Southwest Nova Biosphere

WINTER NEWSLETTER

Vol 3. March 2023

Conservation often regards agriculture as its opposite or looks over it to the banks of pristine rivers or the lichen bearded, old growth forests. This sort of conservation comes easy and makes us feel good as we have representative examples of untouched ecosystems, touchstones that tell us nature is not lost and that if we want it, we know where to go. But conservation is missing its mark if it concentrates on wild lands ignoring the human matrix, and more and more it is recognized that even natural landscapes were long-shaped by indigenous peoples.

Fig. 1. Yellow birch on a mound

In southwest Nova Scotia, Kespukwitk to the Mi'kmaw, the Biosphere "Reserve" Association must focus on agricultural landscapes for four major reasons:

1. Food security and meaningful local employment,
2. Forestry
3. Carbon sequestration
4. Biodiversity

When you walk in the woods, you walk through different histories. The floor of some forests is like waves in a windy ocean because every mound marks where a tree was blown over leaving a pit where its roots had been beside the old root mound (see Article 7 by Peter Neily). A pit and mound topography indicates the land has been continuously a woodland. But where the walking is easy and the surface is even, the land is telling us it was once farmed. Across eastern North America, there has been a regrowth of forest on former farmland (MacCleery, 1992: America Forests: A history of resiliency and recovery. USDA Forest Service FS540). The eastern North American forest reflects a record of climate changes (Little Ice Age to global warming), the "major cut-over" from 1700 to 1850, agriculture, and large changes in the nature of fires from frequent surface fires to conflagrations to fire suppression over the past century. Agriculture leaves the clearest long-term signature of disturbance and the regrowth of forest attests to the resiliency of the ecosystem.

Older Nova Scotians talk of a different way of life in the rural southwest of Nova Scotia. A recent documentary of Brier Island at the end of the Digby Peninsula featured interviews with three life time residents whose early lives all were part of a farming family. Three of our articles this issue give evidence of how widespread agriculture was and how this can be seen in the soil (Kevin

MAP 1. Average family farm size in 1891 (top) and 1941 (bottom). (from MacKinnon,R.A. 1978. The historical geography of Nova Scotia. PhD Thesis, UBC

Keys, Article 1), in the altered patterns of georeferenced aerial photographs (Swinnemar, Smith & Ristow, Article 2), and in the woods themselves (Peter Neily, Article 7). The two hand drawn maps below are taken from the PhD thesis at University of British Columbia of Robert MacKinnon. He colour codes the average amount of improved land of family farms in Nova Scotia; we present only the southwest region.

The decline in agriculture from the turn of the 20th Century to the Second World War was catastrophic: it was a sudden, large-scale alteration of the state of the land.
Is the decline in agriculture good or bad in terms of conservation and sustainable development?

From a strict conservation view, a loss of disturbance in much of the landscape and a slow return through old field to trees increases carbon capture to offset climate change, reduces erosion of soil and the export of nutrients to waterways, and increases habitat for some forest species.

Agriculture is still a way of life and part of the landscape in the LaHave Drumlin ecodistrict and in much of the Annapolis Valley. The landscape creates the aesthetic that the produce fulfils to sustain local tourism and farm markets. The objective of Biosphere Reserves is to "simultaneously promote economic, ecological and cultural goals for sustainable development in the conservation of landscapes" (Konig et al., 2022: https://www.sciencedirect.com/science/article/pii/S0301479722013639). It is important to assess land use through multiple lenses and think about the local footprint of the Biosphere Reserve and then consider how the area reflects sustainable development on the world stage. Although its climate allows for agricultural production over most of the year and ours does not, France is the most food self sufficient country in Europe and imports about 20% of its food needs. In contrast, little (10%) of the Nova Scotian diet is home grown, a point reinforced by Gilberte and Siegmar Doelle of Wild Rose farm who understand how consumers could change this by giving more support to farm markets. In the Second World War, a Valley apple producer told us, the only things Nova Scotians needed from abroad were coffee, tea and sugar. Regaining food security can have positive environmental impacts at the global level if carbon costs associated with long distance transportation of food are reduced and if the food production system in Nova Scotia is ecologically based. Regaining food security by developing local agriculture can help the local economy and have real social value as we see at the various markets across Kespukwitk.

A goal of the Southwest Nova Biosphere Reserve Association is to restore economy to local communities in the southwest Nova and as part of our national pledge and global consciousness, we want to preserve natural areas and plant “two billion trees” to help reduce carbon dioxide levels in the atmosphere. A new study warns against thinking of abandoned rural lands as easy gains for biodiversity or climate because the likelihood of recultivation of these lands is high (Crawford et al., Science Advances, 2022). This gets to the point: we need to think of multifunctional landscapes. The lands now abandoned supported mixed farming that produced goods for the local community. Water powered mills of the 19th century used locally grown grains. This issue presents two examples of organic or ecological farming to demonstrate farming systems that are designed to reduce environmental impacts. Dr. David Patriquin worked for 10 years with a grain and hen farmer in Annapolis County in the 1970s. This scientist: farmer interaction launched a research program involving conversations around the farm kitchen table, farming and research documentation and experimentation. The main result was the demonstration that an Annapolis County farm could be a profitable egg-laying operating without the addition of bagged fertilizers (with the exception calcium) or pesticides. The second example comes from Gilbert’s Cove. Here, Gilberte and Siegmund Doelle are demonstrating that a diverse vegetable farm can produce an array of products in Digby County in Gilbert’s Cove.

In both cases, the one in Lawrencetown of the 1980s the other contemporary of Gilbert’s Cove, the farms are ecologically efficient but to be so, they may forego higher yields more typical of conventional agroecosystems. If society values biodiversity, healthy ecosystems and water supplies, these nutrient efficient farms that have either eliminated pesticide or are organic, should be supported. 23 Targets were agreed upon at the recent COP15 gathering in Montreal, Targets 7 and 10 (below) relate to possible incentives for agriculture. If Canada is supporting the creation of protected areas to preserve biodiversity and the planting of two billion trees for carbon fixation and biodiversity, funding for nutrient efficient farms that encourage biodiversity is a no brainer.

Climate is changing in Nova Scotia and no where more quickly that in southwest Nova Scotia. Guy d’Entremont was inspired by a trip he and his wife made to Italy. Could he set up vineyards in Yarmouth County? Find out more in article 5. Apples and grapes both have the benefit of being perennial crops. These crops need constant monitoring for pest problems but fertilizer inputs are low relative to those of annual cropping systems and the soil surface is undisturbed, minimizing erosion. The last article of the Agriculture section comes from Thomas Cornell who imagines an agriculture that maintains a forest structure: agroforestry. Thomas is inspired by tropical examples but intends to apply these principles to develop an agroforestry based on nut trees in Annapolis County. These examples are a beginning but we ask anyone with agricultural operations in southwest Nova Scotia to submit an article to the Newsletter (fernhillns@gmail.com). Our overall goal is to foster sustainable development in Kespukwitk. There are many ways to work toward this goal bearing in mind that sustainable development tries to find the sweet spot in a triangle bounded by ecological concerns, social goods and economic production and stability.

PRESS RELEASE FOR UN COP15, MONTREAL, 2022.

TARGET 7: Reduce pollution risks and the negative impact of pollution from all sources by 2030, to levels that are not harmful to biodiversity and ecosystem functions and services, considering cumulative effects, including: reducing excess nutrients lost to the environment by at least half including through more efficient nutrient cycling and use; reducing the overall risk from pesticides and highly hazardous chemicals by at least half including through integrated pest management, based on science, taking into account food security and livelihoods; and also preventing, reducing, and working towards eliminating plastic pollution.

TARGET 10: Ensure that areas under agriculture, aquaculture, fisheries and forestry are managed sustainably, in particular through the sustainable use of biodiversity, including through a substantial increase of the application of biodiversity friendly practices, such as sustainable intensification, agroecological and other innovative approaches contributing to the resilience and long-term efficiency and productivity of these production systems and to food security, conserving and restoring biodiversity and maintaining nature's contributions to people, including ecosystem functions and services.

https://www.cbd.int/article/cop15-cbd-press-release-final-19dec2022

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PATTERNS OF SOILS AND PRODUCTIVITY IN KESPUKWITK

By Kevin Keys

Not all soils are the same, and farmers and others who live off the land know this from hard-earned experience. In an area with similar climate, the main factors that cause one soil to be different from another are parent material (the deposit the soil develops from) and topography. Parent material directly affects soil texture (relative sand, silt, and clay content), stoniness (abundance and type), mineralogy (potential nutrient sources), and depth. Topography – in relation to slope position, steepness, length, and direction – directly influences how water flows through the system and how much sunlight or heat an area receives. Over time, all these factors interact (with climate) to determine a soil's drainage condition, moisture holding capacity, potential nutrient supply, biological activity, temperature regime, stoniness, permeability, etc. – features that are used to not only classify soils, but also to rate them for their land-use suitability.

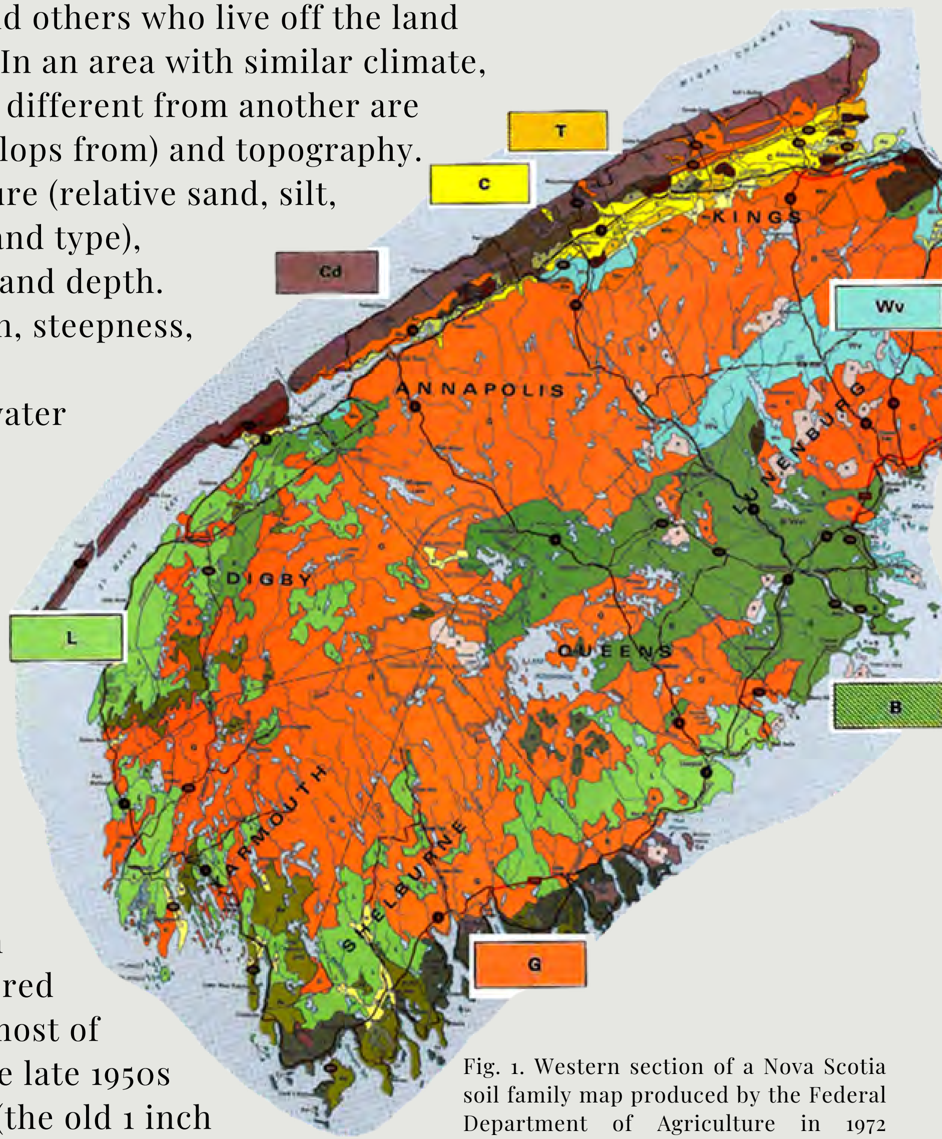


Fig. 1. Western section of a Nova Scotia soil family map produced by the Federal Department of Agriculture in 1972 (compiled by J.I. MacDougall and J.A. Nowland). Symbols for dominant families have been added to this image. Scale 1:450,000.

Nova Scotia is one of the few provinces in Canada that has had most of its area covered by soil survey. County-level surveys for most of western Nova Scotia were produced in the late 1950s to late 1960s at a typical scale of 1:63,360 (the old 1 inch = 1 mile scale). Because of its ongoing agricultural importance, additional detailed surveys were also produced for the Annapolis Valley area in the 1980s and early 1990s. These built on an even longer history of survey work in the area dating back to the 1940s when the first such survey was published: Soil Survey of the Annapolis Valley Fruit Growing Area (1943). Most provincial soil survey reports and related maps can be accessed online through: Soil Surveys for Nova Scotia - Agriculture and Agri-Food Canada (AAFC)

There are about 100 soil series units in Nova Scotia associated with different combinations of parent materials and drainage conditions. These soil series are often named for the area they were first described or are commonly found (e.g., Bridgewater, Canning, Yarmouth, Danesville). For ease of use and interpretation, soil series are sometimes grouped into soil families which are relatively uniform in composition and where the practical physical factors that affect plant growth and engineering uses are considered.

Fig. 2. Map of the Clare ecodistrict.

The image above (Fig. 1) shows a portion of a soil family map produced for Nova Scotia in 1972 by the Federal Department of Agriculture. Although not as accurate as it could be, this medium scale map (1:450,000) is still useful, and is generally well correlated with the MacKinnon agriculture maps shown above.

Most of the North Mountain area is mapped as Cd (Cobequid family) which in this part of the province is represented by Rossway soils derived from glacial till parent material high in basalt (or from weathered basalt bedrock itself). Basalt is a relatively nutrient rich rock, and Rossway soils are generally quite fertile – their main limitations being shallowness and/or stoniness in some areas.

The Annapolis Valley is mapped as mainly C (Canning) and T (Tormentine) families which include soils derived from sandy glaciofluvial outwash deposits. While these sandy soils are certainly found in the Valley, the scale and accuracy of this map does not capture the wide variety of other soils that have been found through more detailed surveys.

As noted by Neily et al. (2017) in the Ecological Land Classification for Nova Scotia, the Annapolis Valley is mainly underlain by soft sedimentary rocks including siltstone, sandstone, shale, mudstone, and conglomerate. These different rock types were the source of most of the variable surficial deposits that now cover the Valley floor. In addition, most of these soils are relatively stone-free and easily tilled, while soils along the northern boundary have also benefitted from inputs of nutrient-rich North Mountain basalt.

Of perhaps greater interest here are the other large soil family units that cover most of western Nova Scotia. The area mapped in orange (Gibraltar family) includes the two most common soil series in Nova Scotia: Halifax and Gibraltar. These soils are generally coarse-textured, very acidic, stony, sometimes shallow to bedrock or naturally cemented, and often have numerous surface boulders (greywacke and/or granite) – all features that make them unsuited for agriculture. Fertility is so low in some cases that even tree growth is limited (e.g., the Western Barrens located around the intersections of Shelburne, Yarmouth, and Digby Counties). All the large “white” areas shown in the MacKinnon agriculture maps above are associated with this Gibraltar soil family.

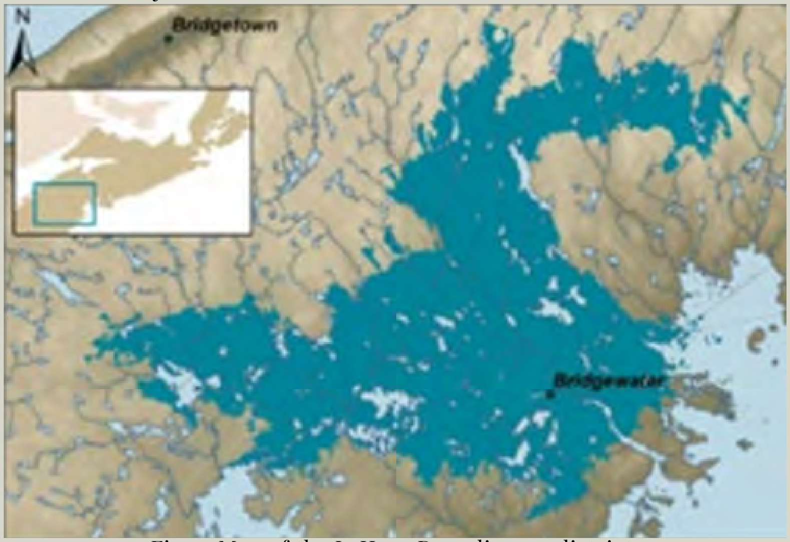


Fig. 3. Map of the LaHave Drumlins ecodistrict.

In contrast, the Barney (B), Wolfville (Wv), and Liverpool (L) families are all well correlated with historic and current farming areas. This is mainly due to the dominant presence of more loamy and less stony soils in these areas (compared to Gibraltar areas), and to the significant presence of drumlin landforms.

Drumlins are elongated, oval-shaped hills deposited by glaciers that are usually well drained, non to slightly stony, and of medium to fine texture (i.e., loamy). Features that make them generally well suited to agriculture.

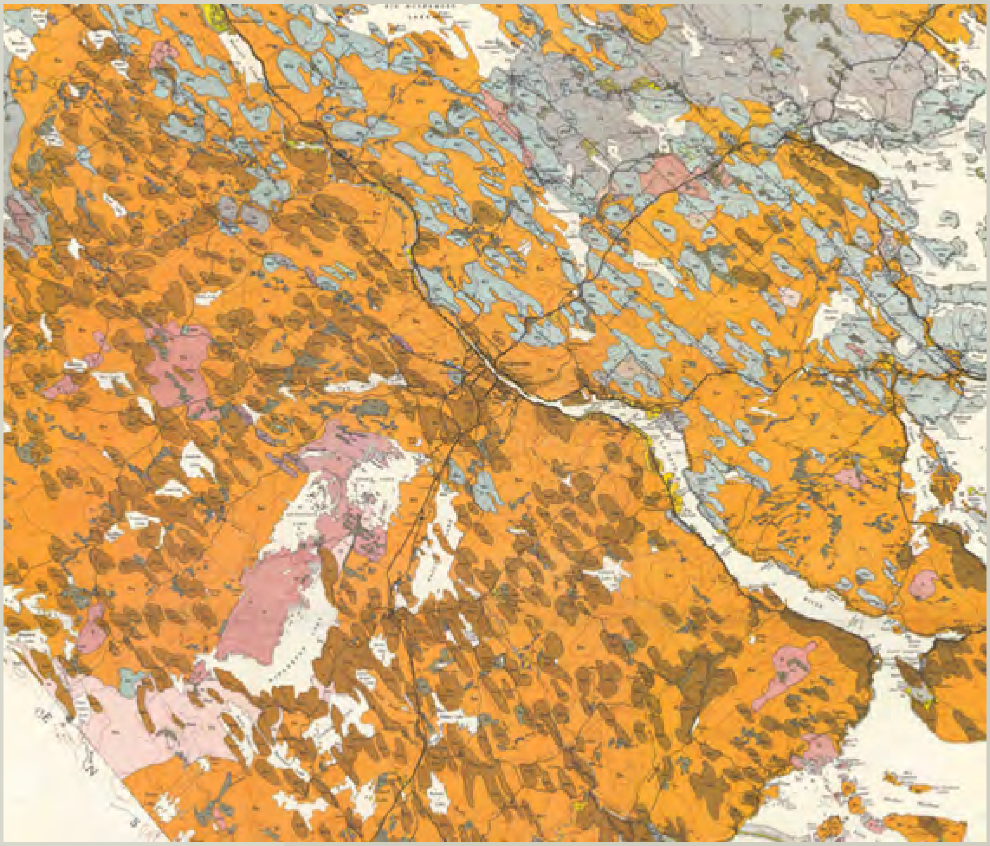
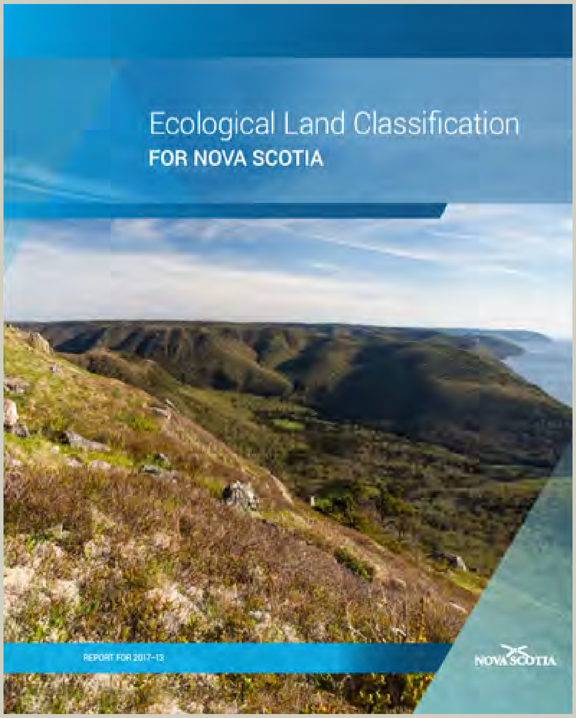


Fig. 4. Clip from the Lunenburg soil survey map showing numerous Bridgewater soil drumlins (brown coloured oval landforms) and Wolfville soil drumlins (light blue coloured oval landforms) all oriented in a southeast direction (from Cann and Hilchey 1958).



As shown in the Ecological Land Classification for Nova Scotia (Neily et al. 2017), the Clare ecodistrict (Fig. 2) encompasses the portions of Digby and Yarmouth Counties associated with mainly Liverpool family soils. This ecodistrict is described as a drumlinized till plain comprised of numerous low drumlins (generally under 20 m) with variable texture and stoniness. Drainage patterns are also highly correlated with slope position in this landscape, with imperfectly to poorly drained areas found between well drained drumlin slopes. It's not hard to imagine that most farming in this area is associated with the low-stone drumlin sites found in this ecodistrict. The LaHave Drumlins ecodistrict (Fig. 3) is even more associated with drumlin landforms (hence the name!).

As noted by Neily et al. (2017), this ecodistrict is considered one of the best drumlin landscapes in eastern North America, with classic teardrop shapes pointing in the direction of ice movement, and rising about 40–50 m above the background plain (Fig. 4). Except for some slope-related constraints, these drumlins make good agricultural soils and have a long history of such use (Fig. 5).

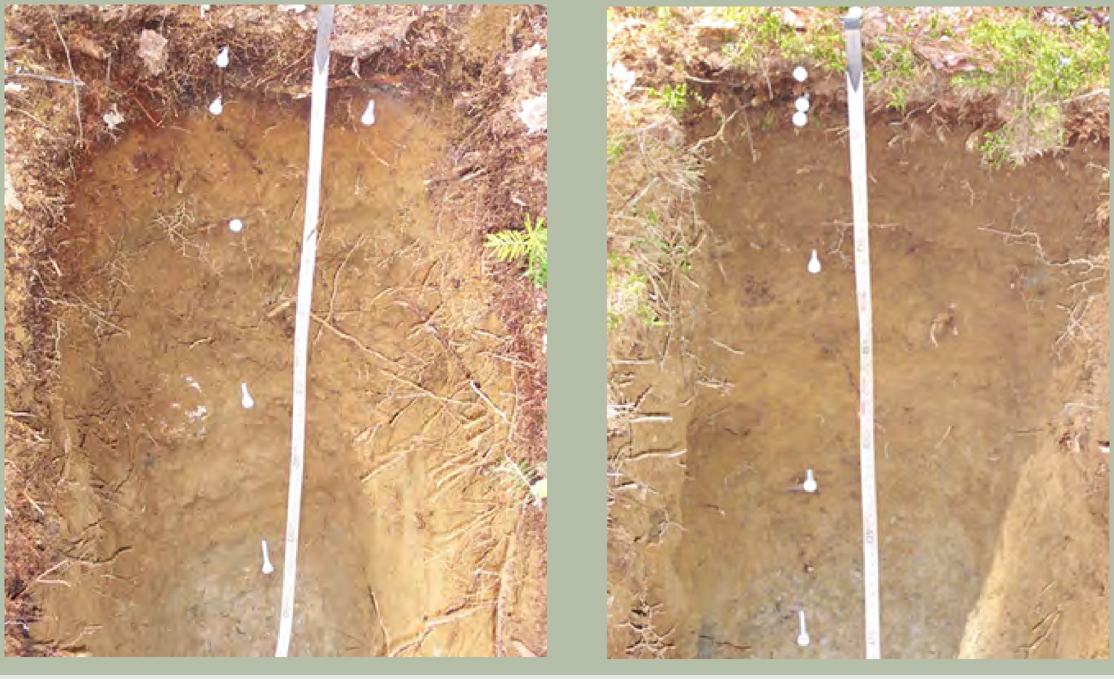


Fig. 5. Two typical Bridgewater soil pits from drumlin sites (Bridgewater soils make up most of the Barney family soils in western NS). The pit on the left is from a forested site not previously cleared for agriculture. The pit on the right is from an old field currently under tree cover. Note the darker brown surface soil in the old field pit. This is due to increased organic matter input from earlier tillage that still shows up decades after active agriculture use.

Compared to other areas in Canada, Nova Scotia does not have prime agricultural soils. Using the Canada Land Inventory (CLI) Agriculture Capability Class system, most areas that can support agriculture in the province are classed as ACC3 or ACC4: Soils with moderate to severe limitations that restrict the range of crops or require special conservation practices. However, soils are inherently variable, and within every mapped soil unit and related land parcel there are usually areas that are better and worse than the average. Over the years, many farmers have figured out where the best land is for growing particular crops and how to work with local soil limitations. As shown by the examples in this Newsletter, this can be done without causing damage to these soils. This is important since, for all intents and purposes, soils are a non-renewable resource, and maintenance or enhancement of soil health is critical for sustainable management at both local and global scales.

A SHORT HISTORY OF AGRICULTURE IN KEJIMKUJIK NATIONAL PARK

By Delbert Swinemar, Matthew Smith and Melissa Ristow

Kejimkujik National Park and National Historic Site (Kejimkujik) was established in 1972 to protect a representative example of the Atlantic Coastal Uplands Natural Region. In 1995, the inland portion of Kejimkujik was also declared a National Historic Site recognising its key importance of the area to the Mi'kmaq people.

Kejimkujik is a sacred place to the Mi'kmaq people based on millennia of occupation. This area was a place of encampments, fish weirs, hunting territories, portages, trails, and burial grounds. The importance of Kejimkujik to the Mi'kmaq is illustrated in the petroglyphs, and the many archeological finds dating back thousands of years. During the 1700s a series of Peace and

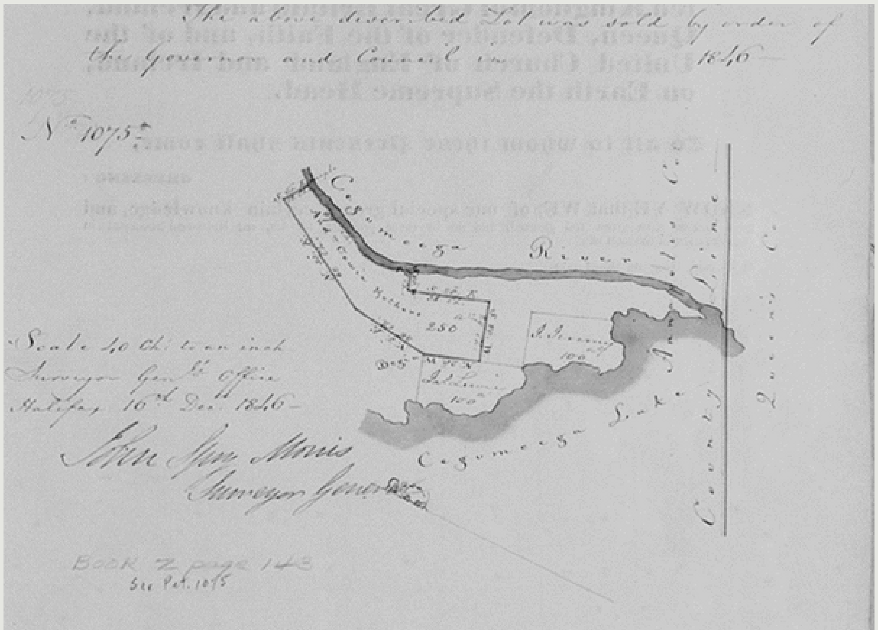


Figure 1: An example of land that was granted to Andrew Cowie in 1846 near the inflow of the Mersey River into Kejimkujik Lake. Note Kejimkujik Lake was commonly called Cegumcega Lake interchangeably with Fairy Lake in the early to mid 1800's, likewise the Mersey River was referred to as Cegumcega River.

Friendship Treaties were signed between the Mi'kmaq and the British colonial administrators, outlining how the territory and its resources would be shared. Modern Canadian courts have upheld these treaties as having continued validity today. Kejimkujik continues to be actively used by the Mi'kmaq people today. Kejimkujik, as all of Mi'kmaki, is unceded territory.

The colonization of Kejimkujik area started in the early 1800's when the land in the interior was granted to settlers. The first land grants in Kejimkujik were made in 1830's.

Granted land came at no cost, except for minimal administrative fees charged during the grant process and a peppercorn of yearly rent. The only requirement imposed on the grantee was to "improve" the land by settling and developing the acreage within a specified reasonable length of time. If the grantee did not develop the land, the grant could be revoked and re-granted to a more ambitious family. A settler wanting land would petition the Governor of Nova Scotia for a grant, often identifying the location on a map where they wished to settle. These requests were made in handwritten documents called "Memorials," which used formula wording, see fig. 1.

The best soils in Kejimkujik for agriculture are found in the North east region of the park which contain drumlins. Drumlins are small hills comprised of till dropped by glaciers in a teardrop shape. The deposited material is comprised of rich fine textured soil, well drained and largely free of large boulders – perfect for agriculture see fig. 2.

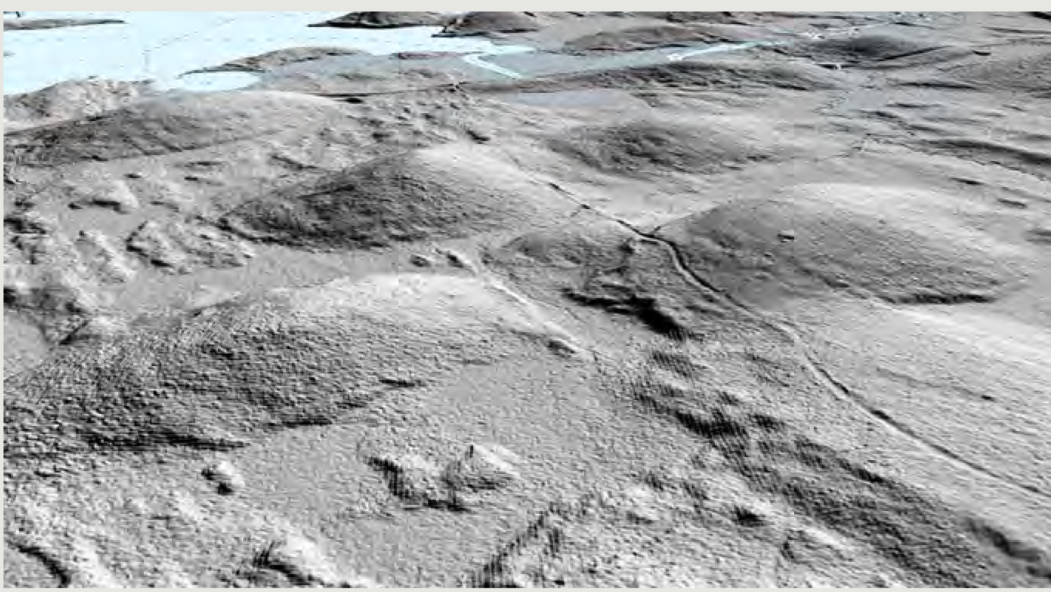


Figure 2: A field of drumlins running north of Grafton Lake within Kejimkujik. Note the inflow of the Mersey River and Fairy Bay in the background for reference.

Due to the richer well-drained soils, drumlins were occupied by different forest types than the surrounding forest. According to early land surveys conducted by Titus Smith in 1801 and 1802 many of the drumlins in this area were occupied by tolerant hardwoods and hemlock forest. Over the past 3 years, the Kespukwitk Conservation Corridor project has created a mosaic of over 500 air photos from 1928 and 1929 for the Kejimkujik and Lake Rossignol area. In the 1928 air photos, active and abandoned farmland is clearly visible on many of the drumlins in the park, see fig 3 and 4.

To better understand the impact of farming on present day vegetation cover, we used these historic airphotos to identify farmed and non-farmed drumlins and compared these areas with today's forest inventory. Drumlins were classified into 4 categories using 1928/1929 airphoto imagery data sets due to the presence of agriculture 1) Farmed, 2) Abandoned Farmland, 3) Non-Farmed, and 4) unknown status.

Of the 55 drumlins lying within Kejimkujik, 37 showed some signs of farming and only 15 no signs of agriculture. By 1928, 10 of these drumlins had already been abandoned. Today these drumlins have largely been left to regrow naturally, with the exception of small areas still kept open (eg., weather station and solar array site).
The current Nova Scotia forest inventory was used to determine the leading tree species currently found on armed drumlins in Kejimkujik. Of the 37 farmed drumlins in 1928/1929, 57% are now dominated by Pinus strobus (white pine) and 23% by Acer rubrum (red maple) (Figure 6). White pine is a considered an early successional tree species in old fields; red maple on the other hand is typical of old field areas that are entering mid-succession.

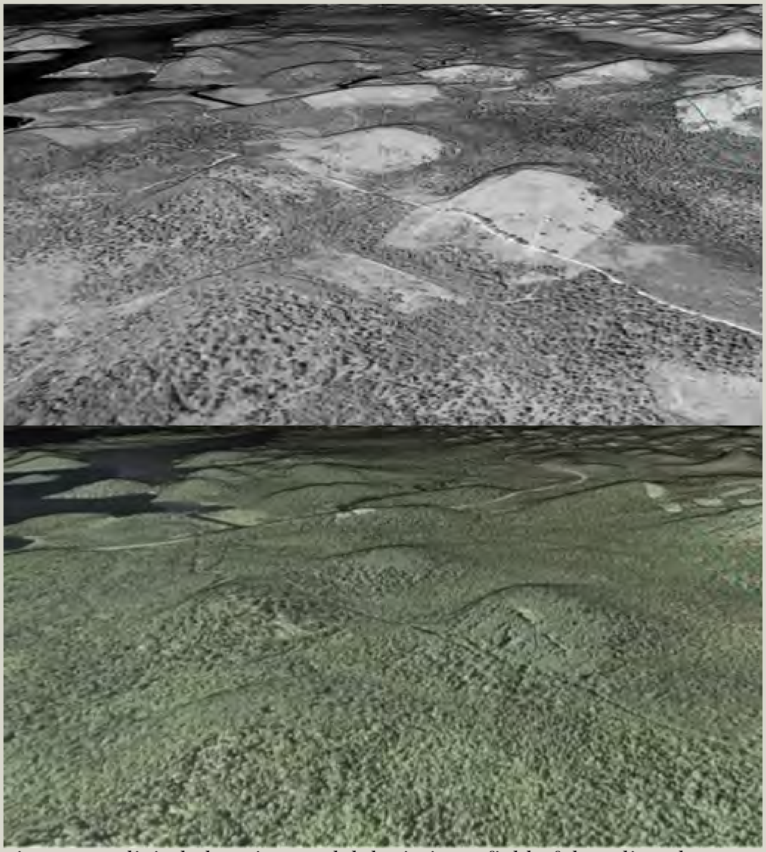


Figure 3: A digital elevation model depicting a field of drumlins along the Canning Field Road north of Grafton Lake, overlaid with air photos taken in 1928 and 1929 (top) and with 2023 satellite imagery (bottom). Many drumlins were partially cleared in 1928 and 1929, noted by the presence of farms on nearly every drumlin.

Figure 4: A picture of an abandoned agricultural field on top of a drumlin near Rogers Brook taken in 1973. Image source: Bourdeau, D. (2008). Kejimkujik National Park and National Historic Site of Canada Ecosystem Science Digital Atlas. Kejimkujik National Park and National Historic Site of Canada.

In a similar manner, of the 15 forested drumlins in 1928/1929, 60% are now occupied by Tsuga canadensis (eastern hemlock) and 40% by Acer rubrum (red maple); Eastern hemlock are considered a climax-forest association in the southwestern region of Nova Scotia; red maple is typical of old field areas that are entering mid-succession.

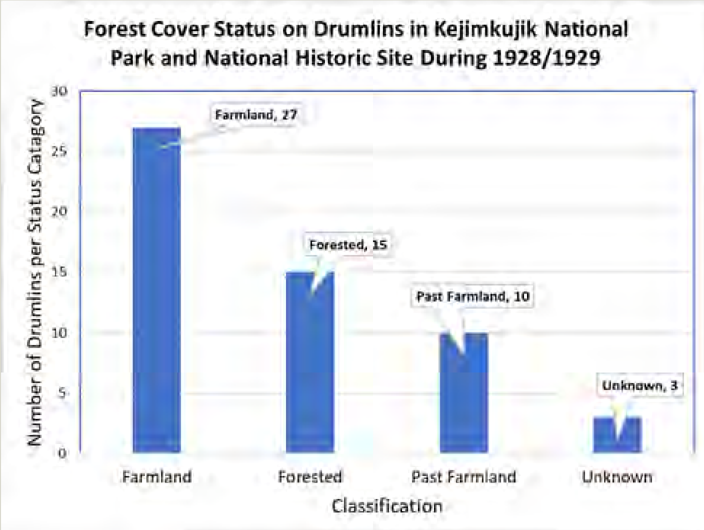


Figure 5: Analysis of forest cover status on drumlins in Kejimkujik based on 1928/1929 (top) and 2023 (bottom) air photos. Drumlins within Kejimkujik were delineated and classified using digital elevation model data. Delineated drumlins were overlayed with 1928/1929 and 2023 air photos classified into four categories based on land use; partially cleared, past clearing, forested, and unknown.

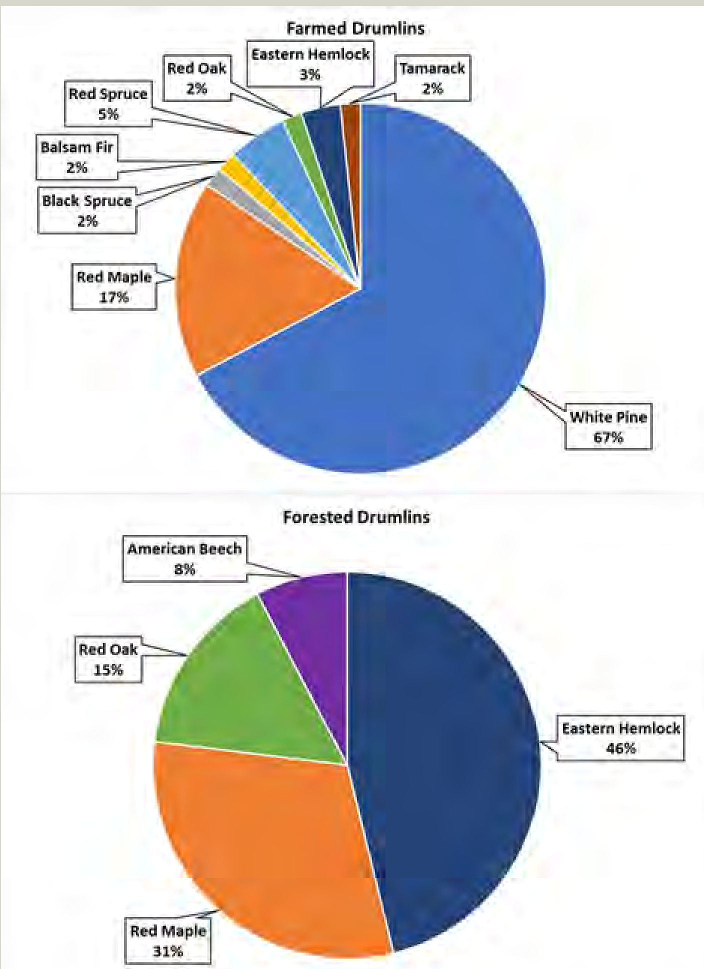


Figure 6: (Top) The leading tree species occupying historically farmed drumlins in Kejimkujik in 2023 and their associated percentages, based on the current Nova Scotia forest inventory. (Bottom) The leading tree species occupying historically forested drumlins in Kejimkujik in 2023 and their associated percentages, based on the current Nova Scotia forest inventory.

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White pine and red maple now dominate the 27 historically cleared drumlins within Kejimkujik, representing 57% and 23% of the dominate tree species respectively (85% collectively). Historically dominate species of beech, sugar maple and yellow birch have not returned to the drumlins.

In conclusion, this study shows that past agricultural activity has heavily influenced the forests of today. When the drumlins were farmed large changes in the soil ecosystem took place, hill and mounds were removed, soil composition changed, and a thick mat of grass prevented many species from establishing and favoured others.

In this region of Nova Scotia, white pine is the first species to establish and still dominates many drumlins. Other species that were much more common- sugar maple, beech and yellow birch are in much lower numbers than drumlins that were not cleared. Climate change, abundant deer population and invasive species (Hemlock Woolly Adelgid, Glossy Buckthorn) are also impacting forests succession on these drumlins.

Only time will tell if tolerant hardwoods will once again return to the farmed drumlins of Kejimkujik.

Please contact Delbert Swinemar with questions and/or comments at: delbert.swinemar@pc.gc.ca

For those that have been following along with the Kespukwitk Conservation Project; the Story Map and Geospatial Viewer will be released soon. The final draft is under review with final edits being made before it goes live to the public.

LESSONS FROM TUNWATH

by David Patriquin (retired Professor Dalhousie Biology)

Combining a field in the faba bean stage of the four-course crop rotation, Aldhouse Farm, “Tunwath” ,North Williamston, 1980

From 1977 to 1986, I and a succession of Biology students conducted observations and experiments at Tunwath farm, a laying-hen/grain farm in the Annapolis Valley, as it made a transition to organic farming; it was one of the first conventional farms in the Maritimes to do so. The farm was owned and operated by Basil Aldhouse, a WWII RAF veteran, and his war bride spouse Lilian; she was from the Valley, and as well as tending to the birds and eggs, Lilian was a full-time teacher.

I went to the farm initially to look at nodulation in fababeans. Basil was one of the few farmers in NS growing this grain legume. Nodulation is the process by which soil or introduced bacteria infect the roots of leguminous plants to form N_2-fixing nodules which enable the plants to use atmospheric nitrogen in place of soil or fertilizer-N (“N” is shorthand for nitrogen).

Basil and Lilian were innovative and their farm unusual in other respects. They wanted to be self sufficient in production of grain for the laying hens; as Basil put it, the “Barn should fit the Land”, meaning they would keep only the number of laying hens that could be fed by grain production of their 75 acres of cropped land. Over time that settled out at about 2000 laying hens. Basil was one of the first farmers in the region to grow winter wheat. In 1975, his oat crop exhibited the highest yield recorded in a provincial competition. That was achieved using conventional methods (with use of fertilizers, herbicides and pesticides) but he had become convinced that this system of production was not sustainable. The final straw for Basil was when he could no longer find earthworms in his cultivated soils.

In 1976, they made a "cold turkey" conversion to organic farming (more commonly referred to at the time as “ecological” or “sustainable” farming or “biological husbandry”). Oat yields tumbled, apparently due to inadequate N. Dept. of Agriculture personnel told Basil it was impossible to grow grains without fertilizer-N. When I visited the farm in 1977 to look at his fababeans, Basil asked "why should my cereals be N-deficient when I have legumes on a third of the land and I'm recycling manure from the barn?"
As a researcher on N-cycling, I thought that was a good question and decided to pursue it. Finding the answer was very much a joint farmer-scientist-student endeavour that in the end took seven years and involved much more than nitrogen, as documented in scientific papers and popular articles (see http://versicolor.ca/tunwath/index.html). Basil died suddenly in that 7th year (1984). Lilian maintained the organic production of eggs for a period but with age finally had to let it go, and kept the fields only for hay – but still with no use of imported fertilizers.
What did we learn that could still have some relevance some 40 years later in our Brave and somewhat scary New World? 1. We could eliminate most use of N fertilizers 2. We need and can live with weeds!

Use of artificial N fertilizers (which are synthesized from natural gas and atmospheric N_2) has continued to increase in spite of their serious ill-effects environmentally, most notably pollution of aquatic and marine systems and generation of GHGs. Even use of organic sources of N - organic wastes and legumes - can contribute to such pollution if not carefully managed to avoid excesses of N in the soil.

The oat stage of the four-course rotation. Clover is undersown with oats so that after oat harvest in summer, clover would be allowed to grow a full year before being turned into the soil as a green manure—a green manure than contained one year’s worth of the nitrogen fixed by the clover.

At Tunwath, self sufficiency in N required a substantial acreage of legumes (clover and fababeans) and tight recycling. We moved away from this type of farming historically not because it didn’t work but because the advent of synthetic fertilizer after WWI enabled us to grow crops without animal manures or rotations with legumes and the advent of herbicides and pesticides after WWII obviated the need for regular rotations to control weeds and pests. Both developments allowed a high degree of specialization in crop and livestock production which lent itself to emerging industrial production models and in turn to massive increases in aquatic and estuarine pollution from farm nutrients.
Could we go back to those old methods and achieve the high yields now required to feed 8 billion people (versus 2.5 B in 1950). There is no biological reason we could not do so. A concerted government/industry/society effort would be required to fundamentally change predominant farming methods. But there are some things we can do as individuals to help drive the change and reduce N-fertilizer use: (i) consume more of our protein in the form of grain


A younger version of a SNBR Project Coordinator in 1984 helping with the farm after Basil died.

legumes (beans, soy, chickpea etc) rather than meat; (ii) buy local from smaller mixed farms (organic or not and with livestock or not, but if not, using locally produced organic wastes) and (iii) incorporate clover into lawns and turfs to replace the need for nitrogen inputs (it also helps to control 'weeds'). Why couldn't NS offer a high-end fully ecological clover-based golf course? There's a $ opportunity for a green investor!
A major benefit of 'tight recycling' of nitrogen is far fewer pest issues. When we experimentally applied N fertilizer to small plots at Tunwath farm, it always stimulated pests and/or diseases. Removing weeds from plots in the fababean fields resulted in aphid outbreaks, and remarkably, reduced grain yields compared to the normally weedy fababeans. The explanation: the weeds consumed small excesses of mineral nitrogen in the soil which stimulated nodule growth and final yields and made the fababeans less nutritious to aphids.

Which brings me to weeds. The close-to-100% elimination of weeds achieved in modern cropping systems (even in some organic systems) is hard on soils, pollinators, wildlife and a lot more. Basil had a high tolerance of weeds and tried to do the minimum control necessary to reduce their negative impacts on yields, rather than trying to eliminate weeds. He saw weeds as 'self-seeding cover crops', coming up naturally after grain crops were harvested and covering fields over winter; also he could see how important there were for wildlife. "The wildlife feed on the weeds, not my crops" he said. Our studies showed that weeds are much less aggressive, and more diverse and are more easily controlled when there is tight N-cycling; excesses of N stimulate both pests and weeds!

As they say, 'it's all connected – N cycling, pests, weeds. Surely, in 2023, it's time to start putting Humpy Dumpty back together again.

WILD ROSE FARM: GILBERTE AND SIEGMAR DOELLE, GILBERT'S COVE

By Nick Hill

"Because of small scale production and few storage facilities the farmers of the area cannot compete successfully with better-organized producers in the Annapolis Valley. Local production of vegetables, small fruits, etc., is not sufficient to meet the needs of the area." (Hilchey et al., 1962. Soils of Digby County. Report 11, Nova Scotia Soil Survey).

While the above has merit—the Wild Rose Farm is small scale, there are few storage facilities and at present local production of vegetables is not sufficient to meet needs of the area—Wild

Rose has operated an intensive, organic market garden for 20 years in a soils area described by the above report as “Fair to poor crop land” with “Severe limitations in use”. The vegetable production is a mixed farm. Siegmar Doelle, a veterinarian at Sisaboo Veterinarian Services in Digby, manages a small herd of 9 heiffers and a horse through a system of rotational grazing over 13 patches of field or field and woods. The spruce pasture is accidental; it is a succession where pasture spruce (white spruce, cat spruce..Picea glauca) has colonized a former pasture—there is the tell tale barbed wire in trees deeper in the woods. The spruce can provide shade in summer and also a different complement of elements for the ruminants’ diet. The cows are provided supplements of hay and of vegetable scraps from the garden. They provide beef but most importantly, they keep nutrients cycling and provide manure to Gilberte Doelle’s vegetable operation.

Gilberte Doelle feeding a young heifer with scraps from the vegetable produce.The Doelles sell their vegetables at the Annapolis Farm Market.

The manure is held in a covered area until used. Some of the manure is mixed into straw and hay to make compost for the garden and greenhouse operation. Some is laid six inches thick on three-foot-wide rows that you can see in the photo below. Garlic is planted in December then covered with a foot of hay. This provides the garlic with a substantial load of balanced nutrient and results in a good garlic crop for sale and a fertile bed for successive vegetable crops. Gilberte understands her crops and considers them according to their plant families, each having its own property. What looks to an observer as happenstance is a little less than an acre divided up into 58 rows that are managed in a 7-year rotation. The ordering has been worked out over 17 years—upcoming is year 18—and each row goes through the sequence:
(1) peas/beans (legumes of the Fabaceae Family) à(2) onions/garlic (“Alliums” of the Amarylladeae Family) à (3) carrots and beets (two families) à (4) potatoes and tomatoes (Solanaceae Family) à (5) peas/beans again (legumes) à (6) cucumbers/squash (Cucurbitaceae Family) à (7) Mustard family (Kale, Brussel sprouts, Kohlrabi, Pak-choi etc.) à ...(1) and repeat.

There is a nutrient logic in the successive vegetable crops used at Wild Rose Farm as there was at Tunwath egg farm. It’s not mysticism. The harvest of each crop takes something different from the soil. The nutrient status of the soil during each rotation is monitored by observation

How well did the crop do? By understanding of the weed context... chickweed = fertile, sheep sorrel = a nutrient deficiency... Or by direct measurement of chemical element concentrations in the soil (e.g., NPK, Ca, Mg...and micronutrients). In ecological agriculture, manure and compost is used to move nutrients from field to field but the only way to add significant amounts to the farm's nitrogen budget is to grow legumes: beans, clover, lupins peas etc. Legume roots contain nodules where the plant supports trillions of bacteria that transform atmospheric nitrogen gas into the protein nitrogen that becomes available to support plant growth, when legumes are eaten by animals or turned into the ground, the nitrogen becomes available to the soil and other plants. Clover is the main legume grown by Gilberte to increase nitrogen supply although she does grow many varieties of traditional beans. In the photo above, the newly planted garlic is in the distance and clover and grass (oats) are being used as a green manure crop. This means that all this green biomass will be turned into the soil and this will return the nutrients taken up by the plants in addition to the nitrogen that was "fixed" in the clover's roots as atmospheric nitrogen was reduced by the bacteria in the nodules.

We visited Gilberte in the off-season in mid-December but there are three greenhouses that are passively heated. Seeds are germinated in plastic trays; trays are nestled on beds of chipped willow twigs—a fast growing Acadian willow—and seedlings grown on to provide more Asian greens and lettuces. The beds in the greenhouse are surrounded by a depth of chipped willow twigs. The soils are amended with compost and the tight plastic, the soil metabolism and the occasional sun made a warm atmosphere on a winter day.

The Doelle farm is organic and influenced by the biodynamic agricultural tradition that tries to make the farm self-sufficient rather than being reliant on organic materials and manure from outside the farm. The legumes bring in new nitrogen thanks to their root nodule bacteria. The cows use pastures that also have legumes (clovers) for nitrogen fertilizer for the grasses.

The cattle may also find traces of other elements from the woodland pasture phase. Flowers -- nasturtiums, sunflowers, statice—are planted in the rows of vegetables which is perhaps a biodynamic inspired act but more so a planting that will attract bees and other insects, increasing the biodiversity of the agroecosystem.

Gilberte and Sigmar sell their produce at the Annapolis Royal market. On less than one acre of intensively cared for land, comes 10,000 pounds per year of vegetables. People question whether more market gardens would compete with their business. Gilberte calculates that based on the 90,000 people in Kespukwitk, there would be room for hundreds more operations like hers if we all bought and ate local.

Something to think about next time in Costco.

D'ENTREMONT RIDGE VINEYARDS

By Jean Guy d'Entremont

The idea of d'Entremont Ridge Vineyards was born in 2011 when my wife Marlene and I spent 30 days in Italy, one day for each year we were married. We explored Italy travelling from one area to the next by train. I was so impressed with the vineyards in Italy with their orientation, straight lines, and growing on the mountain sides in poor soil, yet they produced some of the finest wines. I remember telling Marlene if ever I get a chance I'm going to plant a vineyard. I read up on it and knew what was needed for a location and climate in Nova Scotia to grow grapes. I knew a scientific approach would be necessary to grow grapes. The Nova Scotia climate data study 2014 identified the inland areas of South West Nova Scotia as prime areas of Nova Scotia in terms of heat units and growing degree days. One day, on our drive to our home in Forest Glen, South West Nova Scotia, I noticed a "for sale" sign on a cow pasture in Carleton.

This pasture had a south facing slope and a sandy gravel pit was located a short distance from the field. I immediately contacted the owners and made an offer that was accepted. We hired a consultant, made a site assessment that found the location suitable for growing certain varieties. It was classified as "Yarmouth soil". I met with a winery in the Annapolis Valley where we established the best grapes to grow market wise, and decided to plant Chardonnay on the best location on the property. I felt if we started with the toughest to grow first, that if successful, we could expand with other varieties in the future. It took a year to prepare the field for planting by removing the rocks, adding the proper nutrients. In the spring of 2017, we planted the first 4000 vines. After the first planting was successful, we purchased another overgrown field in Forest Glen, south facing slope. and with a soil classified as "Halifax Soil". We needed to tile drain this second field in Forest Glen. The cost of the tile draining was more expensive than the cost of the property! In Forest Glen, we also had trees cut and the roots removed. Bushes needed to be bush hogged and rocks removed. After spending the first year preparing the Forest Glen property, we planted the same varieties as in Carleton. In 2023, we now have 25,000 vines planted in both Carleton and Forest Glen. We have planted exclusively green grapes by design, because red grape varieties are less suited for our climate. More heat units are needed to guarantee success every year with red varieties. In early February, 2023, we experienced an extreme cold event and we are currently determining the extent of the bud damage. The Annapolis Valley grape growers experienced a similar cold snap and have sustained damage as well. In 2022, we harvested 32 metric tons of grapes that were sold to 3 different wineries. Those grapes produced approximately 28,000 bottles of wine! The wineries are very happy receiving our grapes because since they are grown in different soils than the valley, they have a distinctive taste called terroir, where the grapes taste according to the soil and climate of the area they are grown.

AGROFORESTRY

by Thomas Cornell, Clean Annapolis River Project

Cámbulo - Písamo (Erythrina poepiggiana)" by Alejandro Bayer Tamayo is licensed under CC BY-SA 2.0

I was first introduced to the concept of agroforestry in the context of tropical ecosystems. It was explained that any time trees or shrubs are intentionally integrated into a managed agricultural system, whether that system is for growing crops or livestock, one is engaged in some form of agroforestry.

At the time, I was enrolled in a course taught by Dr. Maren Oelbermann, a professor in the School of Environment, Resources and Sustainability at the University of Waterloo. The course was about tropical ecosystems more broadly, but included a number of discussions on tropical agriculture. During one lecture, I learned that Dr. Oelbermann had conducted some of her post-doctoral research in Costa Rica, where she and her colleagues had experimented with the agroforestry technique, alley cropping and had measured its effects on soil carbon stocks when incorporating rows of the Coral Tree (Erythrina poeppigiana, a nitrogen-fixing legume tree, native to South America) into a field farmed in a conventional rotation of maize and beans.
safely alley-crop – bare soil, even for short periods, would risk severe erosion. Instead, while the main crop matrix of nut trees establishes, we'll inter-plant between them with faster-maturing European × American hybrid hazelnuts, as well as a mix of small fruits. Some of these fruits will be native, like Black Chokeberry, Canada Serviceberry, Highbush Cranberry (Viburnum trilobum), or American Elderberry. Elsewhere we may plant cultivars of Haskap or Highbush Blueberry. The partial shade that the hybrid hazels will receive in the mature system should encourage healthier plants, as they naturally occupy the understory of forests and can produce well even in half-shade.

I was captured by the photographs on the slides, which showed Dr. Oelbermann about fifteen years in the past. She was standing beside a long row of shrubby plants with a long blade in one hand and a cluster of arm-length, leafy branches in the other. In the distance, parallel rows of the same woody plants could be seen, and in between them in the 'alleys', a conventional crop of corn or beans was about to be sown. She explained that in this experimental system, they had removed all of the shoots of the Coral Trees on a twice-yearly cycle, leaving only rows of short trunks ready to respond with another flush of vigorous shoot growth. They had then chopped and laid those pruned branches on the soil where the crops were to be grown, distributed the biomass evenly, and used a disk-harrow to cultivate the alleys and prune the tree roots at the same time. Finally, they would sow the maize or beans and repeat the cycle about every six months.

What I didn't know at the time was that there was another site in Canada which was selected as a temperate-climate comparison. Rows of hybrid Poplar trees were planted at the University of Guelph Agroforestry Research Station. The trees were more widely spaced than the Coral Trees of the tropics – twelve and a half metres between rows, rather than six – however this was because they weren't being managed in the same way. Rather than pruning, chopping and dropping the trees, they were simply allowed to grow and contribute their leaf litter and twigs to the alleys between. The findings were quite remarkable. In both systems, the conventionally farmed fields started with very low carbon content in the soil as the organic matter had been depleted through the constant tillage and the removal of biomass in the cropping system. However, at the initiation of the alley cropping agroforestry systems, with all of the field management practices otherwise left the same, the additional organic inputs of wood and leaf biomass in both the tropical and temperate systems were enough to reverse this decline; there was an annual increase in soil carbon.

These results are important for more reasons than reducing greenhouse gas emissions by changing soil metabolism, or even storing more atmospheric carbon in long term sinks. Increasing soil carbon is achieved through increasing the soil organic matter. Organic matter improves the soil's ability to hold and slowly release water and acts like a glue, helping soils to resist erosion and compaction. Because organic matter is derived from plants themselves it becomes the nutrient capital of the soil, releasing back to the crop the full array of nutrients. In addition, organic matter increases a soil's cation (calcium, magnesium, manganese etc.) exchange capacity. Soils rich in organic matter support a wide array of soil microbiota or microbiodiversity—bacteria, fungi, microfauna and mesofauna. All the above promote healthy soils and healthy crops in ways that agro-chemicals cannot. A carbon-rich soil is a living soil, one that will have in-built resilience in the face of pest infestations, floods and droughts.

Since completing my degree in environmental science, I've frequently remembered that lecture and how it changed my conception of what farming could be. I'd grown up in a rural part of south-western Ontario, my home one of six in a cluster at the corner of two roads, surrounded on all sides by sprawling fields of corn, or occasionally soy. In what would have historically been part of the majestic Carolinian forest's northern range, only tiny woodlots in areas too difficult to cultivate remained, and I didn't respect the scale and complexity of human disturbance until studying it. I'd never imagined myself becoming involved with agriculture, and yet within a few months of graduating from university, travelling the country and seeing the scope of landscape conversion for conventional, animal-based agriculture, my partner Jessie and I wanted to experiment with meeting more of our own food needs in a way that left more habitat intact. The pandemic period of isolation followed shortly after, and we got our opportunity on family-owned land.

In the intervening three years, we've become increasingly interested in perennial agricultural systems which minimize soil disturbance and preserve or even enrich habitat for wildlife. Popular frameworks like permaculture, keyline design, or syntropic agriculture offer more or less specific guidance for designing such landscapes, however I continually return to basic agroforestry principles when imagining how such systems could transform our broader agricultural industry for the benefit of soil and ecosystem health.

There are different categories of agroforestry we can participate in while living in a temperate climate. I've already introduced the first of these, alley cropping, which sees conventional annual crops grown between rows of trees for nut or timber production, the crops benefiting from a more stable micro-climate, carbon input, or pollinator habitat in the perennial rows of trees and shrubs. As Dr. Oelbermann's research has shown, alley cropping can easily be used to great benefit on a conventional, row-cropping farm, with results that could improve yields and crop nutritional quality in the long term.

Four other methods of agroforestry are broadly categorized. Riparian buffers protect water quality from nutrient input, shield fields from flooding, improve aquatic habitat, all while creating a transition between production and wilderness areas. Windbreaks scale up timber, nut, tree fruit and berry production, while also providing habitat for wildlife and sheltering crop fields from wind. Forest farming takes place right among the trees – whether for mushroom cultivation, medicinal herb collection, maple sugar production, or some other purpose. Finally, silvopasture combines trees with pasture land to benefit the diets and welfare of domestic animals, who appreciate shade in the summer and cover in the winter. Some forage grasses even grow best in partial shade.

Today, Jessie and I are experimenting with the slow conversion of approximately twelve acres of old hay field on relatively steeply-sloping land (mostly Black Knapweed, now), into a forest farming system. Left to its own devices, this field would take decades to succeed through brambles, roses and other native shrubs, followed by pioneer trees and eventually, an example of a native primary forest. However, we're planning to manage that process of forest succession, securing other agricultural yields while establishing a long-term supply of perennial carbohydrates in the form of European, Chinese or Chinese × American hybrid chestnuts. In other parts of the system, native Sugar Maple will form the main crop, while other zones will produce Butternut, Hickory, Black Walnut, Mulberries, and perhaps American Persimmons.

The ground on our farm is too steep to safely alley-crop – bare soil, even for short periods, would risk severe erosion. Instead, while the main crop matrix of nut trees establishes, we'll inter-plant between them with faster-maturing European × American hybrid hazelnuts, as well as a mix of small fruits. Some of these fruits will be native, like Black Chokeberry, Canada Serviceberry, Highbush Cranberry (Viburnum trilobum), or American Elderberry. Elsewhere we may plant cultivars of Haskap or Highbush Blueberry. The partial shade that the hybrid hazels will receive in the mature system should encourage healthier plants, as they naturally occupy the understory of forests and can produce well even in half-shade.

Importantly, we don't plan on neglecting the herbaceous layer of vegetation. With at least 15 years to wait until the main nut crop is truly producing, and with a generous spacing in the orchard, we should always have alleys with light access, and areas under each tree with considerable shade. This light gradient will allow multiple activities in the same space – first, areas with better solar access will support the understory trees and shrubs just mentioned, but will also allow a diverse mix of sun-loving forbs to flourish. These flowers will provide nesting and flowering resources for
native pollinating insects, including native bees and wasps. We'll especially be building habitat for solitary predatory and parasitic wasps, which are a diverse group that pose no real risk to humans, while controlling all manner of agricultural pests. Areas of shade will allow us to cultivate culinary mushrooms on logs. We'll also encourage bryophytes, ferns, and shade-tolerant, native ground covers, in order to further support pollinators and other wildlife.

Eventually, we hope to meet the carbohydrate needs of ourselves and others with perennial chestnuts, which have a more attractive amino acid profile than wheat or rice, while also working as a base for flour. We should also have ample healthy fats and protein from hazelnuts, butternuts, walnuts, and heartnuts, all of which are easily stored without refrigeration, and are incredibly calorie dense. In addition, we hope to dry all manner of tree fruits and berries, or preserve them in other ways. It will make me incredibly happy to achieve something even close to that vision, without the annual tillage and fertilizer requirements of conventional agriculture, and without grazing animals removing flowering resources for native insects. We have much more to learn, but the trees are wise and patient teachers, so we'll just keep planting them and do our best to listen to what they have to say.

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FIELD TO FOREST By Nick Hill

The last four articles deal with making use of the naturally productive soils (see article 1: Keys) in southwest Nova Scotia for agricultural production. This next article by Peter Neily confirms in his Table on page 23, the MacKinnon PhD maps which show a wholesale abandonment of agriculture over the 50 year period 1891 to 1941. He describes these communities that are opportunistically returning field to forest. We end these articles with Jamie Ring's discussion of plantations that are an integral part of the Triad approach that allows for the commitment to ecological forestry on the matrix of the Crown land base.

PUTTING OLD FIELDS INTO THE ECOLOGICAL FORESTRY APPROACH IN SOUTHWEST NOVA SCOTIA

By Peter Neily, Nova Scotia Department Natural Resources and Renewables

No one knows how long it will take Nature to restore the natural forest that once covered farmland that has been abandoned in Southwest Nova Scotia. It could be centuries before all the biodiversity, structures and processes associated with the natural forest condition have been re-established. However, that doesn’t mean the early successional old field forests of white spruce (pasture spruce), white pine, and tamaracks that start the healing process have no ecological value. These early forests initiate the site for a more natural forest that will follow and start the process of restoring forest floor and soil conditions, creating biodiversity features and habitat, and re-introducing plants, mosses, fungi, and wildlife.

As described by Kevin Keys in his article “Soils and Productivity in the Kespukwitk”, soils are inherently variable and within every land parcel there are usually areas that are better and worse than the average. So, when the early settlers were granted a parcel of land there was no guarantee that all or much of it was suitable for farming. Often the best farmland along rivers had already been granted, but they had a family to feed and so they cleared the forest and did the best they could. World events in the early 1900s and subsequent economic troubles later resulted in many people leaving the marginal farmlands for opportunities in other parts of Canada and the United States. More recently agricultural fields have been abandoned as farming has intensified requiring smaller acreages.

A 1910 survey of forest conditions in Nova Scotia by Dr. B. E. Fernow, Dean, Faulty of Forestry, University of Toronto, classified 404,924 acres of cleared land (14.25% of the total area) in the Southwest Biosphere. In 2010 the NSDA did a survey of active farmland and identified 62,155 acres or 2.2% of the Southwest. Based on these two surveys roughly 340,000 acres of farmland have been deserted over the past 100 years in southwest Nova Scotia. Much of this acreage has already regenerated to forests, many of which have been

	Annapolis	Digby	Yarmouth	Shelburne	Queens	Total
Farm (cleared lands in acres) 1910	148,880 20.3%	139,328 23.4%	51,088 10.6%	16,528 3.6%	49,100 8.6%	404,924 14.2%
Farm (pasture, crops, and wild blueberries) 2010	39,851 5.4%	10,386 1.7%	8,680 1.8%	795 0.2%	2,443 0.4%	62,155 2.2%
Acreage Surveyed	734,528	595,584	483,376	458,032	569,696	2,841,216

harvested, maybe twice, and are now starting a third forest.

As the human population continues to grow, some of the abandoned farmland with better soils (currently forested or not) may have to be used again for agriculture. Recently abandoned farmland can be reforested with several management objectives in mind. High production forests are one such option with a view to maximize forest growth. Another is to try and restore the natural forest, by-passing some of the earlier successional stages. Landowners may also want to enhance biodiversity and landscape functioning (e.g. connectivity, travel corridors) by establishing forested sections in old fields along riparian areas and wetlands. A Government of Canada program called Two Billion Trees may be able to assist landowners with reforestation projects. For more information contact the Southwest Nova Biosphere Reserve Association.

Natural forests and the species of trees growing on forested soils are determined by climate and the availability of moisture and nutrients from the soil. In Southwest Nova Scotia the best soils support forests of shade-tolerant hardwood such as sugar maple, yellow birch, beech and white ash. These conditions are typical on many of the drumlins (glacial landform of well drained loamy soils). Slightly less fertile soils have forests of red spruce, yellow birch and hemlock. The least fertile soils will typically support black spruce and white pine. Some tree species are called generalists and can be found on both rich and poor sites, examples include red maple and balsam fir. With at least 28 tree species in Nova Scotia there are always exceptions, for example, red oak is typically found on poorer sites with white pine but it can also be found on the rich soils of floodplains where it does exceptionally well.

Most likely the first lands cleared for farming were the fertile floodplains along rivers, especially in Annapolis and Digby counties. Here the forests of elm, sugar maple and ash were cleared. Other sought-after lands were the lower slopes of the North Mountain, the soils here being enriched by the basalt parent material and covered with mixedwood forests of red spruce, yellow birch, and hemlock.

Landownership patterns may also factor into the decision process for selecting the most appropriate reforestation strategy. Narrow lots such as these may be an option for high yield forest plantations.

The stone free glacial tills of the Annapolis Valley also provided deep tills for croplands and orchards.

The drumlins throughout the southwest but particularly in Digby, Yarmouth and Queens counties had both hardwood and mixedwood forests of beech, hemlock, and sugar maple. Coastal farmland along the Atlantic Ocean was marginal at best in most locations with small parcels of white and black spruce and balsam fir cleared to support families who also derived income from fishing. These coastal lots were small and provided a patch of pasture and a garden plot, all requiring inputs to maintain fertility.

It is a slow process for Nature to re-establish the natural forest on abandoned farmland. Usually harvesting or senescence (old age) of the "old field forest" is the first step towards getting back on the natural successional pathway. Stand level disturbances such as harvesting, insect (spruce budworm, tussock moth, and bark beetle), windthrow (hurricanes and tropical storms), and fire create opportunity for early successional species such as red maple, balsam fir, white birch, and aspens. These species are short lived but provide cover for shade tolerant species such as red spruce, hemlock, sugar maple, and yellow birch. Establishing in the understory these young seedlings wait for their chance to gain entry into the upper canopy taking advantage of the enhanced light availability caused when gaps occur due to overstory mortality. Eventually a late successional forest will develop barring any stand level disturbances that may reset the successional pathway.

So how do we restore the natural forests on abandoned farmland. If left for Nature the first forest would be a somewhat artificial forest of white spruce or white pine. Both these species are able to establish on grassy seedbeds but are not typical of the ecosystem in which they are growing. For example, the mixed-wood slopes of the North Mountain do not usually create opportunities for pure stands of white spruce where this species is a minor associate of the overstory. Elsewhere in the southwest the preponderance of white pine provides adequate seed to establish on the favorable seedbeds of abandoned farmlands. In New England old field forests of white pine are featured prominently along the interstate highway through Maine and Massachusetts. Usually, the only opportunity for pure stands of white pine in Nova Scotia occurs following forest fires.


The forest floor of an old field forest is often very level or smooth due to plowing and crop cultivation. Mosses are often extensive with a near absence of herbs and ferns.

Another aspect of these already altered sites is the role they could fill as high yield plantations, also known as tree farms or high production forests. The more wood that is supplied from these intensively managed forests the less wood required from natural forests that could then be managed with silviculture practices more ecologically aligned with natural disturbances to create appropriate age classes, species composition, and biodiversity features. But that's not to say that intensively managed forests have no ecological or biodiversity value, quite the opposite is true and while lower on the naturalness index they still provide habitat for many species and contribute to air and water quality and carbon sequestration. These forests would also be easily accessible and thus reduce additional road construction.

Recently abandoned farmland is often impoverished and is soon covered with alders, goldenrods and wild grasses. However, these lands, usually free of large stones and level are easily planted. Taking an ecological approach the original late successional forest can be determined by noting what is growing nearby on similar soils and site conditions. Planting these species will by-pass the early successional forests of aspen, red maple, white birch, and

Old field forests of white spruce (often called pasture spruce or cat spruce) are often smooth or level due to past plowing and cultivation. Mosses and or a carpet of needles are typical with few herbs and ferns unless there are openings in the overstory. Dead lower branches can be hazardous when walking through these stands.

Rock walls are a common feature of abandoned agricultural lands where rocks were cleared on cultivated lands. Often, they were placed along property lines. They serve as habitat for wildlife such as snakes, weasels, and a variety of rodents. Rock piles (stone dumps) are another feature often found associated with past agricultural use.

and balsam fir that often follow harvesting of naturally regenerated old field forests of white spruce and white pine. Nonetheless, there are still features of the farmland that will continue for several rotations. The diminishing influence of the plow layers and the return of typical forest soil profiles will take several decades. The pit and mound (pillow and cradle) microrelief of the forest floor will require windthrow of mature trees. And the build-up of an organic duff layer requires input of decades of leaves, fine and coarse woody material. And for those farmlands that were cleared of rocks and boulders there can be no replacement of that loss. Fortunately, Nova Scotia's Forest sites are very resilient to disturbance owing in part to our moist, temperate climate that provides a perfect environment for repairing old wounds and restoring natural ecosystems.

"INVASIVE PLANTS": THE NEW KIDS ON THE BLOCK

By Nick Hill

In 2010, Sean Blaney and I were asked to dig in to the introduced plants of the Maritimes. We separated "invasive" plants from those that were introduced exotics. Being exotic meant that the plant had been introduced from outside its range while being invasive meant that the plant had invaded a native ecosystem.

This was a really important distinction for two reasons. If we treated exotics that were taking advantage of old fields that had been abandoned as invasive, then we would have been putting a scare about that this plant had flown the coop and needed to be the target of control efforts. Second, if we did this, we would be suggesting that the exotic was hindering and suppressing native species biodiversity.


Common Hawkweed


Rosa rugosa


Himalayan Blackberry *(Rubus bifrons)*

We still cannot say that any exotic plant in Nova Scotia is reducing native species because we haven't done the research. In some cases, it is clear. A few stand out:

1. Reed canary grass at Smiley's Park. Due to either an increase in nutrients in the Meander River or to altered water level fluctuations, reed canary is replacing the native twisted sedge (Carex torta) in the river side tussocks.
2. Common hawkweed in hardwoods in Antigonish County. This hawkweed was the most common understory herb in a forest with low diversity of wildflowers. No data but data are needed.
3. Rosa rugosa on the shoreline of Brier Island and many other seashores of Nova Scotia. This beautiful rose established large clumps on the seashore and the herb diversity beside the rose was much greater than that below. In all of these cases, we are assessing an exotic plant that as come into a native habitat, a cobble river bank, a hardwood understory, and a seashore, and appears to be outcompeting the native vegetation. Evidence still lacking but optics aren't good.

Agriculture deals in exotic plants. When a crop is planted, it is from somewhere else but so typically are the weeds. When a pasture is established, all the grasses and legumes are exotic (although there is some uncertainty about whether Kentucky bluegrass is wholly exotic). When a pasture is abandoned we are most often left with couch, orchard grass, Kentucky bluegrass, bent grass and sheep's fescue, a few exotic forbs (black knapweed and sheep's sorrel) and native goldenrods. Poplars invade these old field by root suckering in from adjacent woodland and in southwest Nova, black locust trees move into fields using the same root suckering technique, no evidence that they are regenerating from seed in Nova Scotia. Randall Myster and Steward Pickett studied ten abandoned old fields in New Jersey over 31 years and noted that orchard grass could inhibit the growth of woody species for 8 years and that exotic shrubs (Japanese Honeysuckle and Rosa Multiflora) could then inhibit native trees (1992, Journal Ecology 80: 291-302.). In recent times, Randall Myster, now a professor at Oklahoma State University observes that despite these inhibitory processes, overall the succession of areas by native forest trees follows more the tolerance model of succession: species colonize and grow according to their abilities to disperse, germinate and grow.

A recent study suggests that even lands abandoned by agriculture a century ago are more invasible by exotics and it may be that the nature of the colonizing tree cover after agriculture helps to set up the exotic invasion. (Agricultural land-use history increases non-native plant invasion in a southern Appalachian forest a century after abandonment 2011 Kuhlman, TR, SM Pearson, MG Turner Can J Forest Res 41: https://doi.org/10.1139/x11-026). But this colonization of old fields by exotic species is not an invasion of native habitat because these are anthropogenically disturbed habitats, not the pit and mound woodland that has not seen the plough. The overwhelming association of exotics with active and past human disturbances tells us that it is our land-use that has changed biodiversity patterns rather than the exotics in themselves.

Is it bad that autumn olive (Elaeagnus umbellata), multiflora rose (Rosa multiflora), and glossy buckthorn (Frangula alni) are colonizing these lands that were formerly fields? All these exotic shrubs have large seeds that are moved by the birds and mammals attracted to their fruit. This dispersal strategy takes them along anywhere the bird (to fenceposts especially) or raccoon travels. It also lands a large seed into its new place with a nutrient supply from the animal's scat package. Ecologically, this colonization is probably a good thing. A grassy old field succeeds into a shrub thicket. The plants provide flowers to support a community of pollinating insects (especially so Rosa multiflora and Rosa rugosa) and they support a variety of animals that eat the fruit or the seeds. It's all good until we change our mind and want to return these old fields to agriculture, then the exotic shrubs are pests.


Multiflora Rose *(Rosa multiflora)*

In recent times, we have realized that each of these exotics are reaching some native habitats. The autumn olive has an advantage in nutrient poor, sandy soils as at Nictaux's sand barrens or even the dune slacks of the south shore. Multiflora rose is coming into river sides where it has enough light as well as into wetlands. We don't yet whether the plant can colonize wetlands that have not been anthropogenically disturbed. But glossy buckthorn is another deal; we have found it colonizing intact swamps that support the Threatened native tree, the black ash. We have also noted that when forests are cleared in succession, glossy buckthorn can become the dominant shrub in the regenerating landscape. This has ecological and economic consequences. In time, this new assemblage of gray birch and glossy buckthorn will succeed to taller, more shade tolerant species such as white ash but it's telling us that this species can be problematic where forests are cleared near glossy buckthorn populations.

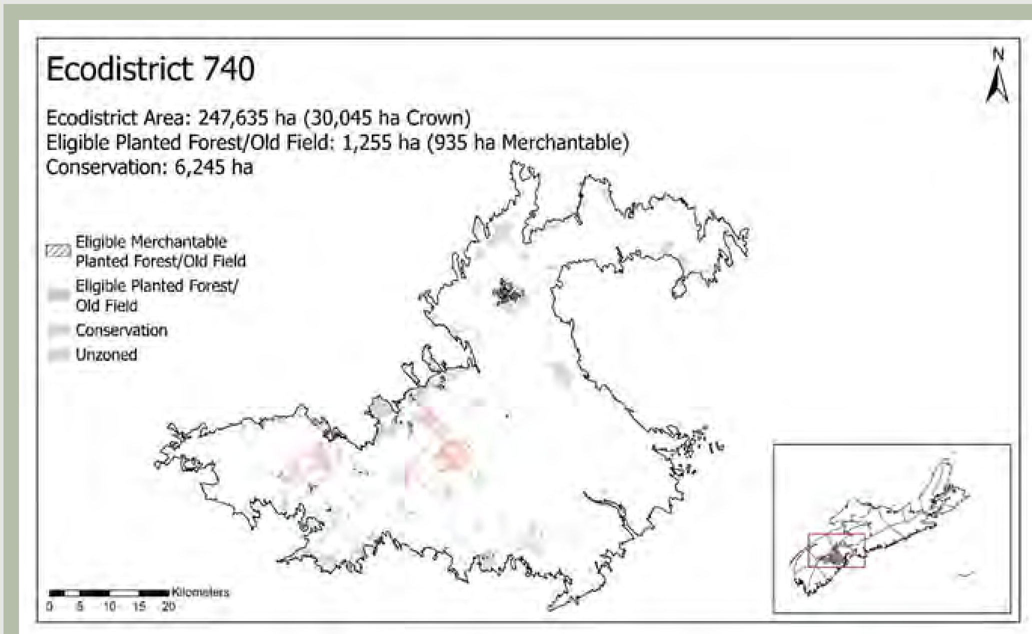
ECOLOGICAL FORESTRY IN NOVA SCOTIA – HIGH PRODUCTION FORESTRY & IMPORTANT CONTEXT FOR THE TRIAD APPROACH

By Jamie Ring, Nova Scotia Department Natural Resources and Renewables

The Province of Nova Scotia has made recent advancements towards the implementation of ecological forestry via the triad model, with the announcement of an initial suite of potential High Production Forestry (HPF) sites.

Prior to the Independent Review of Forest Practices in 2018 and the shift towards ecological forestry, the management paradigm on Crown land could be described as mitigation, which seeks to minimize the impact timber production has on various ecological values (and vice versa, in some cases). This puts ecological values and economic values in direct conflict, and attempting to provide for each on the same hectare is a recipe for unsatisfactory outcomes for both sets of values. The ecological forestry paradigm instead seeks to align economic, social, and ecological values, via the triad model. The triad model as originally described by Seymour and Hunter (1992) is a triad of land allocation involving protected areas and plantations and the larger ecological matrix, managed by "New Forestry principles" (Seymour and Hunter, 1992: 1). The conservation zone is intended to serve as an ecological benchmark, and for the maintenance of natural processes. Management is heavily restricted (often prohibited) in this zone. The conservation zone includes protected areas and areas in the old forest policy layer, currently making up 35% of Crown land.

The ecological matrix is intended to fulfill both ecological and economic values (though more heavily weighted towards ecological values). Management of the ecological matrix is designed to emulate natural stand structure and composition, creating and maintaining stands with multiple age classes, snags/coarse woody material, and long-lived species (where appropriate) through generally low intensity, when it aligns with the natural disturbance regime of the site. On black spruce sites that are subject to stand-replacing fires, the ecologically appropriate harvest could be to regenerate an even-aged black spruce stand (with some additional retention). On red spruce sites that are more often subject to low severity, gap disturbances via wind events, the ecologically appropriate harvest could be a partial harvest that creates small gaps to



Eligible sites (plantations, old fields) in ecodistrict 740 (LaHave Dumlins) for field verification to determine suitability for HPF.

release established red spruce into the overstory.

The third zone is the high production forest zone, or the intensive zone. The primary objective of this zone is to produce timber and fulfill economic values. Ecological values can still be achieved in this zone, but they are not the primary consideration.

The HPF zone will take the form of spruce plantations, with the objective of producing high volumes of timber products (sawlogs and studwood) in short rotations. To achieve high volumes and short rotations, intensive management (with many parallels to agriculture) is required – site preparation, planting seedlings, and competition control so seedlings are free-to-grow to ensure the growth targets of a minimum 6 m3/ha/year are met. Much like in agriculture, nutrient amendments will be required to sustain these yields over multiple rotations. For comparison, management of natural regeneration on productive sites could possibly yield 4 m3/ha/year. Partial harvesting in the ecological matrix, on average, could possibly yield 2 m3/ha/year (or less in may cases) because of the high retention requirements to meet ecological objectives. Comparing HPF to managed natural stands or partial harvesting in the matrix, the same volume can be produced with a 2-3x smaller footprint.


Plantations of black spruce planted in 1980s (dark green) nested within a larger landscape of mixedwood/hardwood forest near Brora Lake, Pictou County (Photo: Len Wagg, 2014)

A key component of the potential site selection of HPF was to answer two questions. Firstly, what areas are suitable for the ecological matrix? The HPF zone excludes areas where ecological values are largely incompatible with economic values (e.g., Blanding's turtle habitat and many other critical wildlife habitat areas, valley corridors for connectivity, Atlantic coastal plains flora buffers, protected area buffers, areas with wildlife special management practices, wet forest, floodplains, or tolerant hardwood sites). Secondly, what areas are unsuitable for high production forestry? This set of exclusions for HPF are predominately economic considerations (e.g., lower spruce productivity sites, coastal and highland forest with limited tree height growth). This subtle but important distinction to make it clear that candidate HPF sites are not a result of placing all the poor sites into the ecological matrix; rather they are the result of an extensive and carefully thought-out screening process to ensure sites with ecological values incompatible with timber production are managed appropriately. The initial sites for HPF are limited to existing plantations and old fields that are not excluded for any of the previously identified reasons. These types of lands are being prioritized because they are already in a managed condition. Additional field verification will be required on all potential sites, before approval is given to proceed with HPF, to ensure that they meet the HPF suitability criteria (and the ecological values of the sites are not incompatible with timber production).

The government has made a commitment that the high production zone will be a maximum of 10% of Crown land. This means that ecological values trump economic values on the other 90% of Crown land. With the high production zone fulfilling economic values, the direct conflict that previously existed between ecological and economic values can be alleviated. The concentration of timber production to 10% of the land base provides the much-needed flexibility of management in the ecological matrix – timber production can occur only where it is congruent with ecological values. It becomes much easier to stay away from sites that require passive management to fulfill ecological values when there is a reliable timber supply from the HPF zone. Implementing the Triad is a large task and an even larger cultural shift around forestry in the province, but the potential ecological and economic benefits that can be realized from its success make the change absolutely necessary.

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TO OUR READERS

The Southwest Nova Biosphere Reserve took part in a meeting of 18 of 19 Canadian Biospheres.
In April, we will be hosting a joint meeting of the Atlantic Biospheres with Fundy Biosphere Region and Bras D'Or Lake Biosphere Region.
We value your readership and invite you to get in touch with our Editor at fernhillns@gmail.com.

Thank you, "wela'lioq"

The Atlantic Biosphere associations at the National Gathering February2023.
Photo credit: Canadian Biosphere Reserves Association

heath and white pines move in on an old orchard

Old field succession on the Annapolis Valley "Sand Barrens" (sandplain heathland). Each round clump is a new Broom Crowberry individual starting from seed to recolonize this heathland that had been an orchard in Kingston. Nina Harvey's MSc thesis (2022) at Acadia with Clean Annapolis River Project (CARP) shows large declines in this endangered heathland BUT also in the agricultural land base. Both landscapes were displaced by forest (see the white pines above) and housing developments. This project was among many funded through the Kespukwitk Conservation Collaborative (kswnsconservation.ca).