smaller a tree is, the quicker it dies. Larger trees may survive for decades, however stem cankers will often kill crown tops. This is where most of the valuable cone-producing branches are. Whitebark pine grows so slowly, trees often need to reach ages of 50 to 80 before they produce cones.

In southeast British Columbia and southwest Alberta, most whitebark pine are dead or dying from blister rust. The mountain pine beetle *(Dendroctonus ponderosae)* epidemic has accelerated the decline, causing great concern since the beetle prefers mature trees which produce the most cones. Many whitebark pine populations are further stressed by increasingly crowded stand conditions. This is a reflection of mandated fire exclusion. By eliminating natural fires, less fire-hardy competitors such as Engelmann spruce *(Picea engelmannii)* and subalpine fir *(Abies lasiocarpa)* have prospered to the detriment of whitebark pine, which is not a strong competitor.

Recognizing the mounting pressures on whitebark pine and dependent wildlife, the Canadian government classified it as endangered in June 2012. It is the first tree in the West to receive this declaration. As of this writing, restoration planning is in the earliest stages and there are no range-wide government restrictions on whitebark pine harvest or use. However, some forest licensees have already incorporated tree retention guidelines in their formal plans (e.g. Spray Lakes Sawmill, AB and Canfor's operations near Cranbrook, BC). While the government of Alberta is nearing completion of its own recovery plan for crown lands, individual forest plans (e.g. C5 and R11) have articulated whitebark pine retention guidelines. The BC Forest Service has issued an informal bulletin providing general information and recommendations for avoiding harvest (www.whitebarkpine.ca/publications.html).

Whitebark pine often achieves merchantable form in forests of mixed species. From 2000-2009, harvested volume in BC's Southern Interior Region was at least 21,388 cubic metres (based on scaling records). Forest practitioners can creatively maintain and promote whitebark pine within managed stands, thus averting complete loss throughout its range. Studies indicate that with active management, it's possible to significantly improve whitebark pine habitat.

Forest professionals can provide clear, measurable and verifiable direction and silvicultural support for whitebark pine through Forest Stewardship Plans (FSPs) and landscape level planning. Species at risk, including whitebark pine, may be addressed through stand-level biodiversity measures and wildlife as FRPA (Forest and Range Practices Act) values in an FSP, where high-value individuals may be identified for reserve selection and cone collection. Stocking standards can incorporate whitebark pine as a preferred or acceptable species if accompanied by a professional rationale in support of objectives for wildlife or biodiversity. Whitebark pine stands, especially those with many cone-bearing trees and in good health, are good candidates for wildlife tree reserves, Old Growth Management Areas, and Wildlife Habitat Areas for grizzly bears.

In areas planned for harvest, it is now important to prioritize conserving and identifying trees which appear to lack blister rust cankers. These trees may be rare disease-resistant genotypes, thus providing a life-link to the species' future in the area since resistance to blister rust can be passed down from the parent trees to their seedlings. Currently, every state and province that administers whitebark pine is identifying, testing, and propagating disease-resistant progeny capable of surviving blister rust. Thinning can benefit whitebark pine by targeting and removing competing tree species. Opening up canopies often improves reproduction of whitebark pine by attracting seed-caching Clark's nutcrackers and providing better light conditions for pine seedling growth. These seed caches are the primary way that whitebark pine regenerates. As an example, in the East Kootenay Region, BC Timber Sales (BCTS) has adapted the following guidelines.

- Stands with less than 50% mature composition of whitebark pine. Canker-free trees should be clearly identified and retained throughout the harvest area, especially trees that have robust crowns capable of producing many cones. Proceed with care to avoid damaging these trees.

• Stands with more than 50% mature composition of whitebark pine. Exclude stands from harvest through group tree retention such as removing these timber types from the harvest area, designating [can be internal too] wildlife tree retention area (WTRA) to meet forest stewardship plan (FSP) retention targets or through establishing internal wildlife tree reserves.

Post-harvest activities such as burning and thinning can also be designed to avoid damage to whitebark pine. By implementing the above-mentioned options, forest professionals fulfill an important role in sustaining this remarkable tree.

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After working as a research scientist and consultant for 15 years around the Pacific Northwest, Jodie is currently working in the operational side at the Ministry of Forests, Lands, and Natural Resource Operations in Squamish. She has been studying and conserving whitebark pine since 1999. Email: Jodie.Krakowski@gov.bc.ca

A healthy whitebark pine with a 'red flag' branch.

Whitebark pines retained in a harvest unit near Canal Flats, BC.

Clark's nutcrackers collect seeds