Sections on Water channels & Wetlands in:

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).

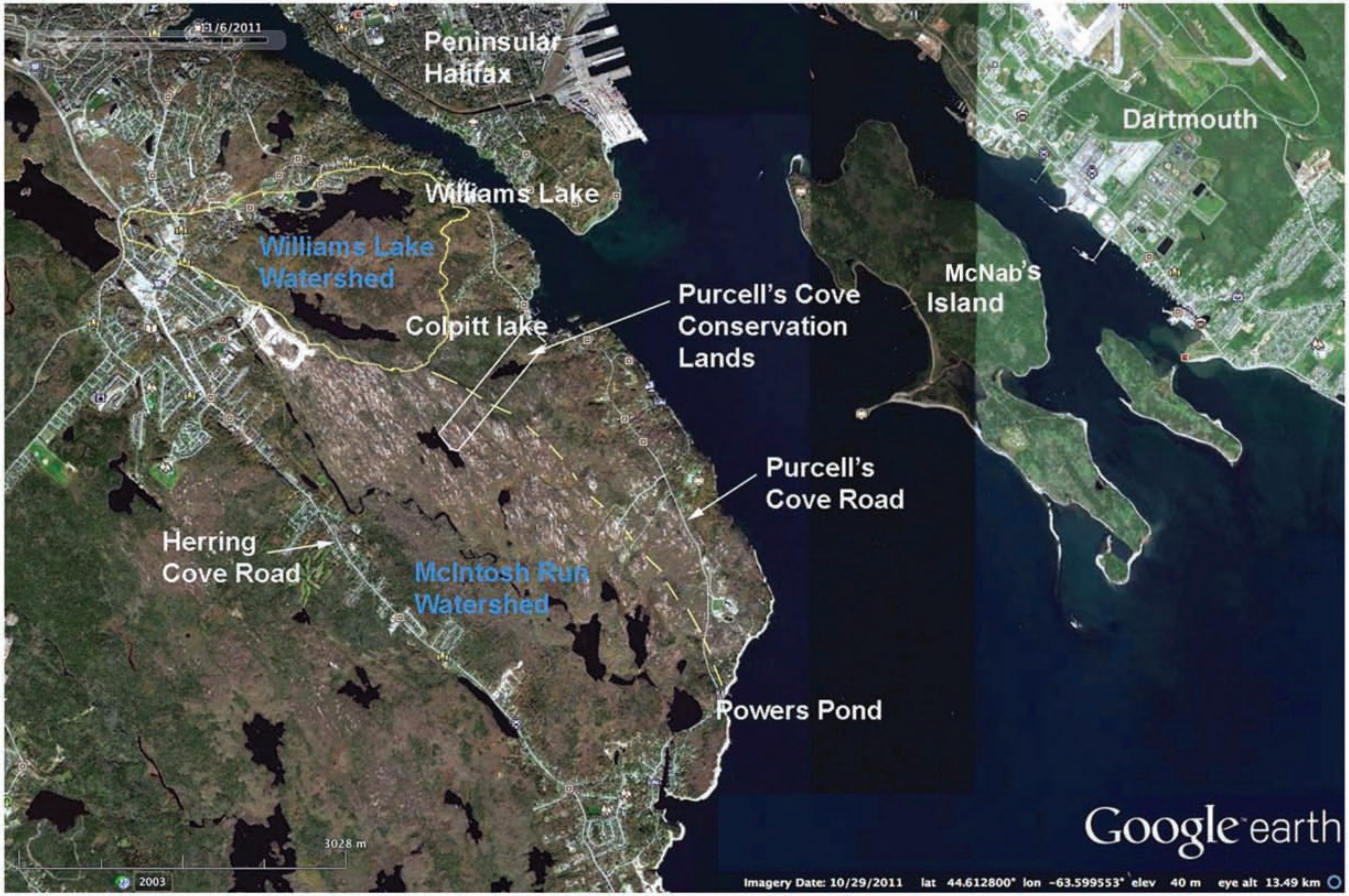

Fig. 1.1 Google Map showing Purcell's Backlands and major watersheds. The boundaries for the watersheds are approximate. Broken line marks eastern boundary of the McIntosh Run watershed.

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.

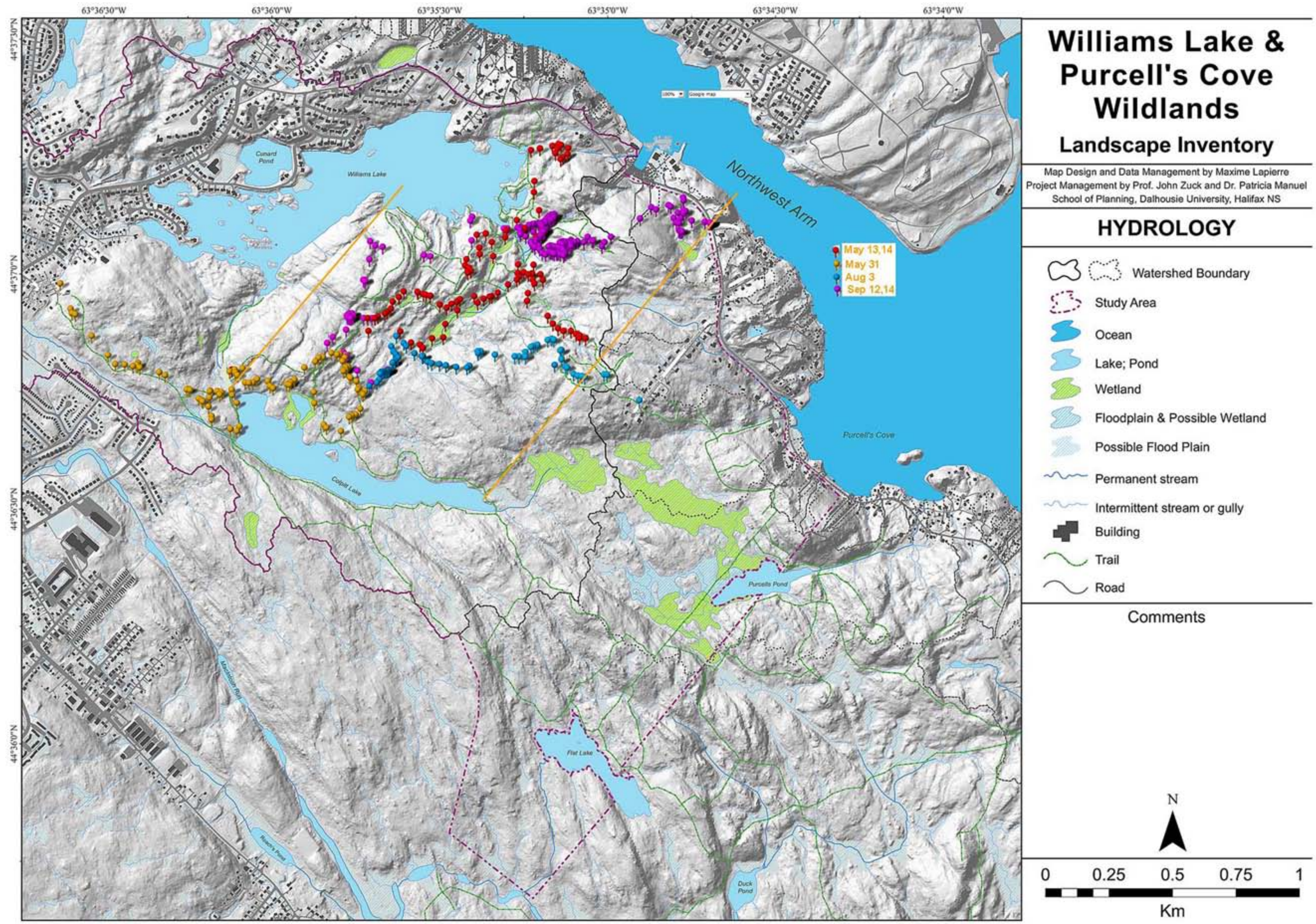

Fig. 2.1 Waypoints for the six surveys which included documentation of vernal pools.
The base map is courtesy of Professor Patricia Manuel, Dalhousie School of Planning. The waypoints were recorded for particular features including vernal pools, so are not exclusive for vernal pools.

7. Water Channels to Wetlands

The parent materials at Williams Lake include massive rock outcrops (Fig. 7.1), erratics and boulder fields and a very limited supply of any finer glacial till. The urban analogy to this natural landscape is a hardscaping of the impervious surfaces of paved surfaces and buildings. Unlike the urban analog, the WLB ecosystems regulate and filter run-off and deliver purified water to Williams Lake.

7.1 The landscape components of water regulation & filtration

The following is a description of three major components of the regulation and filtration system that has developed from weathering and the adaptations of biological communities in the WLB.

I. Run-off from ridge tops

Run-off from ridge tops and outcrops is immediate. Light rains are absorbed by a cryptobiotic community of crustose of fructicose lichens (Fig. 7.2) that had been in a desiccated state of life (anhydrobiosis).

II. Run-off channels: boulder fields and washes

During intense rainfall, water sheets off ridges and outcrops and takes one of two routes.

(i) Run-off in higher slope areas: **Boulder Fields** in ridge coves

(ii) Run-off in moderate to gentle slope areas: **Washes**

Neither of these are traditionally recognized WETLAND types, however, both are critical areas to maintain effective flood control in this natural hardscape.

Boulder Fields

Boulder Fields (Fig. 7.3, 7.4) are not wetlands but harbour an underground stream network. Water can be heard gurgling below surface after rainfall and in fall and winter, they may partially fill with water.

Our reference to "boulder fields" is primarily to the visually striking, rather stark appearing boulder fields with large, very angular (not rounded) boulders, mostly free of any vegetation except for a few mosses and lichens (Fig. 7.4). They are prominent features in the areas of black slates of the Halifax Series. Marcos Zentilli remarked that the scarcity of biotic cover on the boulders could be due to chemical acidity of these commonly sulphide-rich, rocks.

These types of boulder fields might better be referred to as "block fields" which the U.S. Natural Resources Conservation Service defines as:

> A thin accumulation of stone blocks, typically angular, with only rock fragments in the upper part, over solid or weathered bedrock, colluvium, or alluvium, without a cliff or ledge above as an apparent source. Block fields occur on high mountain slopes above tree-line, or in polar or paleo-periglacial regions; they are most extensive along slopes parallel to the contour; and they generally occur on slopes of less than 5%. Synonym – felsenmeer. Compare – block stream, talus slope, scree slope. (NRCS, n.d.)

Elsewhere, in the areas of granitic rock, boulders in somewhat similar accumulations are more rounded, and there is more cover by mosses and bushes in exposed areas than you see in the areas of Halifax Series bedrock, but otherwise the accumulations are similar to those described above. Most stream courses are lined by boulders, and much of the terrain with tree cover is bouldery underneath as well as on top. The WLB are a bouldery landscape (Fig. 7.5). Some of these latter accumulations may be more of the nature of talus slopes.

The role of boulder fields in relation to wetlands and watercourses is only now being addressed. A recent publication by Lichvar et al. (2012) of the U.S. Army Corps of Engineers, "Testing Wetland Delineation Indicators in New England Boulder Fields" examines properties and functions of boulder landscapes similar to those found in the WLB.

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

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

Fig 7.1 Ridge and valley system overlooking south side of Williams Lake.

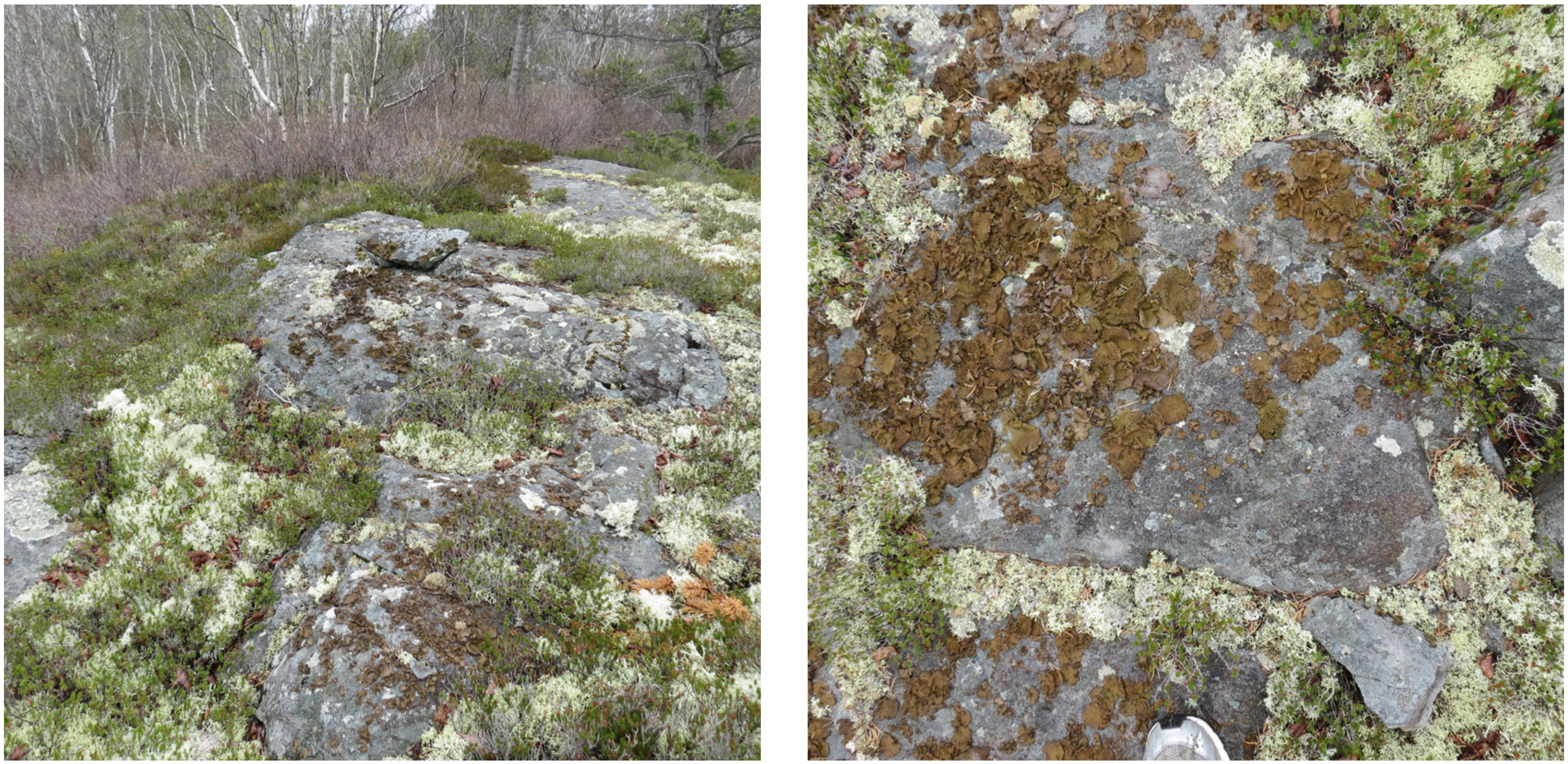

Fig. 7.2 Lichens on rock outcrop.

White lichens are "reindeer moss" (*Cladonia* spp.). Olive foliose lichens are Smooth Rock Tripe, U*mbillicaria mammulata*. Evergreen heath is Broom Crowberry.

Fig. 7.3 Glacial legacy.

Boulder fields support lichen and moss gardens that go through wetting and drying cycles. Featured here are two "reindeer mosses", *Cladonia boryi* (centre) and *Cladonia stellata* (right) as well as the Juniper Haircap Moss, *Polytrichum juniperinum* (centre). Fields are habitat for voles (e.g. Red-backed and Meadow Vole). We noted a vole here during our May 12, 2013 survey but study is needed to determine whether this HRM landscape supports the rare Rock Vole (*Microtus chrotorrhinus*) whose habitat is “hardwood forests on steep talus slopes” (Forbes et al. 2010).

Boulder Fields in the Williams Lake Backlands

Boulder accumulation. There was some standing water below Site G: 44.615518, -63.590688 (Aug. 25, 2012).

"Also intriguing were several lower lying areas where there were massive accumulations of large, angular boulders, most of them composed of the dark Meguma rock. I sent photos to two geologist friends and was referred to John Gosse of the Dalhousie Department of Earth Sciences. He commented:

> "They do look like small localized felsenmeer (sea-of-rocks) fields, but the slope suggests that there may be a different genesis. Without being there it is difficult to be certain, but these kinds of boulder zones are common in glaciated regions. They form either subglacially or, more commonly, along the sides of retreating ice margins. Specifically this looks like a lateral meltwater channel, formed along the side of an ice lobe, with the water flowing downslope. The meltwater stream would have removed the finer sediment and left the larger boulders alone. The angularity of the boulders is also interesting. This is typical in these situations, where the stream was short lived and did not have the energy to round the boulders' edges. On the other hand, boulders that are transported some distance by glaciers will also lose their angularity (depending on hardness and distance of course). That these boulders appear so angular suggests to me that they may not have been transported very far subglacially (though they were certainly covered by ice during the last major glaciation), and therefore may indicate a zone of the ice sheet that was cold-based (stuck to the substrate for most of its history, instead of sliding and transporting the boulders a long way)."

Accumulations of angular boudlers.
Site L: 44.614458, -63.596025 (Aug 25, 2012)

Fig. 7.4 Boulder Fields in Williams Lake Backlands.

The quoted text is from a report on a Halifax Field Naturalists Field Trip posted at http://versicolor.ca/purcellsbacklands/HFNreport.html

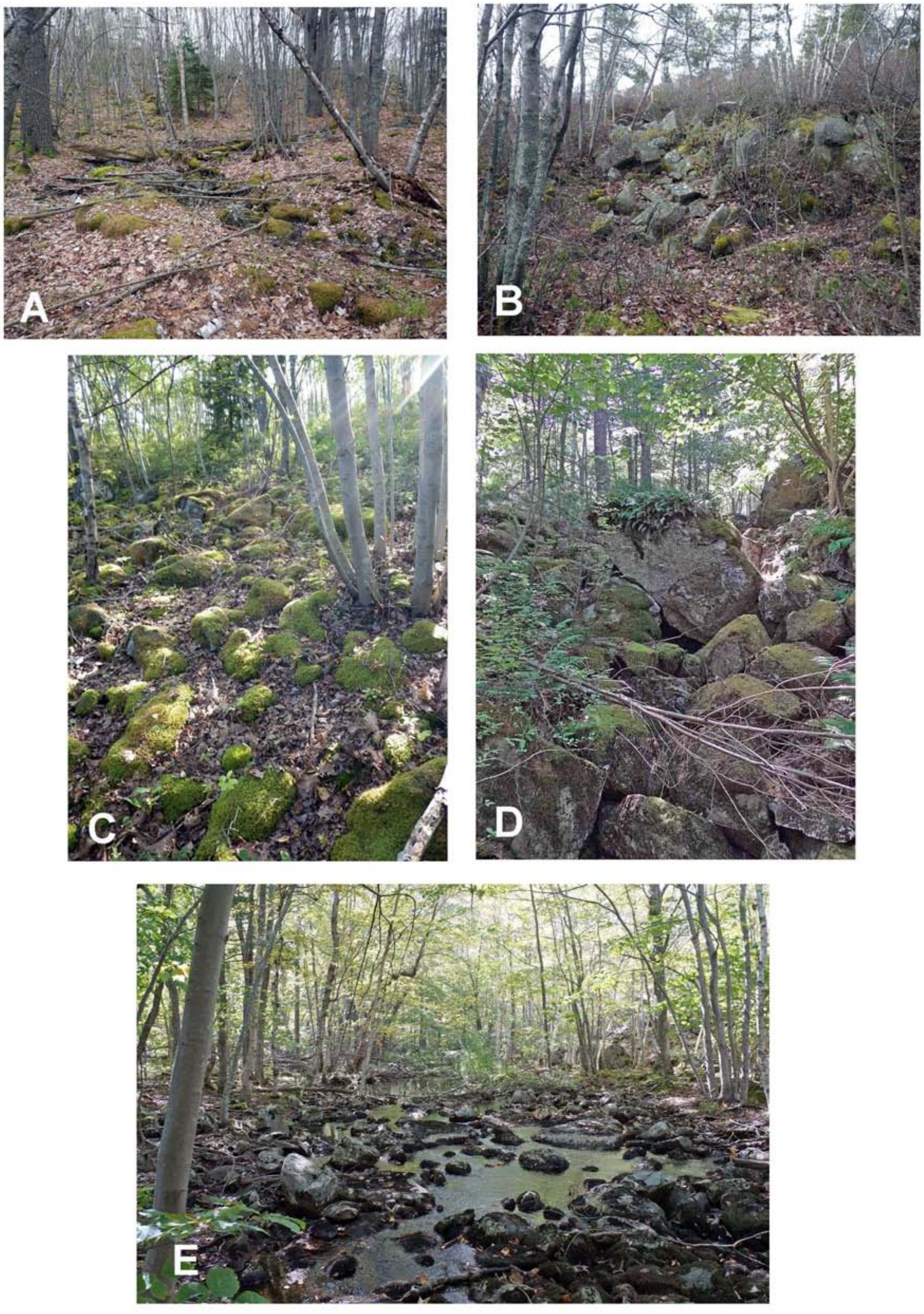

Fig. 7.5 Other types of boulder accumulations.
A, B, and C are in areas of granite bedrock, D and E in areas of Halifax Series bedrock.

Mountain Holly intermittent streams or "Washes"
In the WLB, there is a network of Mountain Holly Washes, or infiltration channels, that are trough depressions down slopes between the exposed ridge and rocks, and the swamps at lower elevation.

Mountain Holly (*Nemopanthus mucronata)* is the signature species and marker of these washes. Mountain Holly has been listed as a Facultative Wetland (FAC) species by Nova Scotia (Blaney, 2011) however, it is recognized as an Obligate (OBL) wetland plant in listings (Lichvar, 2013). It is a tall shrub with slow twisting growth and red barked roots that go deep to wet sediments in these washes; the plant takes two years to germinate and its seedlings occur in washes where leaf litter has been removed by runoff (Fig 7.6).

Mountain Holly marks these wash channels and often co-occurs with Red Maple. The inside wash typically has a shallow peat layer and a mix of sand and fines (silt & clay), the wash channel is lined by a small boulder transition zone outside of which is a HUCKLEBERRY (FAC in NS, FACU = Facultative Upland in US) shrub savannah with birch (Paper or Wire) or Jack Pine.

Washes can be described as infiltration channels or intermittent streams. In dryland regions, larger intermittent streams are called arroyos or gullies and in some US states they are afforded the protection of perennial stream courses, e.g., see New Mexico Wetland Regulations (n.d.) because they account for the majority (e.g. 80%) of the water flow channels in these regions (Levink et al., 2008). Headwater, first order streams can also account for 60% of the total volume of flow of watersheds in the northeast (Alexander et al., 2007) and it has been estimated that such streams have been underestimated in 80% of cases (Brooks and Colburn, 2011).

Flows from ephemeral and intermittent streams drive hydrological regimes in small watersheds such as the Williams Lake Backlands. Mountain Holly and Red Maple canopies of the washes shade and cool the water that flows through them; a part of this overland flow infiltrates in these Washes but a larger portion flows through the channels and infiltrates at Vernal Pool nodes that occur throughout this network of washes wherever slope levels off. Altogether, this system delays and slows water flow, it also shades and cools water, infiltrating a portion and delivering the remainder to vernal pool nodes at intermediate rainfall intensities or the overflow to swamps. Run-off in the Backlands is driven by topography and glacial history—by the ridges and rocky slopes that have little fine glacial till—and the hydrology of the small watersheds functions in the same manner as a dryland area although the climate is quite different. At the Backlands, run-off initially speeds into Mountain Holly Washes, it temporarily fills vernal pool nodes, and then overflows into lower elevation washes, their vernal pools, and finally and into the swamps just above Williams Lake.

Despite the essential role of these ephemeral and intermittent streams in the WLB in channeling and infiltrating water and delivering it to Vernal Pools nodes that form where the slope of Washes levels off, these stream courses have no official protection. To promote infiltration to avoid flooding and stormwater backup, such courses are designed into urban designs and are termed "Swales".

Swales and Washes alike may or may not conform to the requirements for designating wetland:

Table 7.1 Mountain Holly Washes: Evidence for Wetland Status.

Criterion	**Comment**
Hydrophytic Vegetation	The dominant species are FAC, which passes the "50:20" test*
Hydric Soils	Not present
Wetland Hydrology	Yes, because of two secondary Indicators: 1 Geomorphic position (they are troughs) 2 Presence of bare areas & exposed roots (Fig 7.4)

*FAC= Facultative wetland species. "50:20" test: the majority of the plants with largest cover that together account for 50% cover (and any with >20% cover) are at least facultative wetland species, i.e. dominant plants are all wetland plants or at least have facultative wetland status

1) (first at left) Mountain Holly stems in clumps in wash zone with Sphagnum growth at base of clump

2) (at right) Mountain Holly seedling setting up in zone of stream bared soil.

Fig. 7.6 Mountain Holly Washes.

Landscape (at left) = Geomorphic position (two elevation grades: slope + transverse depression and a stream course.

Water flow (below) = bared soil (litter removed) and exposed roots and moss trim lines at left photo.

III. Wetlands

The following is a dichotomous key to the types of wetlands in the WLB:

A. Small wetlands, flooded over winter or after intense rainfall, not saturated in summer
Vernal Pools

A. Larger wetlands, permanently saturated with or without seasonally flooded margins

B. Hydric soils with low accumulation of peat, or treed or shrub dominated communities on peaty soils with large seasonal waterlevel fluctuation and influenced by mineral rich groundwater

C. Wetlands where surrounding topography creates vernal pooling in the marginal zone

Swamp/Vernal Pool complexes

C. Wetlands where topography does not result in such pronounced seasonal differences in flooding, or in soil saturation, at the margin

D. Plant communities dominated by shrubs
Shrub Swamps

D. Plant communities dominated by trees
Treed Swamps: Black Spruce, Tamarack, Red Maple

B. Peatlands that remain permanently saturated and may be flooded over winter and where tree growth is usually stunted or of low (< 30%) cover.

E. Peatlands with substantial groundwater or surface flows

F. Flows from surrounding landscape and upstream wetlands
Fens (Topogenous and Soligenous)

F. Flows associated with lakeshores
Lakeshore Fens

E. Peatlands whose surface layers are largely independent of such flows
Bogs

A **wetland** is defined as: *land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment*. Organic wetlands are more simply referred to as **peatlands**. Peatlands contain more than 40 cm of peat accumulation on which organic soils (excluding Folisols) develop (National Wetlands Working Group. 1997).
Hydric soils are defined as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part of the soil (USDA, NRCS. 2003).

7.2 Wetland organization in the backlands landscape

The Pathway of Water

In natural systems, wetlands are important for filtering water and slowing it down. At Williams Lake, the headwater pathways of flow are not along conventional wetlands or streams yet they function as filters and regulators. Understanding the pathway of water is critical because development typically reduces the number of water pathways and straightens the pathways so run-off is shunted from hardscape to waterbody (Marsh, 2005). This has the effect of reducing the time of run-off and increasing its speed, resulting in greater erosion and less filtration. The loss of ground infiltration, has the secondary effect of increasing water temperature of runoff in summer as water remains on the surface. This may have impacts on the ability of water to hold oxygen for salmonids in Williams and Colpitt Lakes.

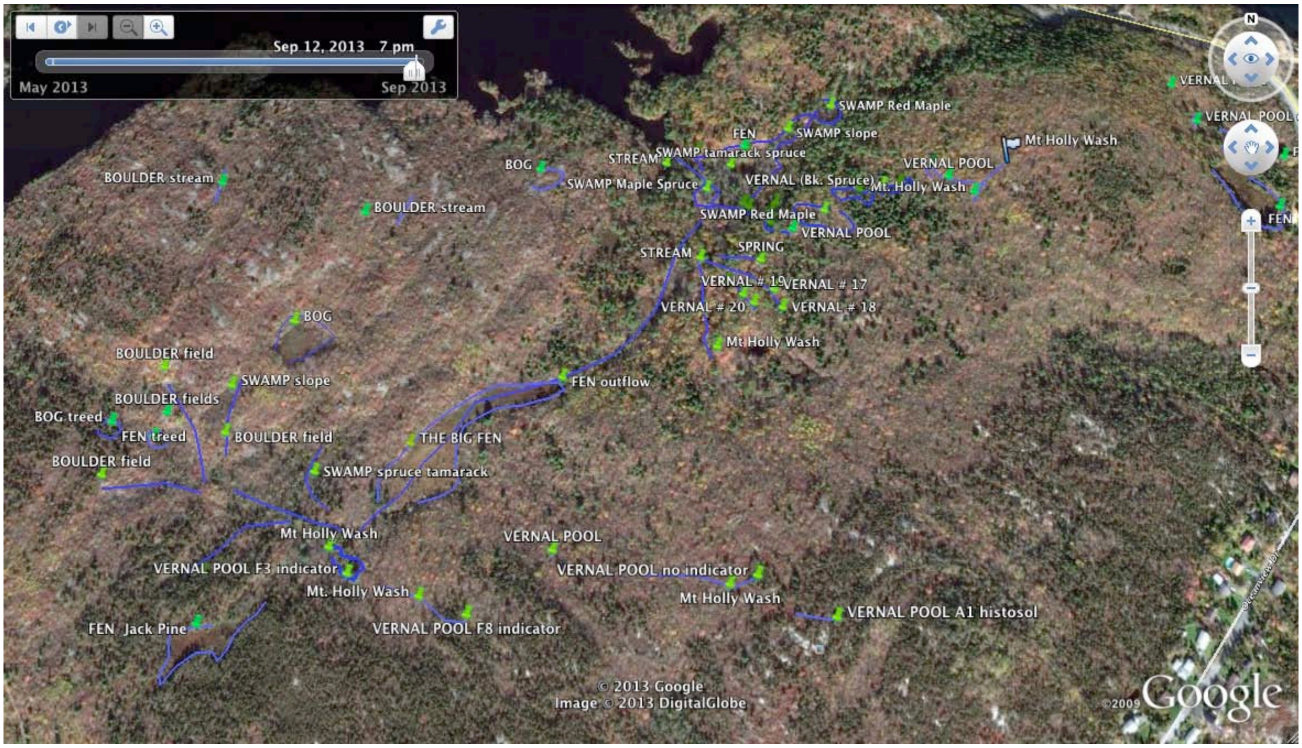

Fig. 7.7 Partial representation of water flows from the barrens into the water course that flows northeast along the contact zone between rocks of the South Mountain Batholith and the Halifax Formation and finally into Williams Lake. See next page for a larger version of this figure.

In the Williams Lake Backlands:

1. Water runs off into **boulder fields** (Fig. 7.7 at left) and into a network of Mountain Holly Washes* (central ridges on Fig. 7.7)
* Boulder fields and washes are essential conduits that recharge wetlands and groundwater BUT are not defined as wetlands.

2. Washes conduct water to **vernal pools** that are nodes where the flow pathway levels off. Vernal pools are wetlands, have dedicated hydric soil indicators, and they recharge **groundwater** and **springs** that maintain large organic based wetlands: **swamps** and **fens**.

3. **Bogs** (self-contained peatlands) are uncommon in this landscape where wetlands both store and discharge flow to **streams** that maintain **Colpitt Lake** and **Williams Lake**.

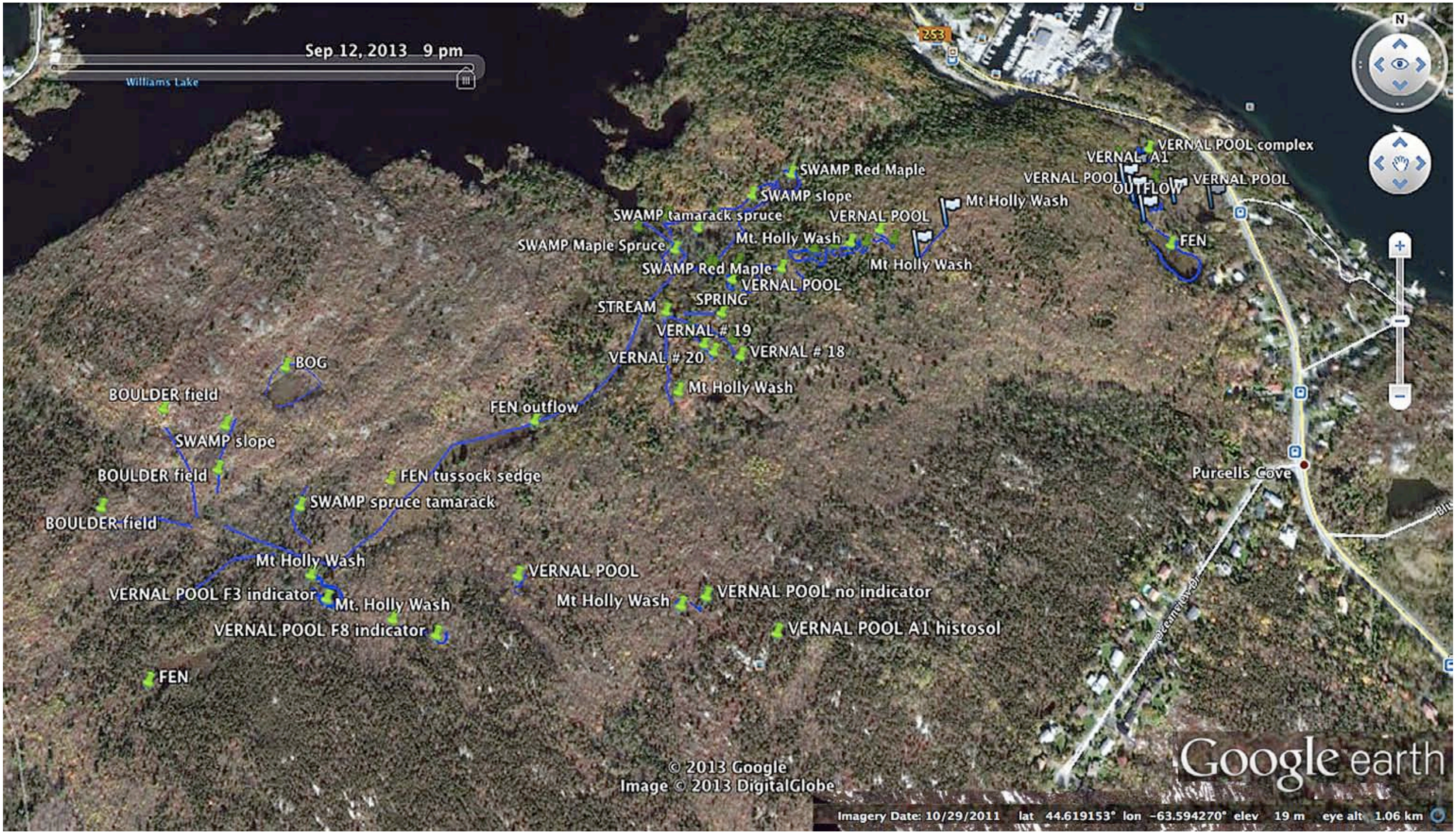

Fig. 7.7 Partial representation of water flows from the barrens into the water course that flows northeast along the contact zone between rocks of the South Mountain Batholith and the Halifax Formation and finally into Williams Lake.

Fig. 7.8 Springs
Much of the water passages in the backlands are below ground. Springs are an obvious example. This spring was found in May when a water flow disappeared from a plateau at a higher elevation and then it reappeared at a lower plateau (ca. 10-15m drop) emerging as a spring. The sphagnum indicates that this area is persistently moist.

Below, the nature and roles of vernal pools, bogs, fens and swamps in water movement and storage in the WLB are described and discussed.

Vernal Pools

Vernal pools occur wherever there are depressions in the landscape and there are impermeable soil or rock layers. Vernal pools ranged in size from less than $5m^2$, a pool that might be the pit formed after a tree fall, to several hundreds of square meters.

For a project supervised by Patricia Manuel at the School of Planning, Dalhousie University, Huan Liu (2012) investigated various remote sensing techniques (aerial photography, satellite photography, and LiDAR - Light Detection and Ranging) and Digital Elevation Modeling for mapping of vernal pool mapping using the undeveloped land in the Williams Lake Watershed as a test case. Her synthesis map of all PVPs (Potential Vernal Pools) is in Appendix A Map 3 of this document. Liu conducted ground-truthing to help in developing criteria for designating a PVP but a formal survey would be required to test the predictions. We documented locations of every vernal pool encountered on six of our surveys (Fig. 2.2). These data, with photographs and descriptions, are being compiled separately from this report and should allow calibration of Liu's PVPs.

Water beetles and Culicid (mosquitoe) larvae were common in the vernal pools. Amphibians (Green Frogs) &/or their egg masses were noted in a few pools in May, but there was no evidence of amphibians for most of the pools. The sparsity of amphibians is quite possibly due to low pH in these poorly buffered systems still highly affected by acid rain (Clair et al., 2011).

The ecological significance of vernal pools is often related to diversity (e.g. amphibians or rare plants) in other areas (Colburn, 2004), but in the WLB their major value relates to hydrological function.

Vernal pools were of most regular occurrence along the network of Mountain Holly Washes and occurred wherever there was a leveling out in these slopes and where there was a rock barrier to flow.

A majority of the vernal pools in the Mountain Holly Washes have Wetland status although none of these appear to have been delineated in the Backlands property while the traditional wetlands (e.g. fens and swamps) were. They are sparsely vegetated in the herb layer (shrub growth is largely large clonal Mountain Holly) and they are bowl-shaped depressions (=Geomorphic Position). The vegetation is dominated (40% cover each, n=4 pools) by Red Maple (on hummocks in the bowl and overhang from pool sides) and by Mountain Holly which suckers up clonally from the lowest pool positions. There are minor amounts of Sheep Laurel and Paper Birch and trace amounts of Bracken and Huckleberry (dominants of the surrounding upland).

Fig. 7.9 Vernal Pool

Soils were usually hydric as indicated by four indicators. The subsoil restrictive layer varies from rock (e.g. the case of A1 Histosol: peat on rock) to sandy soil (e.g. the A11 indicator) to clay silts where a particular indicator, F8: Redox Depressions, noted for use in closed depressions subject to ponding (ie. vernal pools) was observed.

Table 7.1 Plant species and soil wetland description for a vernal pond.

Plants	Hydric Soil	Soil Comment	Additional
Mt. Holly (FAC)	A1	Moist peat	Over rock
Red Maple (FAC)	A11	Depleted under dark surf.	--
Sheep Laurel (FAC)	F3	Depleted matrix	--
Paper Birch (FACU)	F8	Redox depressions	Indicator noted for vernal pools

INDICATOR	SOIL CORES
A1 = "HISTOSOLS include soils that have organic soil material of any thickness over rock or fragmental material that has interstices filled with organic..." Caution: organic as of peat muck of wetland origin.	
A11 = "Depleted below dark surface" 60% of chroma of 2 or less, 15cm thick, starting in upper 30cm **10YR 4/1** (a 35 m^2 vernal pool connected to others in a wash network)	
F8 =" Redox Depressions" For closed depressions subject to ponding 5% distinct to prominent redox 5cm thick, in upper 15cm matrix:redox = **2.5YR 7/3:2.5YR 6/6**	

Typical vernal pool at lower elevation also featuring Mountain Holly but standing water persisted into May and there is much evidence of hydrology: standing water, geomorphic postion, water-stained leaves (at right), sparsely vegetated surface.	
Goldthread (*Coptis trifolia,* Buttercup Family) is an indicator of these systems, so often occurring at their margins as at those of vernally flooded swamps. Goldthread= FAC (but FACW by USFWS).	
Sphagnum girgensohni and *S. palustre* were frequent members of these more typical vernal pools and they are also common in swamps at the Backlands.	

Fig. 7.10 Vernal Pools.

Bogs
Unlike all the preceding systems—the boulder fields, Mountain Holly Washes, vernal pools in networks or interconnected as above via an underground spring—the bogs at Williams Lake Backlands alone, fit Tiner's (2005) description of a terrene system without definite inflow zone or an outflow. Bogs, by definition, are self-contained systems and may be plentiful in flatter landscapes where drainage is poor (e.g. the coastal bogs between Peggy's Cove and West Dover). Their main source of mineral nutrient supply comes from precipitation and hence they are appropriately termed: **ombrotrophic** (Greek words, ombros + trophikos translate to rain + nourishment).

The Barrens landscape is a flow-through landscape and the Bog terrene was an exception to this rule. The drainage map reveals that boulder fields, Mountain Holly Washes, their vernal pools and other isolated vernal pools are higher in the landscape than swamps and fens.

Fens and Swamps
The Barrens landscape is a flow-through landscape with the few bogs as an exceptions to this rule. The drainage map reveals that boulder fields, Mountain Holly Washes, their vernal pools and other isolated vernal pools are higher in the landscape than fens and swamps (Fig. 7.7)

Fens and swamps are flowing systems and both of these ecosystems may be highly organic. There is a greater influence from minerals and sediments in swamps. In contrast, fens are strictly peatlands and as a rule are consistently wetter than swamps, drying out less in summer. Fens can support a tree community (a treed fen) but these trees are usually more impoverished, less robust and contribute less cover than is the case in swamps. Swamps may have a large influence from dead wood incorporation into its organic profile. (National Wetlands Working Group,1997).

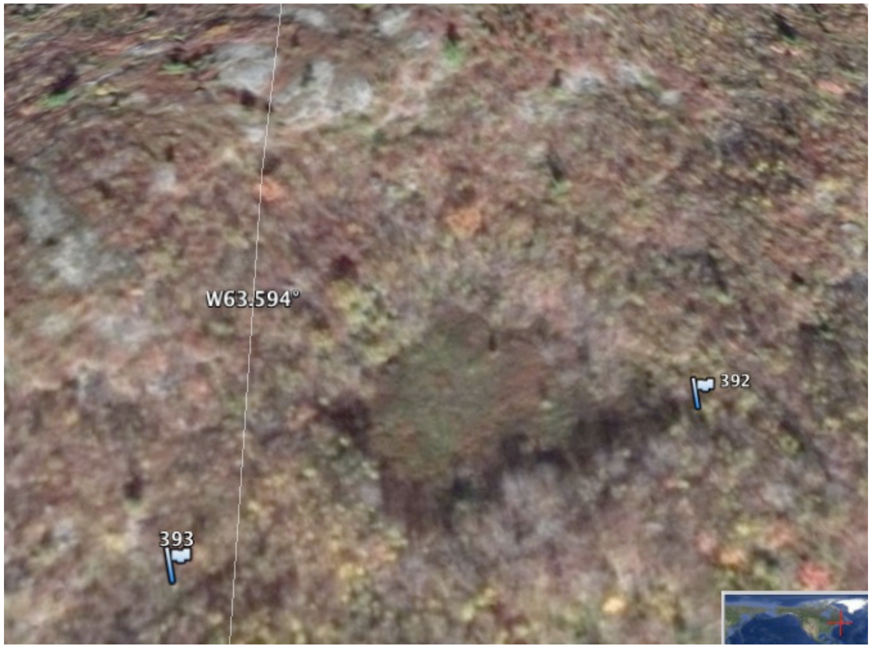

Fig. 7.11 Google image of a bog in the WLB (left) and some of its heath family plants.

The bog is a depression in this landscape and a rock wall surrounds the north and east bog edges There is a slope at the south edge and perhaps a small overflow toward the west which may or may not be functional. Because the supply of mineral nutrient is low, the plants colonizing bogs frequently have unusual nutrient strategies (e.g. insectivory in pitcher plants and sundews). Most of the vascular plant biomass of this bog is made up of evergreen shrubs of the Heath family including: Leatherleaf (the white flowerbells, mid photo below), Sheep Laurel and Bog Laurel and Labrador Tea. These plants are adapted to acidic conditions. Ericaceous mycorrhizal fungi give these plants exceptional mineral uptake abilities and evergreenness means they are more efficient at nutrient conservation. Note that nutrient and water availabilities increase at the bog margin (the "lagg" zone). Here grows the beautiful, deciduous heath family member, Rhodora. Its restriction to that zone may reflect a greater mineral nutrient requirement stemming from its mineral losses from the deciduous strategy.

Tussock Sedge, Sweet Gale
Red Maple and Tamarack
FEN

Black Spruce, Tamarack, Canada Holly and Cinnamon Fern
SWAMP

Carex stricta

Myrica gale in flower

Fig. 7.12 Fen and Swamp

The FEN and SWAMP pictured above are part of the same wetland just above the waterfall gully above Williams Lake. The terrestrial landscape edge to the north of the fen is sloped and there is not much input of sediment and mineral nutrient from this edge. In contrast, the swamp portion of this wetland complex receives inflow from a more gradual slope and the swamp receives drainage from a larger watershed area. Notice that tree growth is sparse in the fen, relatable to greater constancy of waterlogging (less summer drawdown), and that the dominants include the tussock sedge (*Carex stricta*) and the nitrogen-fixing, Sweet Gale (*Myrica gale*).

Fig. 7.13 Canada Holly (red berried shrub) in a swamp in a wet period in the fall.
The presence of this relative of the Mountain Holly is found in richer wetlands.
The size of the dead black spruce is also indicative of a greater productivity site and the influence of dead wood inputs into swamp substrate was noted above.

Two divergent fens, the ‘Big Fen" and the "Jack Pine Fen" illustrate how variation in productivity influences the composition of the fens. Both are linear systems and are peatland flow pathways; both are more constrained by landscape sloping sides that is evident in swamps. The Big Fen is in the center of the Google Map (Fig. 7.7 above). The Jack Pine fen is the most southerly fen on the map.

Jack Pine fen is a narrow fen surrounded by Jack Pine upland. It is unusual in having Jack Pine established in the wet Tussock Sedge/Sphagnum moss matrix. The Jack Pine here and at other sites in the Backlands, has a high serotiny ratio that indicates that there have been recurrent **fires** in the landscape. Diversity was low in this ecosystem though the two typical fen species, Tussock Sedge and Sweet Gale, dominated the vegetation. Apart from scattered Jack Pines there was little additional plant diversity.

Fig. 7.14 The Big Fen.

This fen has the same dominants as noted in the entry fen (Fig. 7.12): the Tussock Sedge and Sweet Gale (both in photo top right). Leatherleaf (same photo, white bell) is abundant and this plant attracted both bumble bees and butterflies (Azure Blues and Coppers) in mid May. In September, the fen has fruit of the Large Cranberry and the Bog Rose (above) and colours of Red maples and Cinnamon Fern (top right).

Fig. 7.15 The Jack Pine Fen

Above: Fire-adapted/dependent Jack Pines in a wet Tussock Sedge Fen.
Below: the peat record reveals several layers of charcoal (see black stripes below right) that extend to the base of the metre long core which is laid out below at left.

Swamps
Swamps are the most common wetland in the central, lower elevation, drainage corridor (Fig. 7.7) for nutrient and sediment flow and deposition reasons elaborated above.

Like fens, there is a range of productivity and ecosystem types over the Backlands landscape. At lower fertility, as at lower watershed area positions closer to the headwaters of these small drainage systems (to the west of the central drainage that runs west to east), treed fens grade into swamps and both may be dominated by Black Spruce and Tamarack.

TREED BLACK SPRUCE FEN soils are A1 Histosols and peat is deep	BLACK SPRUCE SWAMP soils may be mucky and the mineral soil content can be felt as an greasiness

Fig. 7.16 Black Spruce fen and swamp.

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.

(ii) The Wetland/Watercourse Complex
The WLB host a complex set of small and larger wetlands and stream courses that purify water finally entering Williams Lake and presumably, water reservoirs tapped for well water along Purcell's Cove Road.

Many of the smaller but collectively vital elements of this system are not legally protected in Nova Scotia as they are either smaller than minimum area of $100m^2$ required for wetland protection (e.g., many of the vernal pools and Mountain Holly Washes) and/or they would not qualify as wetlands under wetland Protection regulations (e.g., some Mountain Holly Washes, the boulder fields) or are not routinely identified as stream courses to protected under the Wildlife Habitat and Watercourses Protection Regulations (e.g. many of the boulder fields and Mountain Holly Washes), or the protection is very limited (e.g. a 5 m buffer for stream course less than 50 cm width.). In addition to a lack of legal mechanisms to ensure protection, many areas that qualify as wetland (such as slope swamp corridors between flat swamp, vernal pools greater than the legal minimum area or the vernally flooded zone at the margin of swamps having the requisite hydric soil indicators—e.g. F8 or A11) may escape notice by "efficient" delineation which concentrates on closing the wetland being delineated rather than on following up connections between wetlands.

The WLB are mostly scrubby, rocky savannah that would appear to have little ability to moderate flows shed from these impervious rock surfaces, yet, it is well known that unlike many lakes in HRM that have seen development, water quality in the partially settled Williams Lake is exceptional. Water quality is exceptional because within this seemingly hostile landscape is an organization that slows, cools and filters water, maintaining a cool base flow in streams regulating the lake. Williams Lake water quality is maintained through a network of natural swales or "washes" which are intermittent streams that increase the distance of water flow and infiltrate some of it in shaded passageways through fine sediments along wash troughs. The swale-wash network delivers water via surface and ground flow to vernal pools that are unidirectional wetlands which often have an inflow but little outflow. Their flows occur underground and they maintain base flow to fen and swamp along stream systems. The combination of natural swales and infiltrating vernal pools removes both sediment and nutrients of water going into Colpitt and Williams Lake.

Williams Lake is surprisingly transparent for this area of more typically brown water lakes. The brown water comes largely from humic acids produced in the organic soils in swampy forests and fens on much more nearly level landscapes around or feeding the lakes. In the WLB, water washes more quickly off the precipitous landscape and through the relatively small (but still critically important) swamps and fens, so does not bear the load of humic acids so common in most Nova Scotian watersheds. What the wetlands do remove, however, is sediment and nutrients, both detrimental to our oligotrophic lakes.

Currently, the waters of the WLB are thoroughly scrubbed by these networks of washes and vernal pools or in other parts of the barrens, by boulder fields and fens. Development of the Barrens, as we have seen at Dartmouth Crossing or Bayers Lake, would transform this vertically-integrated system of swale and vernal pool into a limited series of impervious plateaus connected by a limited number of surface water run-offs. Run-off hydrographs would not only be flashy but their waters would be warmer in summer because of surface heating from open pavement. The removal of overburden necessary to create the required area of flatscape-hardscape for development of Dartmouth Crossing was piled to form an artificial hillside of rubble and organic debris (soil, peat, trees). The water in the swamp at the base of this artificial hill supported luxuriant growth of filamentous green algae. Williams Lake area has good groundwater water quality for drinking and good lake water quality and temperature for bathing and salmonids (Brook Trout). For the reasons just elaborated using the Dartmouth Crossing model, these ecological services will be lost if this area becomes suburbanized.

(iii) Bird Habitat

This undisturbed wilderness area with its mosaic of habitats is near the coast in the most urbanized area of the province; as such it is important habitat for both breeding and migratory birds as documented for the Williams Lake Conservation Company by Fulton Lavender (2012). This boreal habitat supports a guild of boreal birds that are becoming increasingly rare.

8.2 Fire Management

Formal protection of the WLB would require a management strategy that recognizes the fire-dependent and fire conducive nature of the Jack Pine/Broom Crowberry Barrens, and reduces fire risk to neighbouring communities.

The WLB and the larger Purcell's Cove Backlands must rank amongst the most fire-susceptible landscapes in Nova Scotia and even with a high level of vigilance, fires *will* occur there as attested by recent fires. Thus we surmise that the current level of fire protection in HRM would still allow our settled areas to co-exist with the fire dependent communities of the WLB. A fire starts within the backlands and we put it out, but over time the frequency and spatial distribution of burning is sufficient to maintain the fire dependent communities of the backlands.

It could well be that some use of prescribed fires in the Purcell's Cove Backlands would enhance conservation of the fire-dependent ecosystems and, by reducing excessively high fuel loads, increase fire protection for the adjacent communities. Following the infamous Yellowstone Fire, we have come to recognize that a high level of fire suppression can lead to unnaturally catastrophic fires due to increased fuel loads. The modeling approach of Ellen Whitman and colleagues (Whitman et al., 2013; Whitman, 2013), combined with appropriate monitoring*, could provide a way to assess various options and risks of prescribed fires.

> Wildland fire is not going away. It is time we learn to live with it. Fire is not a war, and an absolute victory is impossible. But to accept reality is not to accept defeat. For perhaps the first time in this nation's history, we know the basics of how to live with fire. We know a great deal about how fire works, and we know how to mitigate its effects in a way that can improve our

*E.g., it might be appropriate to document the age structure/patch distribution of both Jack Pine and Broom Crowberry in the backlands, perhaps combined with measures of fuel load and Jack Pine serotiny. Such information might be used to infer the history of fire in the area and its patch dynamics, in turn contributing to prediction of fire risk and assessment of different fire management options.