Ecological Assessment of the Plant Communities of the Williams Lake Backlands

A REPORT

to

The Williams Lake Conservation Company

by

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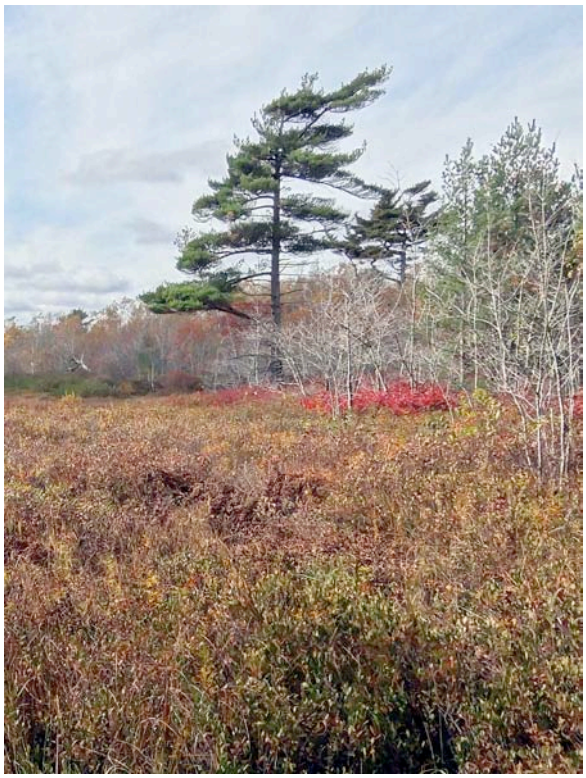

SUMMARY

The Williams Lake Backlands (WLB), covering approximately 200 ha, are the larger, undeveloped part of the Williams Lake Watershed which includes Colpitt Lake and Williams Lake. The WLB are part of "Purcell's Cove Backlands" (approximately the 1350 ha) which include the land between Purcell's Cove Road and Herring Cove Road from Williams Lake at the northwest end to Powers Pond at the southeast end. Lying only two kilometers from peninsular Halifax, the WLB are near pristine wilderness. We traversed various routes through the WLB on twelve separate days between May 13 and Nov. 8, 2013 to document plant communities and wetlands for the Williams Lake Conservation Company, a volunteer organization concerned with stewardship of the Williams Lake watershed.

The WLB present a mosaic of landscapes and plant communities associated with high variability on a fairly small scale in the topography, depth of soil/till, drainage and surface water storage and in the ages since disturbance of the associated plant communities. That variability in turn is related to the presence of glacially scoured hard granite outcrops of South Mountain Batholith, outcroppings of highly folded and metamorphosed Halifax Group black slates and siltstones of the Meguma Supergroup, a contact zone between the two rock types, and glacial till. Overall, the plant communities are those of nutrient-poor, acidic environments and of fire-, wind-, and pest-driven disturbance regimes within a moist temperate, coastal region. Exotic (non-native) species are found only close to roads and houses at the edge of the WLB. These are "old process" plant communities with a high degree of ecological integrity.

The fire dependent/fire adapted nature of the vegetation and carbon dating of charcoal from a core in a Jack Pine fen indicate that fires in the WLB are part of a long-term fire regime that predates European settlement. Indeed, the whole of the Purcell's Cove Backlands is one of the most fire-susceptible landscapes in Nova Scotia, the droughty, windswept high barrens acting as matchsticks. One result is the presence of an old process, fire dependent Jack Pine/Broom Crowberry Barrens community that is nationally unique to Nova Scotia, globally rare and of high conservation significance. In the northeastern U.S., this community transitions to the fire-dependent Pitch Pine/Broom Crowberry community which is well recognized as of high conservation value. The largest single patch of Jack Pine/Broom Crowberry Barrens within the Purcell's Backlands occurs within the WLB, and overall, the Jack Pine/Broom Crowberry Barrens in the Purcell's Cove Backlands are amongst if not the best, representatives of this community in Nova Scotia.

The water regime in the WLB has features of dryland systems, with intermittent stream courses probably accounting for a majority of the water flow. Critical components such as Mountain Holly washes, vernal pools and boulder fields are not currently protected under Nova Scotia wetland and stream course regulations but are vital to maintenance of the larger wetlands and water quality of both surface and groundwater in the area.

The undisturbed nature of this wilderness area, its mosaic of habitats with wetlands, lakes, streams, forest and barrens, and its location by the coast in the most urbanized area of the province make the WLB and the larger Purcell's Cove Backlands significant habitat for both breeding and migratory birds.

It is suggested that conserving the WLB and the larger Purcell's Cove Backlands as natural systems reduces fire risk to adjacent communities compared to allowing more intrusions into the backlands. Implementing strategies such as those promoted in the northeastern U.S. for living compatibly with fire-structured pitch pine ecosystems would enhance both fire protection for neighbouring communities and conservation of biodiversity in our backlands.

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APPENDICES

Photos posted online: http://versicolor.ca/wlbphotos

1. Introduction

In 2013, we conducted a survey of plants species and their habitats in the "Williams Lake Backlands" (WLB) in response to a request by the Williams Lake Conservation Company. Their interest was several-fold: (i) to contribute to their understanding of the Williams Lake Watershed & how it influences water quality of Williams Lake; (ii) to characterize the area in relation to efforts to see it formally protected & (iii) to document wetlands and other features that should be protected in the event some of the area is developed.

The WLB, approximately 200 ha in area, are part of the larger "Purcell's Cove Backlands" (approximately 1350 ha) which include the land between Purcells Cove Road and Herring Cove Road from Williams Lake at the northwest end to Powers Pond at the southeast end (Fig. 1.1).

There are two lakes within the Williams Lake watershed, Colpitt Lake and Williams Lake. The outflow from Colpitt Lake empties into Williams Lake. The northern shore of Williams Lake hosts moderate density housing which lies within the watershed. To date most of the new developments above and to the west of Colpitt Lake are outside of the watershed. Otherwise the large undeveloped area is urban wilderness.

Existing documentation includes:

- A detailed LIDAR-based hydrology map of the specific area prepared by Prof. Patricia Manual and colleagues at the School of Planning, Dalhousie University (Appendix A, Maps 1, 2)

- A report on "Vernal Pool Mapping in the Williams Lake Watershed, Halifax supporting small wetland identification in advance of development" by Huan Liu, conducted under the supervision of Dr. Patricia Manuel (Appendix A, Map 3; Liu, 2012).

- Nova Scotia Dept. of Natural Resources Geological and Surficial Geology Maps (Appendix A Map 4)

- Agriculture Canada Soils Map (Appendix A Map 5)

- DNR Forest Cover and Wetland Maps (Nova Scotia Dept. of Natural Resources) (Appendix A Map 6)

- A report on birds in the WLB was prepared for the Williams Lake Conservation Company by Fulton Lavender (2012).

The Purcell's Cove Conservation Lands, established under the aegis of the Nova Scotia Nature Trust, is the only formally protected area within the Purcell's Cove Backlands. This 35 ha area lies approximately 700 m southeast of the Williams Lake watershed (Fig. 1.1). A species list for that area was updated in 2012 (HFN, 2012). A photo-essay documenting recovery of vegetation in the Purcell's Cove Backlands over a year and a half after the Spryfield Fire of 2009 is also available (Beazley and Patriquin, 2010).

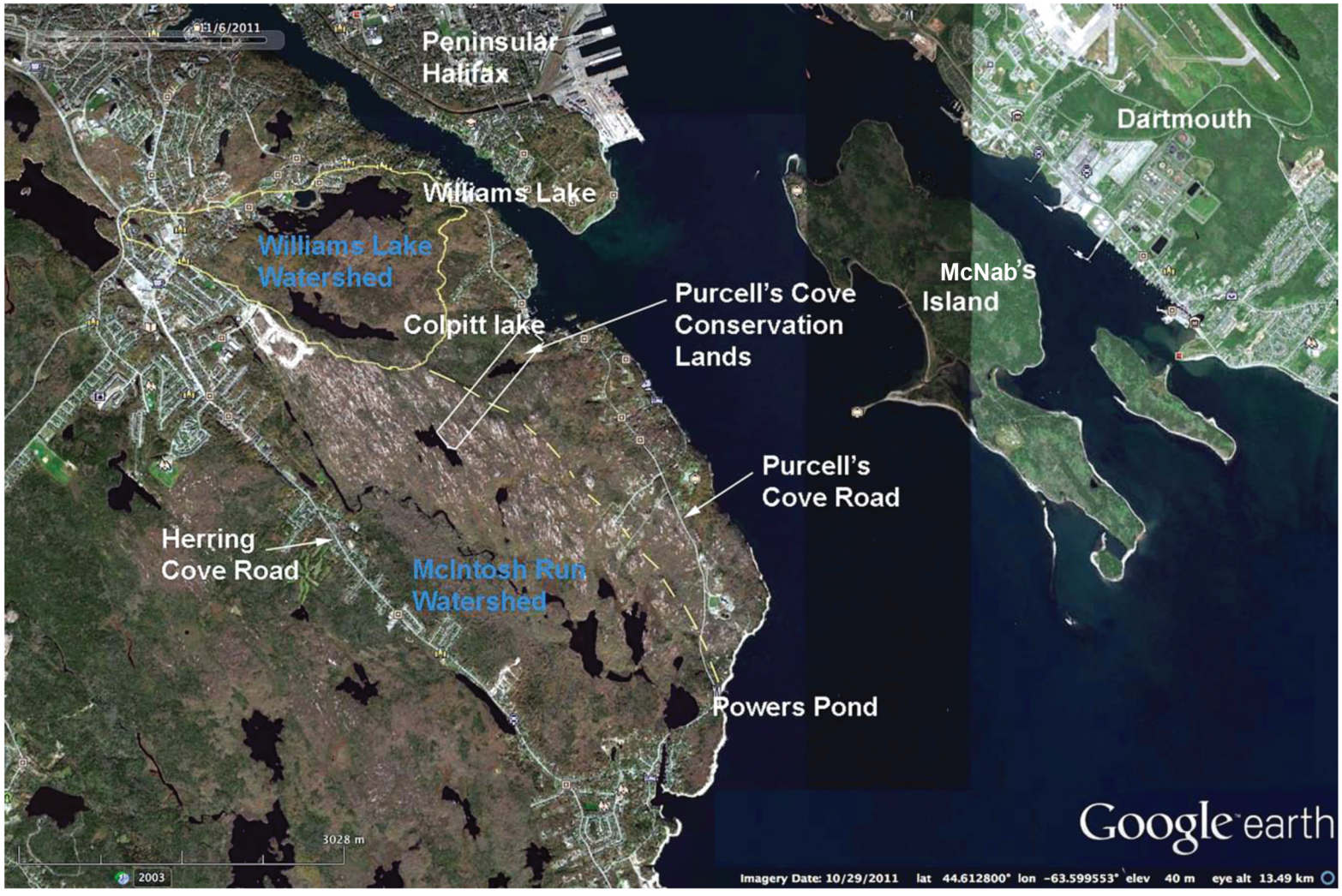

Fig. 1.1 Google Map showing Purcell's Backlands and major watersheds. The boundaries for the watersheds are approximate. Broken line marks eastern boundary of the McIntosh Run watershed.

2. Methods

We conducted surveys in the WLB on a total of eleven days between May 13 and Nov 8, 2013 (Fig. 2.1, 2.2). The surveys were of necessity semi-formal and largely qualitative, given the broad objectives, the limited time, funds and, except for the work of Prof. Patricia Manuel & colleagues on topography and hydrological features, the exploratory context of this study.

On May 13, 14, 31 our focus was on watercourses and wetlands which we wished to view while water levels were still relatively high. We entered via Purcell's Cove Road (May 12, 13) and Colpitt Lake Road (May 31), on the latter occasion with Patricia Manuel. (Dr. Manuel, a member of the Williams Lake Conservation Company and Professor at Dalhousie's School of Planning has conducted hydrological research in the area.) On Aug. 3rd we followed a route from Oceanview Drive almost due west to reach a "Jack Pine fen" close to Colpitt Lake which we had viewed on May 31; that route took us across higher barrens and lightly forested areas on granitic bedrock. On Sep. 12th, we followed a route from Purcell's Cove Road in the vicinity of Melvin Road across the drumlin by the SE side of Williams Lake, down into wetlands by Williams Lake. The initial part of this route lies within the "Purcell's Cove Watershed" (Appendix A, Map 1); the rest of it lies within the Williams Lake Watershed (as did all other sites that we visited). The route took us through upland hardwood forest and heathland as well as through lower lying moist forest and wetlands. On September 14th, we were accompanied by Tom Neily who would document sphagnum mosses, as well as some other mosses and lichens. We re-visited several of the larger or more interesting wetlands identified in previous excursions and we also went into the recently burnt barrens/high areas by the south side of Williams Lake.

On each of the surveys cited above, we documented the GPS location of every vernal pool/wetland encountered, the occurrence of stained leaves and plant species (particularly those diagnostic of wetlands) and, for many sites, the soil type (histosol or not) and depth to bedrock (sampled with an auger). Other relevant features such as the general topography of the surrounding area were noted. Approximately 20 wetlands were formally delineated. Other habitat types and associated vascular plant species, topographic features etc. were noted. Several thousand geo-referenced photos were taken for reference purpose. At two sites in the "Jack Pine Fen" close to Colpitt Lake, successive blocks of peat were removed from the surface down to the bedrock, and examined for the presence of charcoaled wood. One sample was sent to the Beta Analytic in Miami for carbon dating.

Additional surveys were made on May 20, Sep. 17, Oct. 4 & 22 and Nov. 6 & 8 (Fig. 2.2) by David P. to document vegetation in major landscape types identified on a Google Map that we hadn't covered previously and to obtain additional photo documentation.

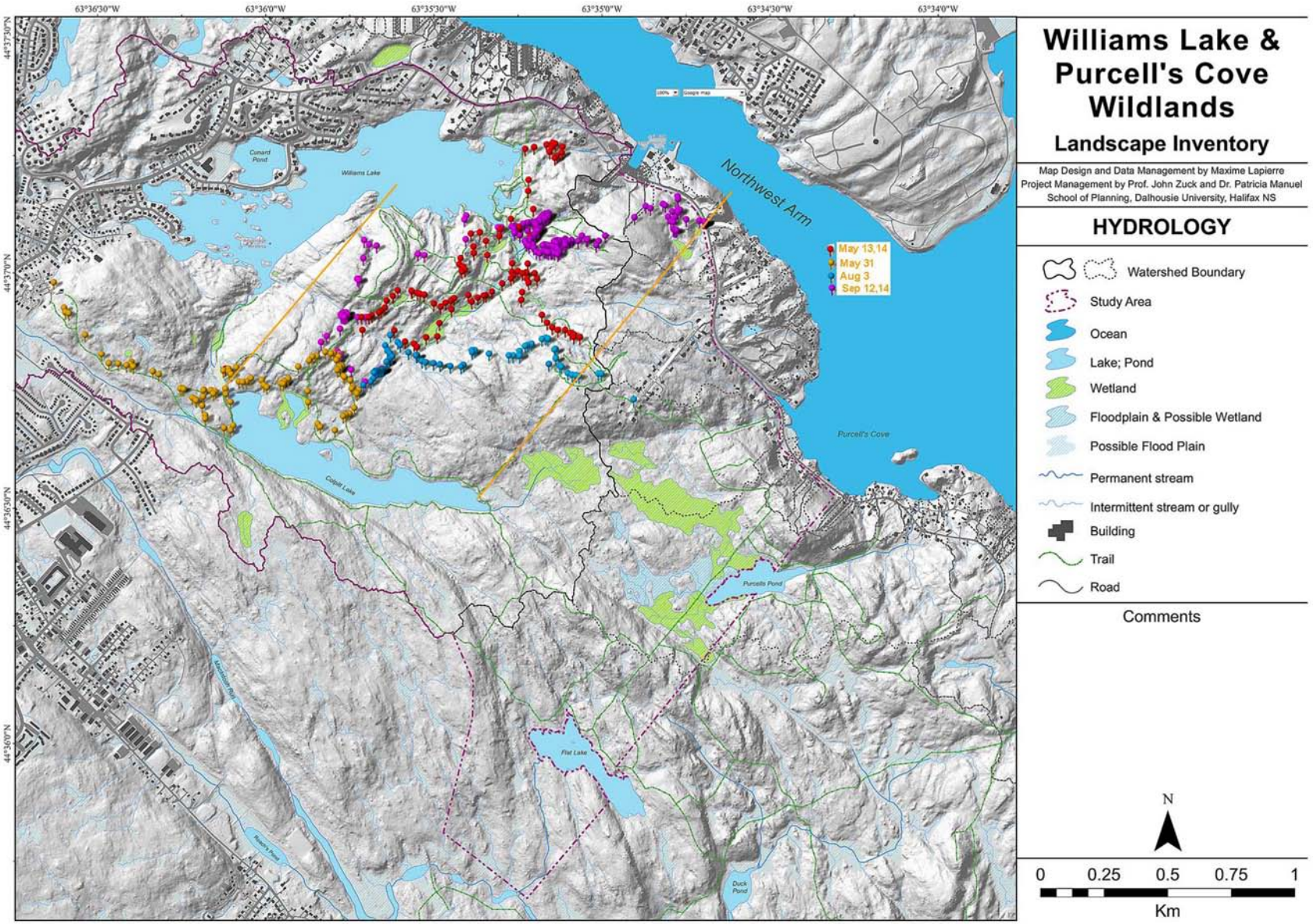

Fig. 2.1 Waypoints for the six surveys which included documentation of vernal pools.
The base map is courtesy of Professor Patricia Manuel, Dalhousie School of Planning. The waypoints were recorded for particular features including vernal pools, so are not exclusive for vernal pools.

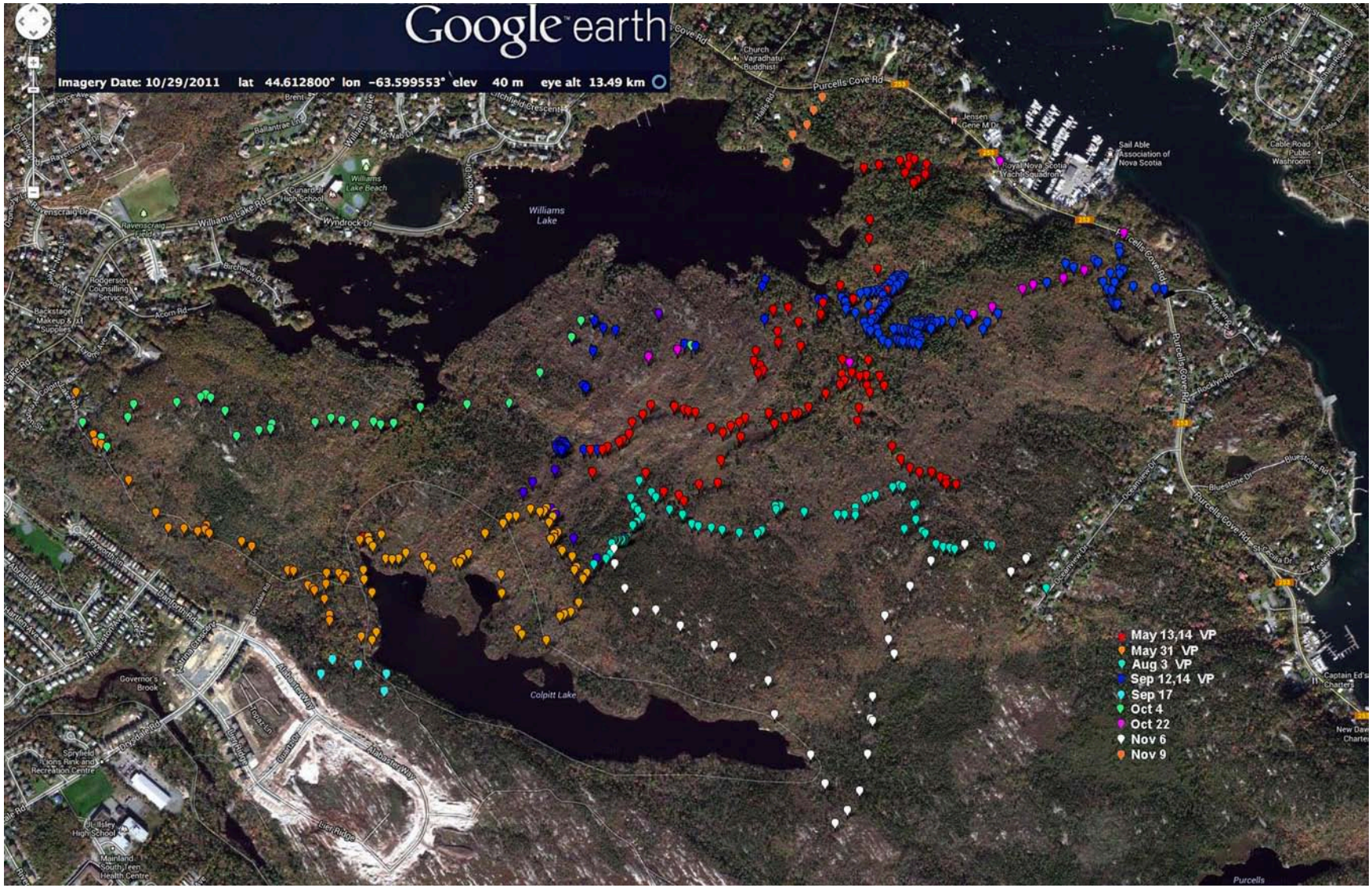

Fig. 2.2 Waypoints from all surveys on Google Satellite Map.

5. Upland Plant Communities

The upland plant communities of the WLB are classified into seven Vegetation Types (VTs, or BVTs for Backland Vegetation Types), described below. Species are cited by their common names. (See Appendix B for the Latin names.) The classification is our own but for the forest types, we identify analogues or near analogues to Nova Scotia Forest Vegetation Types (NSFVTs) elaborated by Neily et al. (2011) for stands of at least 40 years old. The names cite the most common vegetation, with a dash (-) between species of the same strata or growth habit, and a slash separating species of differing strata or growth habits, plus a higher level descriptor, e.g., forest or barren. They are ordered (1, 2 ,3…) from droughty to more consistently moist conditions. The species cited under each BVT are the more common ones.

The plant species of these upland communities are xerophytic (tolerating frequent or extended drought) to mesophytic (living in moderately moist soils and tolerating only occasional shortages of water) the former prominent in this landscape only in the barrens habitats.

UPLAND PLANT VEGETATION TYPES OF THE WILLIAMS LAKE BACKLANDS

1. Broom Crowberry-Blueberry/Lichen Barrens

The term "barren" is defined in the Collins Dictionary of Botany (Bailey, 2006) as:

> A COMMUNITY of relatively sparsely distributed plants that cover less than half the ground area. Such communities are typical of some fairly level parts of the Arctic tundra, often on sandy and serpentine soils. Barrens often have few trees and are dominated by a single species such as mountain avens (*Dryas octopetala*). The plants are often small and stunted compared to individuals of the same species from less infertile habitats, and they often contain groups of specialized endemic species.

Broom Crowberry (*Corema conradii),* a dwarf evergreen, needled, ericaceous shrub is the signature species of this community which occurs on rock outcrops, the woody species growing in thin soils and around crevices, and lichens extending onto bare rock. It is important to distinguish this species from Black Crowberry (*Empetrum nigrum*), and Red Crowberry (*Empetrum rubrum*) which also occur in Nova Scotia but not in the WLB. Other species include the perennials Lowbush Blueberry, Pinweed, Carex brûlé (or Crowded Sedge), Golden Heather, Teaberry, Three-toothed Cinquefoil and the annuals Mountain Sandwort, two panic grasses and the Hidden Sedge. Reindeer and rock tripe lichens and mosses, without vascular plants, often cover the most exposed rock. Reindeer lichens also occur mixed with Broom Crowberry. Huckleberry typically occurs towards the edges where there is more soil and moisture retention, with Broom Crowberry extending into its inner fringes.

This VT corresponds roughly to Coastal Barrens Dwarf Heath of Porter (2013) and the Low-shrub Coastal Communities of Cameron and Soren Bondrup-Nielsen (2013) with the notable distinction that Black Crowberry is entirely absent from the WLB, and probably from all of the Purcell's Cove Backlands (Halifax Field Naturalists, 2012; Beazley and Patriquin, 2010) because of the extreme

droughtiness of these barrens. Where these two species occur in close juxtaposition on a micro-scale in the Polly's Cove area, Broom Crowberry occurs in the drier, well drained area of a rock face, while Black Crowberry may sit in a slight depression in the same rock face (Nova Scotia Wild Flora Society: *Corema conradii*, n.d.). On inland barrens in southwest Nova Scotia, the *Corema conradii* community is "confined to the tops of knolls and ridges, all boulder-strewn and excessively well drained" (Strang, 1972).

2. Huckleberry Heath

"Heath" refers to land with poor, well drained soil dominated by shrubs of the heath family (Ericaceae). In the WLB, heath dominated by Huckleberry occurs where soil depth and moisture retention rise above levels in the Broom Crowberry-Blueberry/Lichen VT, but are not sufficient for trees and/or tree growth is restricted by repeated fire. Typically this community borders the Broom Crowberry-Blueberry/Lichen Barrens and extends over a few to tens of meters or occurs in large patches on fairly level but high ground in the midst of otherwise forested landscape. Common associated species include Lowbush Blueberry, Lambkill, Teaberry, and on deeper soils, Bayberry and Wild Raisin. In patches where drainage is impeded, Huckleberry is replaced by Rhodora and/or Leatherleaf. This Vegetation Type corresponds roughly to the High Shrub Coastal Heathland of Cameron and Soren Bondrup-Nielsen (2013).

3. Jack Pine/Broom Crowberry Barrens

In this VT, Jack Pine occurs (i) as single or a few gnarled trees growing in cracks on rock barrens, (ii) in smallish (10-50 m across) treed patches with Jack Pine alone or dominated by Jack Pine and (iii) in more contiguous, larger patches interrupted by rock barrens or wetlands. Tree canopy cover ranges from less than 10% percent to about 60%. Big-toothed Aspen is the most common other tree in most mixed stands, followed by Red Maple, Wire & Paper Birch, Red & Black spruce. (Additionally, Jack Pines occur singly and in clusters in the Red Pine/Jack Pine/Broom Crowberry VT, and isolated Jack Pines occur in the Birch/Maple/Aspen VT, usually adjacent to their occurrence on Jack Pine/Broom Crowberry Barrens.) Broom Crowberry and Huckleberry are the most common associated shrubs, the Broom Crowberry occurring in edge areas on shallower soils, often with Reindeer Lichen, while Huckleberry occurs on deeper soils, growing tallest (to circa 1.5 m) where there is more exposure to the sun. Sheep Laurel may also occur, and in wet pockets, Huckleberry is replaced by one or more of Leatherleaf, Rhodora, Inkberry.

The composition and site conditions for this VT are very similar to those for NSFVT OW1 (Jack Pine/Huckleberry/Black crowberry/Reindeer lichen), except that the latter cites Black Crowberry as characteristic, and Broom Crowberry occurring only occasionally. As well, the more fire-sensitive species listed under OW1 such as Hemlock and *Bazzania trilobata* (a liverwort) are not found in Jack Pine/Broom Crowberry Barrens in the WLB. Under the Canadian National Vegetation Classification system, many details of which are not yet publicly available, it corresponds to Subassociation A301b *Corema conradii*, in the Association A301 Jack Pine/Black Huckleberry – Black Crowberry/Three-toothed cinquefoil/reindeer Lichen

Woodland (S.Basquill, Nova Scotia Dept. Natural Resources, personal communication).

4. Red Pine-Jack Pine/Broom Crowberry Coniferous Woodland
This VT occurs on higher and sloping land with rock outcrops to the south of Williams Lake towards its western end. Red Pine, Jack Pine, Black Spruce, Big-toothed Aspen and Red Maple are the prevalent trees, with some Paper and Wire Birch, Tamarack, Red Oak and Mountain Ash forming a largely open canopy forest. In a few smallish areas, Jack Pine is the sole tree species.

Broom Crowberry forms a fringe around trees extending into the rock outcrops, displaced by Huckleberry where there is more soil. Other species include Wild Raisin, Bayberry, Lambkill, Ground Juniper, Lowbush Blueberry, Teaberry, Trailing Arbutus, goldenrods and in wet areas, Mountain Holly and Wooly Sedge. There are some large mats of reindeer lichen in quasi-shaded as well as exposed areas. The larger rock outcrops have smooth surfaces and are mildly sloping; they appear to be popular with mountain bikers, whose activities have largely bared the surfaces.

Many of the Red Pines were entirely dead, with more living or partially living specimens towards the east; the dead plants had been heavily bored. It seems this infestation has not yet affected red pines on land bordering the east and south east sides on Williams Lake.

This vegetation type approximates FECNS VT OW4 (Red pine-White pine/Broom crowberry/Grey reindeer lichen) with the notable difference that deciduous species are more abundant than described for OW4.

5. Paper Birch–Red Maple–Big-toothed Aspen Early Successional Forest
This early successional shade-intolerant hardwood forest occurs in patches and large sweeps throughout the area. It occupies most of the valleys in the set of NW/SE oriented glacially scoured ridges and valleys by Williams Lake. Paper and Wire Birches, Red Maple, Red Oak occur mostly as stump sprouts (in clumps). Some areas have prolific Big-toothed aspen which spouts from its extensive roots. There are scattered pines and spruces (Red and/or Black Spruce), few Balsam Firs. Lambkill and Huckleberry cover much of the ground between trees. Bracken Fern and Teaberry are common. This VT corresponds closely to NSFVT IH6 (Paper Birch – Red maple/Sarsaparilla – bracken).

6. Red Oak–Red Maple/Witch-hazel Hardwood Forest
This VT occurs in higher/better drained patches within the White Pine - Red Pine - Red Oak Mixed Forest VT, most significantly around and on the summit of the drumlin southeast of Williams Lake. Witch-hazel and some Shadbush form a subcanopy at 3-5 m height below Red Oak and Red Maple, Paper Birch, occasional White Pines and Spruce (Red and/or Black). Balsam Fir occurs in the shrub layer only. Lambkill and Huckleberry are common shrubs. Bracken Fern is common. This VT corresponds closely to the NSFVT IH2 of the same name (Red oak – Red maple/Witch-hazel).

Fig. 5.1 Upland Plant Communities. A: Broom Crowberry-Blueberry/Reindeer Lichen Barrens; Black Huckleberry (red) at border continues under Adjacent Birch-Maple-Aspen Early Successional Forest. B: Huckleberry Heath. C: Jack Pine/Broom Crowberry Barrens. D, E: Red Pine-Jack Pine/Broom Crowberry Coniferous Forest, Red Pines are partially or wholly dead.

6. Role of Fire in Structuring the Plant Communities

The fire dependent/fire adapted nature of the vegetation and evidence from cores in a Jack Pine fen indicate that the fires in the WLB are part of a long-term fire regime that likely predates European settlement. Indeed, the whole of the Purcell's Cove Backlands is probably one of the most fire susceptible landscapes in Nova Scotia. One result is the presence of fire-dependent Jack Pine/Broom Crowberry Barrens which are of conservation significance. The "fire story" has important implications in part because there is a common perception that fires in the backlands only began with European settlement. In this section, we elaborate on these concepts and the evidence for them.

6.1 Fire in Nova Scotian forests

Estimation of the natural frequency of forest fires in Nova Scotia has proved controversial, in part because of its bearing on forest management practices. Clearcutting is said to emulate the effects of frequent stand-replacing disturbances, notably fires in the boreal forest. Thus there is interest in the extent to which fires (or extensive hurricane blowdown which is often followed by fires) have structured Nova Scotian forests - such forests would be considered naturally suitable for clearcutting or "even-aged management", as opposed to selective harvesting or "uneven-aged" or "multi-aged management" which is considered more akin to natural processes in the "Acadian Forest".

There is general agreement that the frequency of fires in Nova Scotia increased very significantly over natural levels after the arrival of the Europeans.* It remained high until the mid to latter 20th century, when effective fire control and a much lower incidence of deliberately set fires reduced the frequency to low levels and possibly even below the natural frequency in some areas (Wein and Moore, 1979). Estimates (or opinions) of fire frequency in the mixed forest and tolerant hardwoods in which wind-driven gap dynamics constitute the major disturbance vary from several centuries to over 1000 years (Loo and Ives, 2003; Mossler et al., 2003).

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*The extent to which native peoples in Nova Scotia made regular use of fire as a land management tool in Nova Scotia is not yet clear (Wein and Moore, 1979; Loo and Ives, 2003; Mossler et al., 2003; Ponomarenko, 2006).

It is the estimation of the proportion of our forests which were subject to large scale, stand-replacing disturbances (mostly fire) in pre-European times that is controversial. Personnel in the Nova Scotia Dept of Natural Resources have estimated the proportion as follows:

> Fifty-one percent of the forested area evolved from infrequent and/or gap natural disturbance regimes and developed uneven-aged softwood forests of red spruce, eastern hemlock, and white pine or uneven-aged hardwood forests of sugar maple, yellow birch, and beech. **Forty-three percent of the forested area developed from frequent natural disturbance regimes giving rise to predominantly even-aged forests of balsam fir, jack pine, red pine, black spruce, and red maple.** The remaining six percent of the land area has site and climatic conditions that produce treeless barrens, wetlands, and rocklands, and krummholz. (Neily et al., 2008, bolding ours).

Others contend that the majority of the 43% of forest considered to be developed from frequent natural disturbance regimes has been made more fire susceptible by the post-European fire regime and clearcutting which has caused forests to be younger, with finer fuels, more fire prone in structure, with more resinous (coniferous) species.

> The pre-settlement forests of northeastern North America probably consisted of forest types that were much less prone to fire (Mott 1975; Anderson 1980; Anderson et al. 1986; Green 1987;Warner et al. 1991). Fires in these types of forests were probably restricted largely to surface fires, causing much less canopy mortality. For instance, the shade-tolerant hardwood forests characteristic of much of the Maritimes are not prone to crown fire disturbance. The present forest with its high percentage of a single conifer species is far more prone to destructive crown fires… The degree to which a steady-state, climax forest dominated the pre-European settlement forest of the Maritimes and the role of large-scale or catastrophic disturbances in interrupting the development of such OG forests will continue to be a matter of controversy and debate. Nevertheless, it is evident that the forest-disturbance interrelationships we see today are probably the result of the transformation of long-lived, disease-resistant, windfirm, less fire-prone pre-European settlement climax forests to shorter-lived, disease-, wind-, and fire-prone early successional forests. (Mossler et al., 2003)

From this perspective, it is argued that we should manage those forests to favour more longer lived, shade tolerant species and forests that are more resilient, more biodiverse and better adapted to our climate and to climatic warming than forests maintained by clearcutting (Bancroft and Crossland, 2008; Mossler et al., 2003).

There is agreement, however, between disparate camps that Jack Pine communities in areas such as the WLB are naturally fire structured while recognizing that human intervention increased the frequency above natural frequencies (Neily et al., 2008; Anon 2005):

> "Throughout Nova Scotia Loucks (1962) noted the presence of fire origin species such as jack, red and white pine, red maple, wire and Paper Birch, and red oak in his forest districts. Although he acknowledges that the occurrence of fire and its frequency has probably increased since European settlement the conditions conducive to fire are a product of the topography, soils and climate and that these conditions exist mainly in the lowland ecodistricts and western ecoregion. Fernow (1912) states "approximately one-fourth of the present forest area of the Province is semi-barren of commercial trees. This condition has been brought about by repeated fires in situations possessing naturally the coarser soils. Johnson (1986) states that "although most settlers tried to be careful with fire, burning only at what they considered to be safe times, fires often got out of control and burnt extensive areas". In the Atlantic Coastal ecoregion fires have been common but they appear to have been started by settlers to extend their pasture land (Loucks 1962). However, **the presence of Jack Pine in several places on the Canso peninsula, and on Isle de Madame, suggests that the constant winds may create a droughtiness that is conducive to fire.**" (From Neily et al., 2008; bolding ours.)

> "In my view, there are only a handful of site types in Nova Scotia where geomorphology, soils, climate, etc., create the conditions that permit the frequent, stand-replacing disturbance of ecological processes and hence produce a non-climatic climax or non-subclimax (eg. edaphic climax) vegetation. Some examples are: **Jack Pine on Target Hill and a few other prominent granitic knobs in Halifax County**; the pines on the sand plains of Annapolis Valley; black spruce-Jack Pine on the sand plain near Oxford; and balsam fir-Paper Birch on exposed spur ends in the steep-sided canyons of northern Cape Breton Island." (From Anon, 2005; bolding ours.)

FIRE TERMINOLOGY

Selected terms from Stacey et al., 2012**. European Glossary for Wildfires and Forest Fires** http://www.fire.uni-freiburg.de/literature/EUFOFINET-Fire-Glossary.pdf

Fire dependent ecosystem
An ecosystem which requires periodic fires in order to maintain the character, diversity and vigour of its intrinsic plant and animal communities. A fire dependent ecosystem will often be composed of pyrophile species (species that are able to survive wildfires and/or to regenerate after wildfires through germination stimulated by fire, stumps sprouts or aerial re-growth (i.e. broadleaved trees).

Fire dependent species
Plant and animal species which require regular fires in order to trigger or facilitate regeneration mechanisms, or to regulate competition from other species. Without fires, these species would become extinct.

Fire resistant plant
A plant species which has morphological or seasonal growth characteristics that give it a high probability of surviving a wildfire. Heat-insulating bark, seasonal dormancy, and the ability to regenerate through stump sprouts or aerial re-growth (broadleaved) are specific examples of fire resistant characteristics. [Sometimes used interchangeably with **Fire tolerant**.]

Fire sensitive ecosystem
An ecosystem with a low resilience to fire. Fire sensitive ecosystems will struggle to recover from the passage of a wildfire.

Fire sensitive species
Species with a relatively high probability of being killed or scarred if a wildfire occurs. Specific examples include trees with thin bark or highly flammable foliage, or animal species that are unable to evade the heat of a wildfire.

Fire regime
The pattern of fire occurrence, fire frequency, fire seasons, fire size, fire intensity, and fire type that is characteristic of a particular geographical area and/or vegetation type.

Fire types There are three different schemes for classifying fire type:

1. Classification of a fire or section of fire according to the fuel level within which it occurs. For example, aerial, crown, understory, surface and ground fires.
2. Classification of a section of fire according to its position along the fire perimeter. For example, head, tail and flank fires.
3. Classification of a fire or section of fire according to the visual characteristics it displays. For example, smouldering, creeping, backing, running, torching, spotting, crowning, fire whirl, convection driven fire etc.

Aerial fuels
Any fuel found at a height of more than 3.5 metres above the ground surface.

Crown Fire/Crowning
When a fire burns freely in the upper foliage of trees and shrubs. There are three different types of crown fires:

- **Active Crown Fire** – A fire that advances as a wall of flame engulfing all surface and aerial fuels.
- **Independent Crown Fire** - A fire that advances through aerial fuels only.
- **Intermittent Crown Fire** - A surface= fire involving torching behaviour but without sustained crowning activity. Rate of spread is controlled by the surface fire.

Ground fire
A fire burning below the surface fuel layer.

Surface fire
A fire that burns within the surface fuel layer.

Understory fire
A fire that burns beneath a canopy of trees. It can occur during the course of a wildfire or may be a tactic for a prescribed burn.

Prescribed burn A planned and supervised burn carried out under specified environmental conditions to remove fuel from a predetermined area of land and at the time, intensity and rate of spread required to meet land management objectives.

6.2 Recent fires in The Backlands

Fires since the early 1900s have included those listed below, likely amongst others.

2012: Approximately 15 ha on high barrens and associated forest/woodland on the south side of Williams Lake (see fire icons in Fig. 3.4) burned on May 21, 2012 before being doused by fire fighters. It was a stand-replacing fire in which aboveground portions of all trees and shrubs were killed. Our observations in 2013 indicate the hardwoods (birch, red maple, oak) promptly stump-sprouted, bushes such as Huckleberry and Rhodora grew up from underground rhizomes, while Jack Pines and Black Spruce and Broom Crowberry are regenerating from seed.

2009: The 2009 Spryfield fire burned an area reported to be approximately 800 ha in the Purcell's Cove Backlands. The northwestern extremity reached Jack Pine barrens just southeast of Colpitt Lake (Fig. 3.4), as revealed in a survey of that area on Nov. 6, 2013.

2006/2007: During a survey on Sept 12, 2013, we noted charcoaled debris on the ground and partially burnt white pines in an open area on top of the drumlin just to the east of Williams Lake. For the location, see Fig. 3.4. Inspection of historical imagery in Google Earth suggest the fire occurred between June of 2006 and July of 2000, most likely in the spring of 2007 which is a peak time for fires in Nova Scotia. The limited burn of the sparsely distributed trees suggest this was essentially a surface fire, and the Google imagery suggest it was limited to about 5 ha (Fig. 6.1).

1964: Residents in the Williams Lake area cite 1964 as the year of a fire in the backlands that extended into the forest on the eastern side of Williams Lake, sparing only the large red and white pines that today bear prominent fire scars at their bases.

Circa 1959: A local resident David P. met in 2009 while monitoring recovery of vegetation in the vicinity of Lower Mud Pond after the 2009 Spryfield fire told him that the last big fire in the Lower Mud Pond Area occurred 45 years prior to the 2009 fire, i.e. in 1959. (He recalled the fire from his childhood.)

1917: At a talk David P. gave to the Halifax Field Naturalists in 2010 about regeneration of forest and barrens after the Spryfield Fire of April 30, 2009, the late Jill Alexander, daughter of Captain Arnell, said the last big fire on the Captain Arnell property was in 1917. (The Capt Arnell property is one of two adjacent properties contributed to the Nova Scotia Nature Trust to form The Purcell's Cove Conservation Lands.)

Residents in the Williams Lake area commented that they report sightings of smoke in the backlands to fire department officials at least once a year. Often they are campfires that don't escape, sometimes they have required fire fighters to put them out.

Fig 6.1

Google Earth Images of the drumlin on three dates.

The distinct brown (bare) patch appeared between June 18, 2007 & July 27, 2007. In the Oct 14, 2010 photo, reddish coloration Is associated with huckleberry which recovers quickly after fire.

6.3 Modeling the fire risk

Ellen Whitman and colleagues applied a spatially oriented fire modeling approach to examine "Future Wildfire Risk in the HRM Wildland-Urban Interface Under Climate Change" and "Urban Forests And Hazard Management: Trade-Offs Between Wildfire Risk And Benefits From Trees In The HRM Wildland-Urban Interface" (Whitman et al., 2013). Spryfield and Beaver Bank were used as case study areas. They concluded:

> At present, WUI [Wildland-Urban Interface] wildfire risk is high, and modeling suggests that the severity of climate conditions for wildfire will increase in the future. This increase in fire weather will be offset by a shift from high-fire risk species in the AFR [Acadian Forest Region] to a deciduous, lower-fire risk community. This shift will be gradual, and may include intermediate periods of elevated wildfire risk in the mid-term. In the short-term the reduction of wildfire risk through fuel treatments should be the priority for management, but as wildfire hazard decreases with the changing forest community, priorities should shift towards the promotion of urban forests. To mitigate the removal of trees through fuel treatments, managers can plant low-wildfire risk tree species that are also adaptable to future climate change, under the recommendations of both *FireSmart* and the UFMP [Urban Forest Management Plan]. When given a spatial and temporal context the management trade-offs are easily navigated.

Whitman and colleagues did not discuss the possibility of zoning for no-build areas in the most fire-prone landscapes such as the WLB. The spatial modeling, detailed in a thesis by Ellen Whitman (Whitman, 2013), included the entire Williams Lake watershed, and utilized Fuel Codes of the Canadian Forest Fire Behaviour Prediction System, which is specific for different vegetation types including vegetation type similar to those in the WLB. We wrote Ellen Whitman to clarify some aspects of the modeling.

> David P. :
> I have been working with a colleague in the Williams Lake area to document possible conservation values. A highlight for us are the Jack Pine Barrens, which occur atop of ridges and scattered smaller outcroppings. They include a suite of fire dependent species including some rarities which can be described collectively as fire adapted and fire-dependent, and suggest a long history of fires probably dating well into pre-European times. We have some evidence for that from cores taken in a fen, but that needs follow up.
>
> There is rapid drainage of the Jack Pine Barrens and the lichens & litter and ground vegetation such as Broom Crowberry dry quickly providing good kindling. Thus we view the Jack Pine Barrens as "matchsticks" that increase the likelihood of fires over the larger area whether started by natural causes or humans. (A small fire occurred on the Jack Pine barrens by Williams Lake in spring 2012.)
>
> Would you concur with this view?
>
> Ellen W. :
> Your logic seems sound to me. The modeling I did assumed random ignitions all over the Spryfield study area, meaning that fires were dependent only on weather and fuels/landscape. Despite that randomness, large fires generally occurred much more often around the barrens, with some escaping downslope towards Purcell's Cove Rd., as has happened in the past two fires in that area. The Jack Pine and the dry brush are definitely a strong driver of fire in that area… I didn't try to focus on the Jack Pine barrens as a source of fires, the way you seem to be suggesting. I do, however think your 'matchsticks' idea is valid.

6.4 Vegetation-fire dynamics

The Williams Lake Backland landscape resembles a series of waves of windblown rock ridges that stretch in a northwest to southeast direction. The ridge tops are colonized by low bushy vegetation and some widely spaced, open canopy trees, while between the ridges, closed canopy forests develop on glacial till that is rich in cobble to boulder-sized material (Fig. 6.2) The plant communities that are adapted to such infertile, droughty conditions are highly flammable. The history of fire has led to a predominance of fire-adapted plant communities in the Backlands that differentiate it from plant communities bordering north side of Williams Lake. The upland plant communities in the WLB are dominated either by fire-dependent (notably Jack Pine and Broom Crowberry) or fire-adapted species (e.g.,White and Wire Birches, Big-toothed Aspen, Huckleberry). Non-adapted species (Hemlocks, Hobblebush, Yellow Birch, Sugar Maples and wildflowers such as Common Lady Slipper, Trillium, Cucumber Root) have long ago been selected against by fire, except by the wet corridor along the outflow stream from at the eastern end of Williams Lake and closer to houses where there is a higher degree of fire protection.

The most flammable vegetation is found on hard rock outcrops where glaciation has removed the till from the outcrops and left only occasional erratics. Between ridges, there is an accumulation of infertile till made less fertile by the predominance of cobble and boulders; these create fast surface drainage conditions selecting again for drought-tolerant vegetation. The infertility, acid conditions and droughtiness in the uplands, selects a stress-tolerant vegetation comprised for the most part of slow-growing woody plants. Extreme droughtiness leads to evergreen plants with inrolled leaves (the Broom Crowberry, Golden Heather and Jack Pine) as well as flammable reindeer lichens, and volatile oils and resins (in Huckleberry and Jack Pine) (Fig. 6.2). There is a smaller fuel load on the most exposed ridges but these areas dry out within hours in the sun and their fine tinder makes them the matchsticks that can spread fire through Jack Pine to paper birch stands and down to large White and Red pines closer to the lake.

Viewed in this context, the upland plant communities can be grouped in three classes going from those with species that are fire dependent, to a mix of fire-dependent and fire adapted species, and finally to the lakeside forest that lacks species that are highly sensitive to fires, with the more sensitive species found along stream corridors and in better protected areas near houses and roads.

WILLIAMS LAKE NORTH LANDCSAPES: Pine and Hemlock, Long-term residential.

WILLIAMS LAKE SOUTH LANDSCAPES: Rock Outcrops and Fire Dependent/Fire Adapted Plant Communities

Matchsticks: Fires may start in fine debris and dried vegetations of Broom-Crowberry (burned remains here) mixed with reindeer lichens and dead resinous Huckleberry leaves on rocky outcrops and moves by wind into communities with greater fuel loads

Fig. 6.2 Windblown rock ridges.

1. The Fire Dependent Outcrop Community

The Broom Crowberry-Blueberry/Lichen Barrens VT on the exposed outcrops is a fire-dependent community. It includes a guild of fire-dependent species, the signature species being the **Broom-Crowberry** (*Broom Crowberry conradii*), a dwarf evergreen, needled shrub. This is a globally uncommon (G4) species restricted to disjunct patches of fire-shaped landscape from the New Jersey Pine Barrens to Nova Scotia. It regenerates best after fire* and its occurrence in a landscape belies a history of fire (Martine et al., 2005). **Golden Heather** (*Hudsonia ericoides*) and **Pinweed** (*Lechea intermedia*) occur with the Broom-Crowberry and are members of the fire-adapted Rockrose Family (Cistaceae). This family is well-known for having seeds with a physical dormancy overcome by exposure to fire (Baskin and Baskin, 1998) and although there is no information on such a dependency in our Cistaceae in the Barrens, their seedlings were first to germinate after the Spryfield fires of 2009 (Beazley and Patriquin, 2010). Lastly, **Carex brûlé** (or Crowded Sedge, *Carex adusta*), the vernacular name accepted by Flora North America, is also known as the Burnt Sedge (Arsenault et al., 2013). This sedge requires disturbance such as fire that exposes mineral soil for it to establish and persist (Arsenault et al., 2013, Voss and Reznicek, 2012).

A guild of seed-banking annuals (Matlack and Good, 1990) to short-lived perennials take advantage of the fire disturbances. These species are not, in contrast with the above, necessarily fire-dependent though their recruitment at Williams Lake Backlands is restricted to these fire bald areas. These include the rare **Mountain Sandwort** (*Minuartia groenlandica*—S2), two Panic grasses (*Panicum depauperatum* & *Panicum acuminatum*), and a sedge (*Carex umbellata*).

Fire adapted Huckleberry occurs towards the edges of the Broom Crowberry-Blueberry/Lichen Barrens VT where there is more soil and moisture retention (the Huckleberry Heath VT) and continues as a carpet into the adjacent treed communities. Huckleberry *Gaylusaccia baccata*) with its with resinous leaves is not strictly dependent on fire, has been shown to become increasingly dominant after multiple fire in southwest Nova Scotia (Strang, 1972) because its rhizomes allow it to survive the most intense fires. It was one of the first shrubs to re-green the burned backlands landscape after the 2009 fire (Beazley and Patriquin, 2010).

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*Broom Crowberry vegetation is completely destroyed by most fires, but the plant survives by accumulating seeds in a below-ground seedbank. Seedlings are rare except after fires which stimulate germination by an as yet unknown mechanism but which may involve smoke rather than heat (Martine et al., 2005). Another oddity of this species involves seed dispersal. Broom Crowberry makes use of ants to move its seeds away from the parent bush. It equips each of its seeds with a fat-rich packet called an elaisome. The ants carry the seeds into their underground nests where they feed the fatty tissue to their larvae. The seeds are discarded but remain in storage around the nests until they germinate after a fire. Recent research has shown that without the ants, the population growth and survival of Broom Crowberry would be limited by lack of dispersal (Hilley and Thiet, 2013).

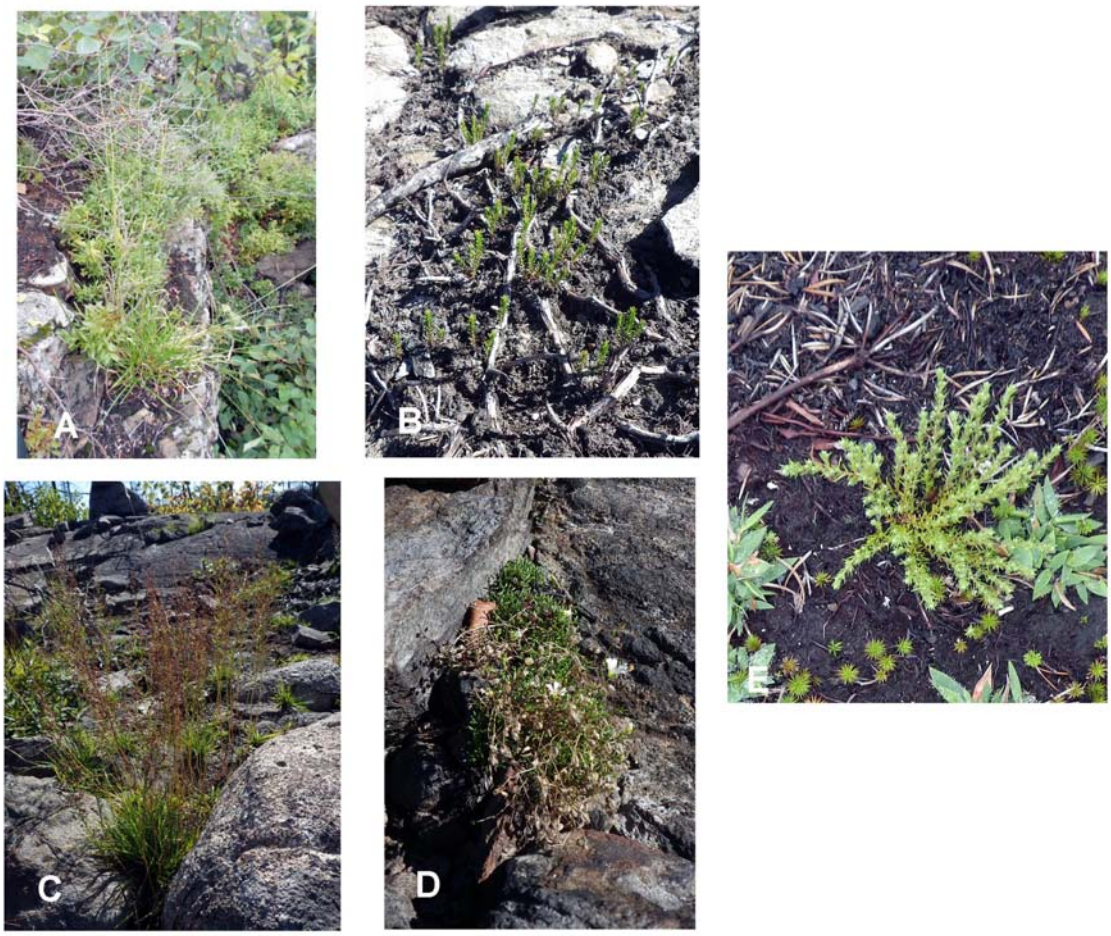

Fig. 6.3 Seedbankers establishing in fire-bared peat in an area burnt in 2012.
A Crowded Sedge, B Broom Crowberry, C Pinweed, D Mountain Sandwort,
E Golden Heather.

2. Fire-Dependent to Fire-Adapted Transition Communities

Immediately adjacent to the bare outcrop community are slopes that have developed a layer of dry peat humus on top of the same rocky outcrops and support the treed areas of VTs 3,4 and 5 (Jack Pine/Broom Crowberry Barrens, Red Pine-Jack Pine/Broom Crowberry Coniferous Forest, Birch-Maple-Aspen Early Successional Forest). Most prominent in the backlands is the fire-dependent, **Jack Pine** (*Pinus banksiana*) which is a short-lived, shade-intolerant pine growing in Nova Scotia on fire dominated, exposed rock along the Atlantic Coast and on sandy gravels in northwest Nova Scotia. This pine can withstand low-intensity fire but with time after a previous fire, flammability of Jack Pine stands increases and generates stand-replacing canopy fires which it survives through production of serotinous cones (Flannagan and Wotton, 1994; Carey, 1993). Temperatures of 50ºC degrees and higher, generated by crown fires are required to melt the resin and allow cones to open and release seed. This is a genetic condition; the proportion of trees whose cones must have fire to release seed reflects the fire history of the landscape. Serotiny levels in Jack Pine populations reflect the time since stand-replacing fires (Gautier et al., 1996). The New Jersey Pitch Pine Barrens populations are high proportion serotinous populations whereas populations in fire-suppressed regions (Givnish, 1981) or in barrens habitats in which stressors other than fire limit competition in the absence of fire (Conkey et. al., 1995) have low proportion of serotiny. In this regard, it is notable that counts made at five sites in the WLB indicate that the majority of Jack Pines were serotinous (>70% of cones completely sealed - Radeloff et al. 2004). Seedlings of Jack Pine begin to appear within a year after a fire, spurred on by the removal of competitors and release of nutrients following the fire.

Underneath these scrubby pines is a well-adapted deep rhizomed, heath community dominated by Black Huckleberry. Other deep rhizomed, fire adapted members of this community include Bracken (*Pteridium aquilinum*), Sheep Laurel (*Kalmia angustifolia*) and Lowbush Blueberry (*Vaccinium angustifolium*).

The Red Pine-Jack Pine/Broom Crowberry Coniferous Forest VT, dominated by Red Pine occurs in a very restricted area just to the southwest of Williams Lake. Red Pine is a species of the "Great Lakes - St. Lawrence Forest Region and in the southern sections of the Boreal Forest Region extending from southern Manitoba, eastward to Newfoundland, and as far south as West Virginia" (Flannagan and Woodward, 1994). It is adapted to surface fires of moderate intensity which suppress competitors, but regrowth after intense top-killing fires is dependent on reinvasion by seedlings from trees that escape fires (Bergeron and Brisson, 1990). Thus the limited presence of the Red Pine-Jack Pine/Broom Crowberry Coniferous Forest VT in the WLB is likely due to a relatively high frequency of stand-replacing fires.

Fire-Adapted stump-sprouting hardwoods of the Birch-Maple-Aspen Early Successional Forest VT grade into Jack Pine and Red Pine VTs. At high fire intensity, Jack Pine seeds survive in serotinous cones to repopulate the open charred landscape. At lower intensities and lower frequencies of fire, Jack Pine establishment is prevented by ground shading from vigorous stump sprouting hardwood trees and tall shrubs—primarily from the Paper Birch, Red Maple and Witherod (Wild Raisin) and, on some sites, Wire Birch and Big-toothed Aspen which regenerate quickly from buds on the root crown or roots. The short-lived

Paper Birch is a keystone plant of Boreal Forest regions that are prone to fire. Its extremely peeling bark— akin to the Eucalyptus spp.—is highly flammable and good tinder for putting succession back to regeneration (Fralish and Franklin, 2002). The Paper Birch trunk succumbs to the fire it brings on but fire produces a seedbed for the next generation of birch and the parent birch trunk base resprouts multiple times to resume its place.

The Red Oak–Red Maple/Witch-hazel Hardwood Forest VT is a bit of a special case, occurring around the top of the drumlin in deeper soil/ till than elsewhere in the WLB, but well drained and droughty as in VTs 1,2,3,4, 5. It's a typical situation for this VT which corresponds closely to the NSFVT IH2 of the same name (Neily et al., 2011). Red Oak withstands and benefits from surface (understory) fires which suppress competitors of Red Oak seedlings, especially on higher fertility sites, but it is killed by most canopy fires (Basquill et al., 2001, Dey and Fan, 2009). On the Drumlin, the Red Oak dominated stands merge into Birch-Maple-Aspen Early Successional Forest VT and thence open Huckleberry Heath which burned in 2006 or 2007 and are likely subject to intermittent surface fires.

In all of these burned VTs, there are few of the typical woodland wildflowers. In these hardwood "shrub savannahs", the most frequent herbs grew from tough (*Aralia nudicaulis, Gaultheria procumens*) underground stems. Long rhizome herbs were uncommon in upland (e.g. Wild Lily of the Valley and Starflower—*Maianthemum canadense*, and *Trientalis borealis*). Herbs with fleshy, short-rhizomed underground storage (Painted Trilliums, Lady Slipper Orchid, Cucumber Root, Twisted Stalk = *Trillium undulatum, Cypripedium acaule, Medeola virginiana, Streptopus roseus*) that are common in typical acidic woodlands in the HRM are absent.

An unbroken cycle of fire-regeneration-fire has wholly shaped every facet of these ecosystems.

3. The Lakeshore Pine-Oak Woods

As fire moves to the more sheltered areas, closer to Williams Lake, it passes through large individuals of White and Red Pine. Repeated fire appears to have reduced the surface fuel load to low levels in comparison with most Nova Scotian mixed forests. Fires that sweep down from the barrens and shrub savannah reinforce the fire-adapted membership of even these lakeside communities. Key signs are the near absence of the guild of fleshy forest herbs (see above) and the prevalence of Huckleberry and Wild Raisin in the understory shrub community. The large White and Red Pines have not escaped fire, rather they have been able, for the most part, to recover from fire injury. The predominance of flat-faced trunks with bark suture healing shows that these pines recovered after fire blistered their trunk in the direction facing the fire. The surviving cork cambium tissue on either side of the burned trunk face, grew laterally, and slowly covered the fire exposed wood. Photos show a gallery of both White and Red Pines in a sequence from full recovery to permanently scarred to succumbed to fire (Fig. 6.6). Wildflowers such as Common Lady Slipper, Trillium and Cucumber Root have long ago been selected against by fire. The more fire-sensitive trees such as Hemlock and Yellow Birch, and Hobble Bush are generally absent except by wet corridors and closer to houses where there is a high degree of fire protection.

Serotinous Cones of Jack Pine
do not open unless the cones are heated.

The Backlands have a Serotiny Index >74% which is similar to fire shaped landscape of the New Jersey Pine Barrens.

Fire-Dependent to Fire-Adapted Species

High proportion serotinous Jack Pine population = Fire-Dependent reproduction

Deep-rhizomed Black Huckleberry and Bracken Fern = Fire-Adapted

Stump sprouting Paper Birch (midground)= Fire-Adapted

Fig. 6.4 Fire-Dependent to Fire-Adapted Species

Fig. 6.5 Stump-Sprouting Scrub Savannah

The fire frequency may be lower in an area of boulder mounds. Here, high vegetation cover gives no gaps to allow Jack Pine seedling regeneration.

Fig. 6.6 Fire-scarred pines.
Most damaged trunks are surrounded by Black Huckleberry

6. 5 Fire record in the Jack Pine Fen

The prominence of Jack Pine and Broom Crowberry in the WLB, the perspective of foresters that such areas as naturally fire prone, and the modeling of Whitman and colleagues all suggest that while the frequency of fires increased with European settlement of the area, this is a naturally fire prone area and there is likely a longer history of recurrent fires in the area.

We looked to the fens for a possible record of pre-European fires. On our May 30th survey we found Jack Pine growing amongst sphagnum in a section of a fen near Colpitt Lake. Jack Pine–Broom Crowberry communities border the fen, thus we suspected that fires had swept right up to if not across the fen and that there could be record of such fires in the peat. Auger samples taken though the peat showed several layers of charcoal.

We went back to that fen on Aug. 3rd to more precisely document the occurrence of charcoal and to obtain samples for carbon dating. After removing the surficial, loose sphagnum, blocks of peaty substrate approximately 15 x 15 cm square were cut with a saw and laid out in pieces as they were removed from successively deeper layers. Any smeared surfaces were removed and then we looked for layers with darkened debris resembling charcoal. Such layers were cut out and placed in plastic bags. Later they were washed onto a sieve and darkened debris removed with forceps and stored in plastic bags in a freezer. Subsequently, we examined a subset of the samples submicroscopically under the guidance of Quaternary geologist, Dr. Ian Spooner (Acadia University), to distinguish charcoal from woody debris darkened by sulfides by their iridescence – this is more discerning for larger fragments, than smaller. Putative charcoal fragments, some together with what were clearly non-charcoal, darkened woody debris, were found in all of the 5 samples we examined, including some large fragments in the deepest sample. We sent 3 large fragments taken from the deepest sample (75 to 78 cm at site 1) to Beta Analytic in Miami for carbon dating. In their procedure, they confirmed the presence of charcoal and dated it at 1250 years BP +/- 50 years (Appendix D).

Table 6.1

Site:	**Site 1**	**Site 2**
Horizons with darkened debris (extruded)	13-22 38-44 38-43 46-50 66-70 75-78*	0-15 30-40 50-60
Total length of extruded chunks	90	85
Depth to rock base	83	75

*Charcoal fragments carbon dated

Since this sample came from close to the bedrock, it might be said that fires in the area go back to *at least* 1250 years. It is interesting that there were more zones of darkened debris at site 1 than at site 2. Site 1 was in a more restricted area with

more tree cover both in the fen and nearby than at site 2 which was at the edge of the open, non-treed area of the fen; thus it could be expected that fires would more frequently impact site 1 than site 2.

With a saw at hand for the peat cores, we also sawed a slice from the base of a Jack Pine at site 1 (Fig. 6.8) to obtain a disc for aging: dating showed the tree to be 44+/-1 years old (1959+/-1), quite similar to the reported time for a large fire in this vicinity cited above (circa 1959).

6.6 Fire intervals required to maintain Jack Pine and Broom Crowberry

Jack Pine and Broom Crowberry are quintessential "fire-dependent" species. Thus the occurrence of either species in abundance, and more so the two in combination, suggests a history of repeated fires at fairly short intervals.

To be sustained in abundance and as even-aged stands, Jack Pine stands require fire intervals that are not too long (roughly, in excess of 100-150 years) or too short (5-10 years):

> The minimum seed-bearing age of open-grown jack pine is 5 to 10 years. Some seed is produced every year and serotinous cones accumulate in the crown… Jack pine begins to show signs of decadence by age 75 [17], decreases in frequency by 150 years, and may disappear completely after 200 years [13], although some relic jack pine survive nearly 250 years [40]. In the absence of fire, jack pine is succeeded by longer lived species such as red pine (P. resinosa) or white pine, or by more shade-tolerant species such as balsam fir and black spruce (Picea mariana). Black spruce, which often seeds in at the same time as jack pine, grows slower but lives longer, becoming codominant after 90 years and eventually succeeding jack pine [16,40,42]. On the driest, harshest sites, jack pine may persist and form an edaphic climax [67]…
>
> Fire regime: Estimates of fire intervals in jack pine forests are generally less than 50 years [40]. Based on jack pine fire scars, the shortest and longest times between major fires in jack pine forests of northern Ontario were 5 and 30 years, respectively [50]. The mean fire return interval for jack pine forests in the Athabasca Plains in northern Saskatchewan and northeastern Alberta is 38 years [16]. Large upland ridges and ridge complexes, far from natural fire breaks, burn most frequently. Jack pine forests that burn more frequently than every 5 to 10 years become pine barrens [31]. Major stand-replacing fires in the Boundary Waters Canoe Area occurred in years with summer droughts [40].
>
> The accumulation of litter and debris on the forest floor over time increase the likelihood of moderate- or high-severity fire [40]. A lichen mat, a highly flammable and continuous fuel source at ground level, develops within 40 years and is important in supporting fires in jack pine forests [16]. [See Fig. 6.9]
>
> _____
> Source: Carey (1993)

> Fire intervals, the time between fires on the same area (26), have been calculated for jack pine in various locations. In the Boundary Waters Canoe Area of Minnesota, fires burned over the same area an average of every 6.1 years between 1727 and 1972 (21). Before settlement (1727-1868), the average fire interval in this area was 4.3 years with 21 to 28 years between major fire years (21). Eighty-four percent of the 532,000-acre land area burned during these major fire

> Years. Heinselman (19) believes that jack pine barrens on sandy plains experienced light, surface fires as often as once every 15 to 30 years throughout jack pine's range. In lower Michigan, Simard and Blank (32) found a 28-year average fire interval between 1830 and 1980. Before settlement (1830-1849) the average interval was 27 years and dropped to 10 years during settlement (1850-1909).
>
> With initial suppression efforts, the period lengthened to 18 years and is now about 30 years. Major fires now occur an average of once every 28 years.
>
> _____
> Source: Rouse 1986

Whether local extinction of Jack Pine Crowberry occurs under longer fire intervals (e.g., 100+ years) depends on spatial factors as well as fire intervals (Le Goff and Sirois, 2004).

Like Jack Pine, Broom Crowberry is largely restricted to habitats historically subject to repeated fire and declines in abundance have been related to fire suppression (Martine et al., 2005; NatureServe, 2013). Martine et al. (2005) reviewed literature and conducted observations related to regeneration of Broom Crowberry after fire. Typically plants are completely killed by hot fires, but such kill-off is followed by high seedling recruitment from the buried seedbank the following year.

> To summarize, populations of Corema conradii that experience an intense fire show a number of common responses. One immediate response is the death of the adult plants. This culling can be so effective that local populations may appear to have been extirpated. A longer-term response is the emergence of many new seedlings in the years immediately following an intense fire. The stimulus that fire provides to cue or condition the seeds to germinate is not known. One consequence of mass mortality in adult plants and the subsequent emergence of a new cohort of juvenile plants is the production of uniformly aged subpopulations.

High seedling recruitment of Broom Crowberry was likewise noted in local barrens after the Spryfield fire of 2009 (Beazley and Patriquin, 2010), and in the fall of 2013, we noted high seedling densities in barrens by Williams Lake that burned in May of 2012 (Fig. 6.9).

Martine et al. (2005) discuss the dynamics of Broom Crowberry populations in relation to life history characteristics, in particularly the species' dioecious habit (separate male and female plants), its spreading growth habit, a juvenile growth stage (without reproduction) of 5-10 years, growth and reproduction over 10 to 25+ years, senescence after 25+ years and die-off after 40-50 years. They suggest that longer delayed (e.g. 30+ years), very intense fires may completely wipe a population. Shorter interval fires, being less intense, may be less damaging, but a moderately intense fire that stimulates recruitment followed by a second fire in less than 10 years (i.e. before they begin to set seed) could again wipe out a local population. Thus, broadly, the "desirable fire interval" for Broom Crowberry, circa 10-50 years, corresponds to intervals cited as favouring Jack Pine.

The frequency of recent fires noted under Section 6.2 suggests frequencies in that range, and likely explains the relatively healthy nature of the Jack Pine and Broom Crowberry populations in the WLB.

Our observations of charcoal in the fen suggest a history repeated fires going back at least 1250 years. Based on the occurrence of six distinct charcoal horizons at Site 1 above with the oldest dated 1250 years, we might estimate the historical frequency as considerably longer than 10-50 years but it is likely that the less intense or extensive fires are not reflected in that record. As well, our separations of charcoal layers, conducted visually in the field, were rather crude and more precise studies could reveal a greater frequency of charcoal in the fen record. On the other hand, it's possible that Broom Crowberry, whose recruitment can be stimulated by disturbances other than fire (Martine et al., 2005), would survive intervals longer than 50 years regardless of fire on the most exposed barrens areas (Burley and Lundholm, 2010; Porter, 2013; Strang, 1972). Likewise, while the serotony ratio was high for Jack Pines in the WLB, it was not 100%, and there could be some recruitment of Jack Pine over longer intervals into barrens habitats in which other stressors limit competition in the absence of fire (Conkey et. al., 1995). So while the current abundance of Broom Crowberry and Jack Pine likely reflect fairly short intervals (10-50 years) between fires, they may also have persisted over longer intervals (but probably less than 200 years) in the rock barren habitats in pre-European times.

Fig. 6.7 Searching for a record of historical fires in a Jack Pine fen.

Fig. 6.8 Aging a Jack Pine at Site 1.

Dimensions of the disc were 8.35 by 6.7 cm for this approximately rectangular disc, average 7.5 cm (3”). Ring counts were my 42, 44, 45, 46 and 47, 44, 44, 40 (two observers), average 44.

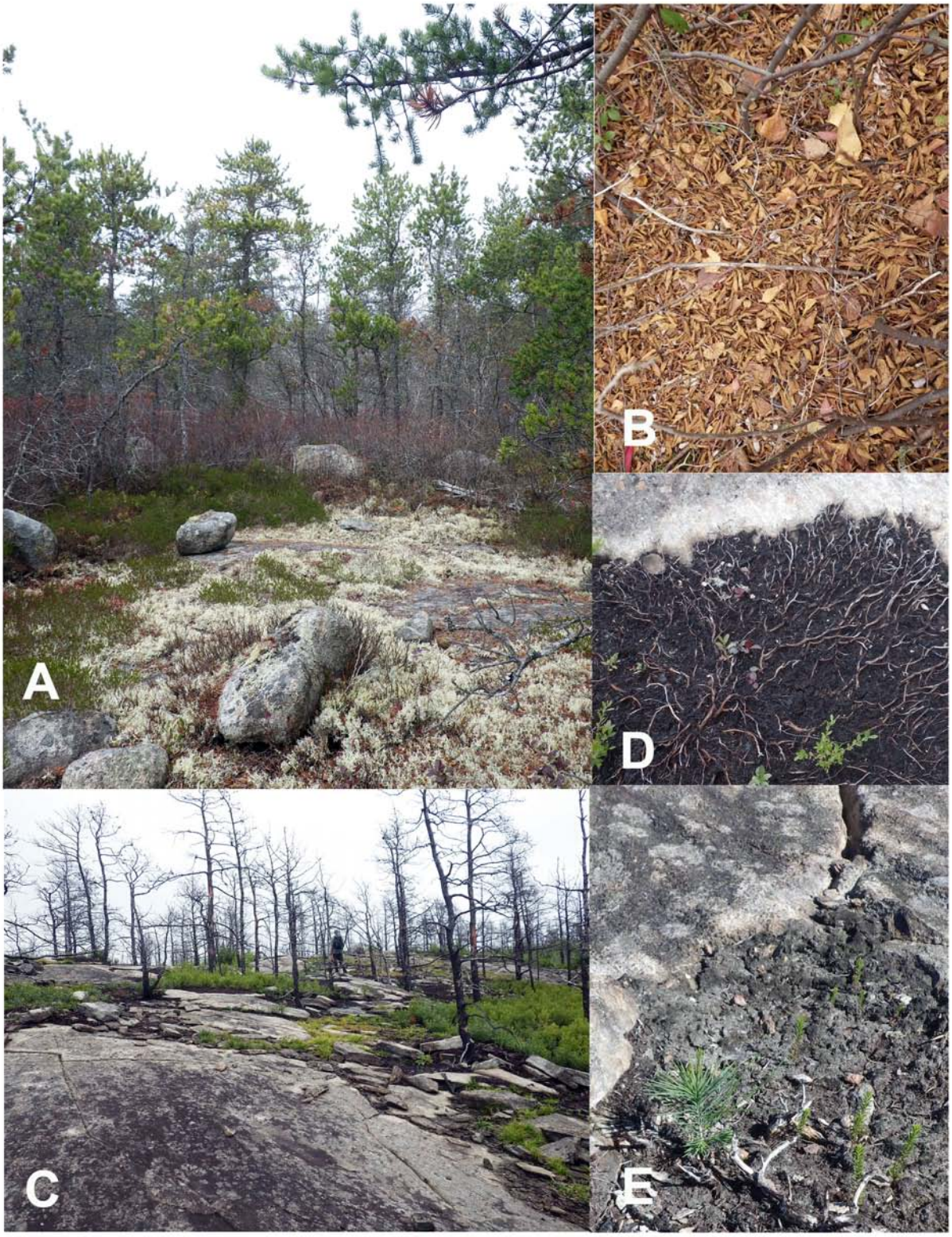

Fig. 6.9. Pre and Post-Fire scenes in Jack Pine/Broom Crowberry Barrens.

A. Jack Pine, probably 30-40 years age. Dead lower branches create ladder fuel. Reddish hue by trees is huckleberry with its last leaves on Nov 6, 2013. Lichens in the foreground form paper-like fire starter materials when dry. B. Twigs and resinous leaves accumulate as kindling under Huckleberry. C. Jack Pine barrens that burned May 21, 2012, viewed Sep.14, 2013. Huckleberry under the dead trees; some sedges can be seen closer to bare rock. Note charred areas on the rock surfaces once covered with lichens. D. Dead branches of broom crowberry after 2012 fire, viewed Sep.14, 2013; blueberry has spouted from rhizomes deeper in soil. E. Seedling of Broom Crowberry, and one seedling Jack Pine in area burnt in 2012 fire, viewed Oct 4, 2013.

8. The Case for Conservation

The WLB and the Purcell's Cove Backlands more broadly present a Thomsoneseque Wilderness close to peninsular Halifax and minutes away from moderately dense residential and commercial settings along Herring Cove Road from smaller neighbourhoods along Purcell's Cove Road. There is pressure to develop more of the area. From an ecological perspective, there are substantive reasons to protect the area, one of which is that it hosts rare, fire-dependent plant communities and species. In turn, recognition that the area is one of the most fire-susceptible landscapes in Nova Scotia and management to reduce fire risk to adjacent communities has benefits for both conservation and fire control.

8.1 Prime ecological values

We suggest three aspects of the WLB make them prime candidates for conservation from an ecological perspective.

(i) The Jack Pine/Broom Crowberry Barrens

The combination of Jack Pine, an iconic boreal species, and broom crowberry, an Atlantic Coastal Plain dwarf shrub of the heather family, is found within Canada only on scattered rocky outcrops near the Atlantic coast of Nova Scotia. It occurs only sparingly in similar habitats in Maine, where it overlaps with the globally rare Pitch Pine/Broom Crowberry association. Nova Scotia's Jack Pine/Broom Crowberry Barrens are likewise globally rare (Appendix C).

Coastal ecosystems at large are the most modified of all Nova Scotian and North American systems because 80% of roads and development are focused here. The **Jack Pine/Broom Crowberry Barrens** are particularly vulnerable, and so especially rare, because they are slow-growing, stress-tolerant, evergreen communities. These are most susceptible to all of the suburban modifications: nutrient enrichment, increased pH (from pavement, concrete and imported gravel beds and soils) and increased disturbance.

This stress-tolerant barrens ecosystem hosts, in addition to the Jack Pine and Broom Crowberry, three slow-growing, rare plants: the Mountain Sandwort (S2), Golden Heather (S2) and Lesser Brown Sedge (S2/S3). Broom crowberry has S4 status in Nova Scotia, but is precarious outside of Nova Scotia. The WLB Jack Pine/Broom Crowberry Barrens is a rare ecosystem with stress-tolerant plants that have survived only because the area escaped development.

A variety of open canopy, fire structured pine barren and pine savannah communities involving a dozen plus species of pine occur across North America (Anderson et al., 1999). Historically these ecosystems have been reduced to a few percent of their original extent through settlement and agriculture and, in the last 50-100 years, through conversion to other vegetation types as a result of fire suppression. Today, conservation of as much as possible of the remaining intact areas is a priority of many agencies and communities.

> "Northeastern U.S. pine barrens are globally rare, pyrogenic, early-successional habitats that support rich and unique assemblages of rare and declining biodiversity" (Gifford et al., 2010)

In Nova Scotia, the sandy pine barrens of the Annapolis Valley, in which broom crowberry is a signature component, have been reduced to less than 3% of their original cover through settlement and agriculture (Carbyn, S. et al. 2006.). Our rocky Jack Pine/Broom Crowberry Barrens are being whittled away by development, a prime example being the loss of jack pine barrens to the development at the edge of the Williams Lake Backlands (see Landscape in Transition at http://versicolor.ca/transition). Also, barrens close to settled areas tend to be favourite sites for Mountain Biking and ATVs, both of which, if not focused on specific trails, are very destructive of barrens habitats.

The Jack Pine/Huckleberry/Broom Crowberry Barrens of the WLB and the larger Purcell's Cove Backlands are amongst the most healthy and locally abundant of this community type in Nova Scotia (Appendix C.) Clearly, the Jack Pine/Huckleberry/Broom Crowberry Barrens of the WLB and as much as possible of the larger Purcell's Cove backlands deserve protection. Nature Trust's Purcell's Cove Conservation Lands, an 35 ha strip of land just to the south of the WLB represent a significant first step. Protecting all or most of the WLB (approx 200 ha) would be a substantive second step.

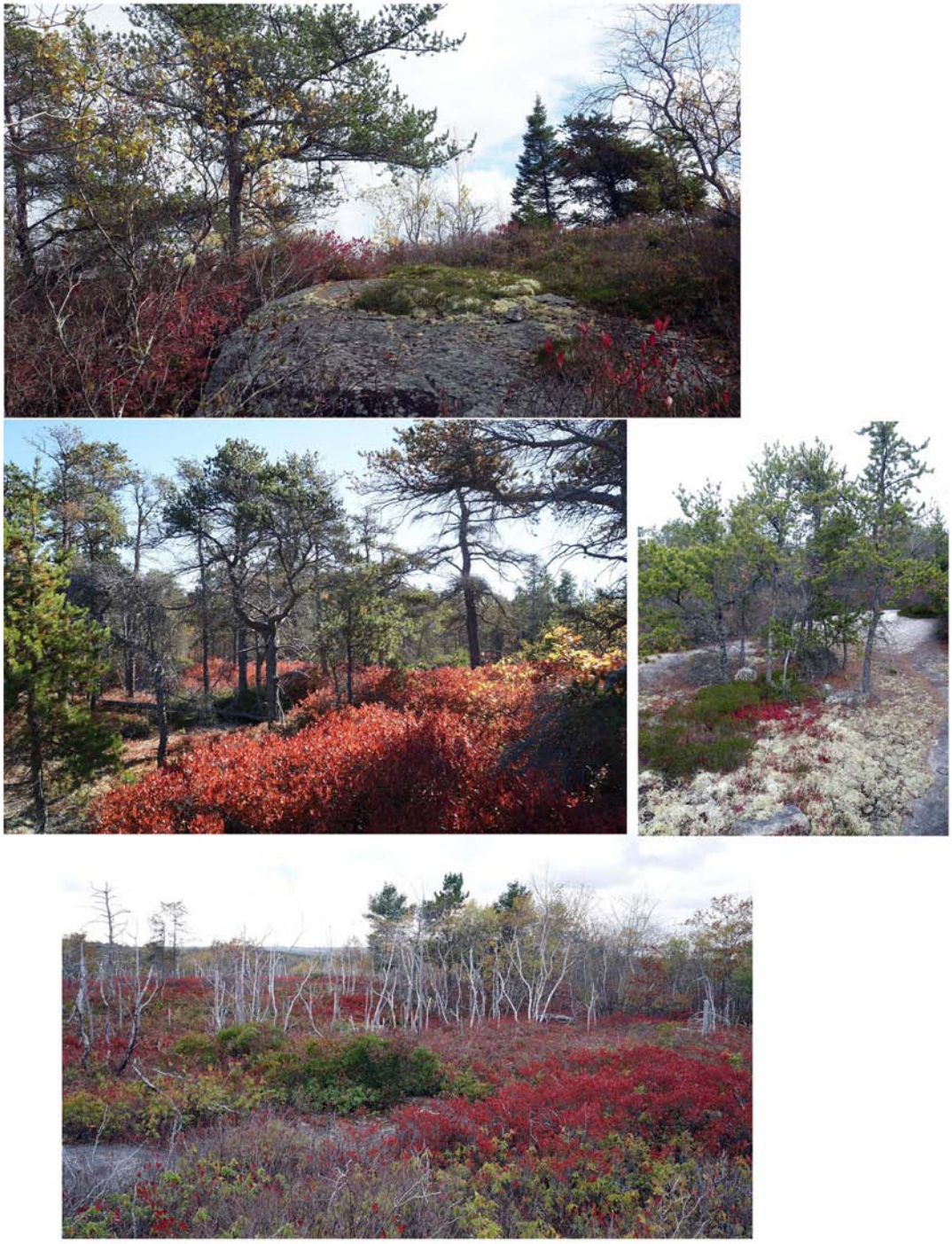

Fig.8.1 Fall in the Jack Pine/Broom Crowberry barrens (top 3 pics) and heathland on top of the drumlin that burned in 2007.

Losing such areas would be a conservation loss on a North American scale but the loss to aesthetics, recreation and ecological services would be ours alone.