UBC Okanagan Biodiversity
Interim Report

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Introduction

For several years, we have been leading informal walks on the UBC Okanagan campus for persons interested in learning about local biodiversity. These informal walks, dubbed "Birds, Bugs & Botany", have largely been conducted in spring (March to May) and have provided a good opportunity to engage with graduate and undergraduate students. Having led these walks for about a decade, we are now frequently also asked to lead walks for classes, and for various events on campus.

We have learned much about the natural heritage of our campus, and have become increasingly concerned that this heritage be sustainably managed. Thus, in the spring of 2018 we decided to more formally document our observations to facilitate preservation of the indigenous species, control of invasive species, and promote the sustainable management of campus lands.

The data collected will also constitute a key educational resource, particularly for Biology, but also for faculty and students in the Department of Earth, Environmental & Geographic Sciences, the Department of Community, Culture and Global Studies, and other members of the university community.

Methods

To facilitate our work, we began by dividing the campus into a series of sectors, that were relatively uniform units as characterized by land-use and major vegetation types (Fig. 1).

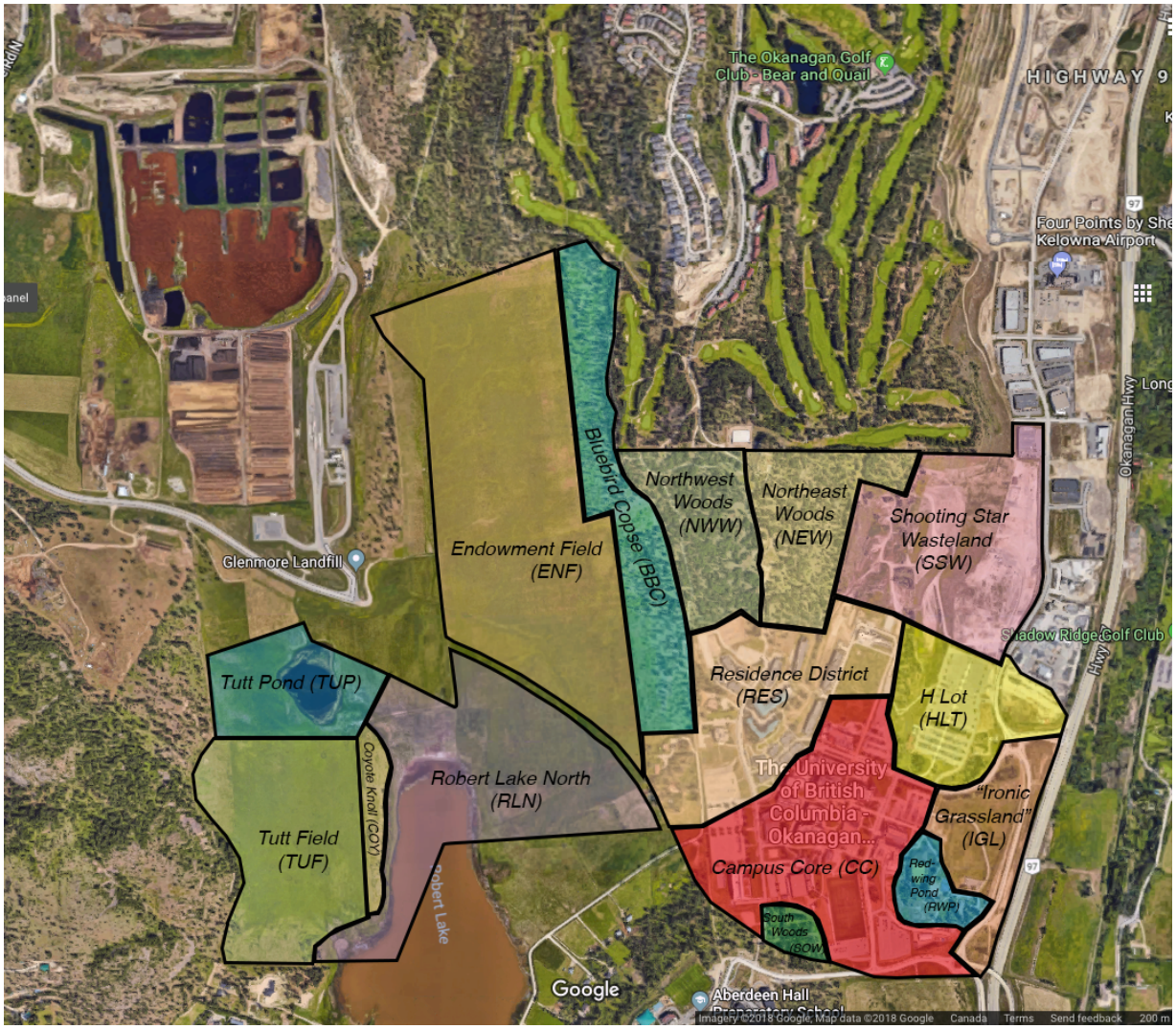

Figure 1. Landscape units used for campus biodiversity surveys: Bluebird Copse (BBC), Campus Core (CC), Coyote Knoll (COY), Endowment Field (ENF), H Lot (HLT), Ironic Grassland (IGL), Northeast Woods (NEW), Northwest Woods (NWW), Residence District (RES), Robert Lake North (RLN), Tutt Field (TUF), Tutt Pond (TUP), and South Woods (SOW).

Given the size of our campus, and the number of species that occur there, we decided to forego quantitative surveys in favour of a more qualitative presence/absence record. We attempted to visit each of the landscape units regularly (at least once every three weeks) throughout the summer (May to Sept), following meandering routes through each landscape unit. In addition to our 2018 records, we incorporated records of additional species from other years. For two known birding "hot spots" (Robert Lake and Tutt Pond), we have incorporated observations provided by other members of the Okanagan birding community. For a part of campus (principally CC, HLT, RES) we were able to incorporate tree inventory data provided by Arborscape to UBC. Note that the species identifications used in our data do not always agree with those used in the Arborscape database.

Results, Discussion, and Recommendations

The results of our recent compilation have been collated into a 23-page Excel workbook, available for download (http://www.paleolab.ca/bbb/campusdiversity.xlsx). The following account provides a synopsis of that larger work, with an interpretation of our findings.

The total area of the UBC Okanagan campus lands comprises approximately 215 ha, encompassing a mix of undeveloped woodlands, grasslands, meadows, cultivated fields, and wetlands, in addition to the developed urban core (academic buildings, student residences, and parking lots). In terms of vertebrate species, in total we have compiled a list of approximately 155 species of birds, 15 mammals, 4 amphibians, and 4 reptile species. In addition, we have noted approximately 250 species of vascular plants, 7 bryophytes, and 19 lichen species.

Although more time needs to be devoted to grasses, the vascular plant list should be nearly complete. The lists for other taxa are less comprehensive. The bird species total is probably an accurate reflection of their diversity for the campus in total, but many species may be missing from lists for individual sectors of campus. There are likely to be many more species of small mammals present; the invertebrate species count is only a tiny fraction of what remains to be documented on campus.

The lists comprise a mix of indigenous and non-native species. The vertebrate list (birds, mammals, etc.) is dominated by native species, but the vascular plant list comprises a huge number of non-native, invasive or potentially invasive, species. A few species are designated provincially or federally as species-at-risk, including most notably badgers, great basin spadefoot and American avocet. Some of these may breed on campus (e.g., badgers, Great Basin spadefoot and American avocet), but others are regular, seasonal transients (e.g., long-billed curlew, tundra swan) feeding during migration at Robert Lake, or rare, accidental strays delivered to campus by storms (e.g., surf scoter, and long-tailed duck).

Subsequent sections of this report provide an interpretation of our results in terms of ecological integrity, educational significance, and sustainable management of campus lands.

Grasslands, Meadows & Cultivated Fields (COY, ENF, IGL, TUF, part of RLN)

About 40 % of UBC Okanagan campus lands (80 ha) consist of grasslands, meadows, and cultivated fields. While some of these lands are cultivated for forage crops (hay, alfalfa), many

of these areas are dominated by non-native, invasive species of plants. Although grasslands are a natural part of the Okanagan landscape and are potentially worthy of protection, almost none of the campus lands remotely satisfy such a designation. In particular, we note that the field on the east side of campus is infested with an array of invasive species; thus, it has been dubbed the "Ironic grassland (IGL)", an area that might superficially resemble a grassland, but is largely a sea of non-native weeds: cinquefoil, thistles, knapweed, dock and tumble-mustard. In terms of the plant community, it offers little in terms of conservation value. It would require a huge restoration effort to rehabilitate the area to anything natural. Its only conservation value is as a foraging area for predators (badgers, great-horned owls, raptors); they likely make good use of the Columbian ground squirrels and the other small mammals that thrive there.

Badgers, notably, are designated as a red-listed species in British Columbia and as an endangered species, protected under the federal Species at Risk Act (COSEWIC 2013). Badgers likely construct dens in the area occasionally; their excavations are well-known in adjacent areas (Redwing Pond and University House).

Most of the other open spaces lie on the west side of campus (ENF, RLN, TUF, TUP) and are used for forage production; thus, the plant community has value mostly in terms of agricultural production. This open landscape also potentially serves as breeding habitat, mostly for pocket gophers, western meadowlarks and savannah sparrows, and as foraging habitat for owls, various raptors, pipits, geese, and mountain bluebirds during migration. Coyotes frequent the area, probably feeding on a variety of small mammals.

To what extent ground-nesting birds, like savannah sparrows and meadowlarks, are able to successfully raise their broods in the field is unknown. If the forage is cut too early, their nests will be lost.

This area is likely extensively used by the Great Basin spadefoot, a species-at-risk known to migrate to the margin of Robert Lake to breed (ENF, RLN, TUF, TUP). Because the spadefoots spend much of the year underground, little is known about their habits on campus. During migration a substantial part of the population is likely to be at risk of being crushed by traffic on John Hindle Drive. A radiotelemetry study is needed to better map and fully understand this species' campus needs. Recently, much of campus has been designated as critical habitat for this species-at-risk (Environment and Climate Change Canada. 2017).

The one small area of campus that approximates a natural grassland community is a small rocky ridge on the western margin of Robert Lake. Coyotes have constructed a den on the east side of the ridge, close to the margin of Robert Lake; thus, we refer to the ridge as "Coyote Ridge (COY)". Although, some non-native plants are established here, there are also some iconic, native grassland species (e.g., sage, rabbit-brush, mock orange, mariposa lilies, balsamroot, white currant, saskatoons, shooting-stars and alumroot). Several of these native species do not occur anywhere else on campus, and were traditionally used by the *Syilx* (Okanagan First Nation) people; thus, these plants have important educational and cultural, as well as conservation value.

Forested Areas of Campus (BBC, NWW, NEW, SOW)

About 15% of campus (35 ha) is forest or woodland. Mostly these forested areas lie on the north side of campus, between the residences and Quail Ridge Golf Club. There is also a small woodland on the south side of campus, lying between the gymnasium and John Hindle Drive.

These woodlands are dominated by ponderosa pine with lesser amounts of Douglas-fir, and sparsely scattered Rocky Mountain juniper and cottonwood. Beneath this canopy is a shrub-layer, mostly comprising saskatoons, snowberry, roses and Oregon grape. In the spring and early summer, a variety of wildflowers (e.g., balsamroot, buttercups, fritillaries, desert parsley, lemonweed, milk vetch, death camas, and mariposa lilies) attract pollinators. All of these are common, native species, and they have considerable value as a resource for teaching students about native plant communities. In addition, some indigenous plants are present only in one or two isolated patches in the campus woodlands (e.g., bitter-root, soopallallie, buckbrush, common juniper, paintbrush, and yellow penstemon), and could easily be extirpated from campus lands.

These woodlands are extensively used by campus residents, and in some cases by mountain bikers. The woodlands are being fragmented by a proliferation of walking and biking trails, that are creating avenues for many invasive species (e.g., prickly lettuce, knapweed, salsify, cinquefoil) to enter into the woodlands and degrade their integrity. To maintain the future integrity of these woodlands will require careful management to mitigate against trail proliferation and to rehabilitate the degraded and disturbed habitats.

The woodlands are home, at least seasonally, to a variety of birds including, for example, chickadees, nuthatches, flickers, kinglets, yellow-rumped warblers, sparrows, western bluebirds and crossbills. The university has been rather aggressively managing these areas by thinning trees, and removing underbrush and deadwood. While this management reduces fire risk, it also reduces habitat for some species.

Many of the shrubs that have been removed formerly provided cover, and berries for summer and winter forage. Cavity nesting birds seem to be declining on campus. Apart from flickers, woodpeckers are scarce or absent. Some wildlife trees are needed in the forest; not all dead trees should be removed.

Bird boxes can be used to partly mitigate the decline in cavity-nesting birds. Fortunately, bluebird boxes have been erected and maintained by Michelle Hamilton and the KLO Middle School. These are well used by western bluebirds in the "Bluebird Copse (BBC)", adjacent to the endowment land fields (ENF). The campus gardening club has erected several additional bird boxes on campus. One was occupied by pygmy nuthatches in 2018.

Wetlands (RLN, RWP, TUP)

If one includes lake and pond surfaces, about 7% of campus lands (15 ha) can be considered wetlands. These wetlands are especially diverse in terms of bird life.

Over the years approximately 140 species have been recorded at Robert Lake; this is the single most important wetland for migratory birds in the Central Okanagan. Because it is frequented by a diverse array of birds, including many rarities, Robert Lake is constantly surveilled by local birders (Gebauer 2018).

Northwest of Robert Lake, good views of Tutt Pond have only been accessible in recent years; about 60 species are known there. East of the EME building at Redwing Pond, about 50 species are known.

It would be difficult to over-rate these wetlands as an educational resource. They are frequented by biology classes, including especially BIOL 372 (Field Ornithology) and BIOL 375 (Flora and Fauna of Inland Waters), and serve as focal points for campus nature walks.

The grasses, rushes, cat-tails, and bulrushes that surround the wetlands are essential breeding habitat for water birds. They provide classes an opportunity to directly observe the distinctive morphological, anatomical and physiological adaptations of wetland plants. Some of the wetland plant community bordering Robert Lake may qualify as a provincially red-listed alkali marsh.

The most immediate threat to Robert Lake is the progressive freshening of its waters. The most distinctive members of the Robert Lake ecosystem (e.g., avocets, spadefoots, glasswort) all depend on the high salt content of its waters. That high salinity has evolved over many years (potentially centuries or millennia) as dissolved salts were carried to the lake in groundwater and then hyper-concentrated via evaporation off the lake surface.

The hydrology of the Robert Lake basin has been changing in recent years. Some of this change is probably natural, but some part will also be attributable to irrigation, stormwater input, and upslope development on campus, Quail Ridge, the landfill, and potentially most of the lands extending upslope to Lake Country. Last year, water was being pumped from the landfill property, onto UBC lands, thereafter flowing towards Robert Lake. As a consequence, the water level in Robert Lake filled to the point where its waters were being pumped across into Brant's Creek.

This situation is not sustainable. The Robert Lake ecosystem depends on the lake's high salinity. Those salts have only very slowly accumulated in the basin, but now, many years of accumulated salt are potentially being pumped out of the lake in a single season. If this trend continues, a likely scenario will see Robert Lake lose its distinctive salt-adapted community, with cat-tails colonizing and encroaching on the lake margins; thus, Robert Lake could soon be filled with cat-tail marsh.

Mitigation of this problem likely requires a system (a pipe) to facilitate a bypass of excess, relatively fresh water around the Robert Lake basin. Design of the system would need to ensure that 1) Robert Lake's high salinity is maintained, and 2) the natural range of water level fluctuation in Robert Lake, including completely drying out in some years, is maintained. During low-water phases, especially during late summer, many shorebirds feed on the exposed muddy lake margins.

Urban Lands (CC, RES, HLT, SSW)

The main campus consists of a variety of developed lands (student residences, academic buildings, parking lots, and an extensive gravel pit (nicknamed the "Shooting Star Wasteland"). Together these uses account for about 33% (70 ha) of campus lands. They are essentially urban in character, and most of the natural vegetation has been displaced by pavement, lawns, buildings, and disturbed surfaces. For the most part, these lands have little value from a conservation perspective, but some of the plants have educational value, and the loss of native vegetation has, in part, been mitigated via landscaping using a few native plant species (e.g., Oregon grape).

The educational value lies principally in the diverse species of trees that have been planted on campus. Two of the conifers (ginkgo and dawn redwood) are native to China, and considered living fossils. They may be found as fossils embedded in rocks in parts of southern British Columbia (e.g., the White Lake and Princeton Formations). Limber Pine is a provincially red-listed species that has been planted at several locations on campus. Many of the broad-leaved trees (e.g., maples, sweetgum, ashes and oaks) are representative of forests in eastern North America.

There are a few trees that pose, or potentially pose, problems:

1) Siberian elm is an invasive species, well-established on campus. Many of the trees have been removed, but they are likely to be a continuing problem.

2) The invasive tree-of-heaven has made it to campus. There are only a few trees currently, but they will likely multiply rapidly – so some timely control is likely warranted.
3) One of the more common shade trees on campus is the Norway maple. At present, they do not seem to be expanding from campus. Their ability to spread is probably limited by the dry natural Okanagan soils.
4) Another campus tree, the callery pear has become invasive in parts of eastern North America. Again, we haven't seen it spreading, but it is a species worth monitoring in future.

In addition to these trees, there are new invasive weeds continually appearing on campus. Many are now so thoroughly established that eradication of these species is likely impossible. With respect to at least two species, however, some modest and timely efforts might be rewarded. A small patch of scotch thistle on the west side of H Lot could be eliminated with a modest control effort. Similarly, skeletonweed exists at a few locations on campus, including R Lot (at the interface between the residential area and woodlands), adjacent to H Lot, in the SSW (the greatly disturbed "Shooting Star Wasteland"), and in the NEW ("Northeast Woodlands"). Again, some modest control efforts might eradicate this weed.

While some species are new arrivals on campus, some are also being extirpated. The only lupine patch, at the southeastern extremity of campus, was lost via roadwork accompanying the new traffic circle and John Hindle Drive.

Two notable species-at-risk have used these "urban" areas of campus, badgers and Great Basin spadefoot. Prior to the establishment of UBC Okanagan, Okanagan University College staff noted the presence of a badger in the vicinity of Redwing Pond (east of the EME building). Badgers have more recently, in 2015, excavated an extensive system of burrows adjacent to University House. The following year a family of badgers appeared in the industrial park, just south of campus, and subsequently migrated onto campus (June 2016), adjacent to J Lot.

When three badgers were killed on Hwy 97, adjacent to campus in July 2016, it was thought that the campus badger population had been wiped out. Thereafter, however, a badger burrow appeared in fall 2017 adjacent to Redwing Pond. In May 2018, badgers were sighted at a burrow in an earthen bank, separating the gravel pit from Hollywood Rd, at the northeast extremity of campus. In 2018, other burrows, or potential burrows, were also located in the waste area behind the Purcell residence, and in the weedy "ironic grassland" north of University House.

From the badgers' perspective, these areas obviously offer good habitat, with abundant prey and suitable soils for constructing burrows. Badgers however range very widely, constructing burrows in various different locations throughout the year, so their appearance on campus is rather unpredictable. The increasing traffic on Hwy 97, and construction of new roads (e.g., John Hindle, and the forthcoming northward extension to campus of Hollywood Road - from Sexsmith Road), further threaten this species. We don't know what steps might feasibly mitigate against this threat.

A small population of Great Basin spadefoot was discovered in April 2013, breeding in a ditch forming the northern border of H Lot. Spadefoot tadpoles soon appeared and successfully completed metamorphosis in the ditch. Although evidence of spadefoot breeding (spring calling) has been noted in the ditch each spring since, there has been no comparable evidence of reproductive success. Two aspects of the ditch maintenance are likely contributing: 1) most of the ditch now dries out completely, very early in the breeding season, and 2) the one segment of the ditch that still retains water is now overgrown with cat-tails and other wetland plants. The spadefoot seem to prefer a more barren habitat. At this point, it is possible that the ditch is serving as a "sink" rather than a "source" of spadefoot (i.e., spadefoot may now be attracted to the ditch to breed, but the juveniles may die rather than being successfully recruited into the campus population).

Conclusions & Future Work

The UBC Okanagan campus lands encompass a range of habitats home to diverse communities comprising both indigenous and invasive, or potentially invasive, non-native species. The indigenous species include several species-at-risk (e.g., badger, avocet, Great Basin spadefoot). Sustainable management of campus lands is necessary to protect the species-at-risk, but also to preserve a significant educational resource, and prevent campus plant communities from being further degraded by alien weeds.

An area of particular concern is Robert Lake, where the current high waters and freshening trend threaten the existence of its distinctive salt-adapted flora and fauna. The proliferation of trails,

including unauthorised trail construction by mountain bikers, are a significant threat to the integrity of campus woodlands. In addition, campus lands provide key habitat for badger, spadefoot, and American avocet, and these species-at-risk deserve special consideration in campus planning and management.

We intend to continue documenting campus diversity in the current and forth-coming years, and to use our photograph collection to provide more extensive documentation of campus biodiversity. Little to no effort has been so far devoted to identification of grasses or bryophytes.

One of us (Ian) has a study leave approved for 2019-2020. A principal focus of his leave is developing an on-line, virtual museum of campus biodiversity, relying on our photographs. During the initial development phase this museum may be most easily hosted on his personal website, but should later migrate to a more permanent home, perhaps hosted on the BRAES or sustainability office websites, where it can serve more fully as a resource for planning, management and education.

Acknowledgements

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