RITHET'S BOG

CONSERVATION STRATEGY

Prepared for:

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March 1997

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ACKNOWLEDGMENTS

This study was supported by the Corporation of the District of Saanich, through a unique partnership with the University of Victoria. I am grateful to Dr. Don Hunter, Director of Parks and Recreation, and his staff for their support over the past two years. I have also enjoyed working with Karen Hurley, Manager of Environmental Planning Services, and David DeShane, Manager of Parks Operations.

I would like to give special thanks to Dr. R.T. Ogilvie, Dr. Adolf Ceska, Dr. Richard Hebda, Dr. Nancy Turner, and Diane Mothersill for their expert advice when reviewing an earlier draft of this report. The plant species list for Rithet's Bog was greatly expanded this year with input from Terry Taylor and Dr. Adolf Ceska.

I would like to acknowledge the help and support of my committee at the University of Victoria: Dr. Nancy Turner, Dr. Michael Edgell, Dr. Richard Hebda, and Dr. Dan Smith. I would also like to thank members of the Rithet's Bog Conservation Society for their enthusiasm and determination as the society expanded to become an important player in conserving the bog.

Finally, I would like to thank Nick Page for continuing encouragement, support and critical reviews of the draft report.

1.0 INTRODUCTION

This report presents a strategy to guide future restoration and management activities at Rithet's Bog. The strategy has been developed around the goal of maintaining or increasing populations of bog-dependent species. It also addresses the upland communities surrounding the bog.

Wetland conservation efforts require community support and volunteer participation. The strategy includes ideas for wetland education and interpretation, and suggestions for volunteer-based activities. It also provides a framework for monitoring changes in vegetation composition, wetland processes, and wildlife habitat-use; results will be useful for directing future restoration and management activities and evaluating their success. The strategy includes recommendations for specific management concerns such as path maintenance, changes to wildlife habitat, and invasive species control. Finally, it is important to note that the strategy is based on current knowledge, and will need to be modified as the bog changes and our understanding of local bog ecosystems and restoration methods increases.

1.1 Environmental Setting

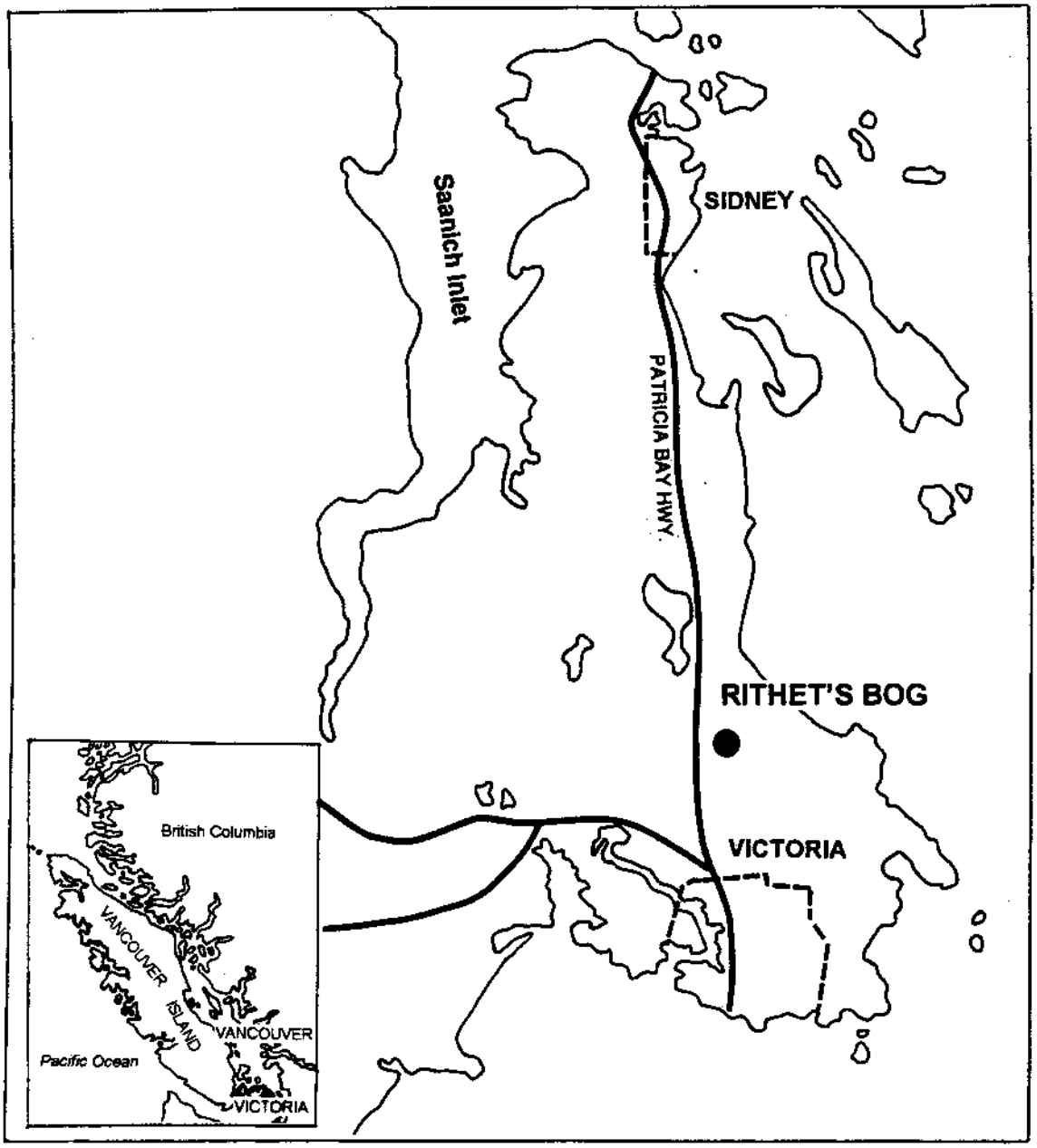
Rithet's Bog is a 42 hectare nature sanctuary (municipal park zoning P5) located in the Broadmead area of Saanich, near Victoria, B.C. (Figure 1.1). The park is owned and managed by the Corporation of the District of Saanich. Rithet's Bog is the last remaining bog of seven large bogs formerly found on the Saanich Peninsula (McMinn *et al.* 1976). As a locally rare habitat type, the ecological, archival, and educational value of Rithet's Bog has long been recognized by local naturalists and scientists (e.g., Roemer 1972; Dearden *et al.* 1976; McMinn *et al.* 1976; Ceska 1981, 1983; Turner and Hebda 1991).

The ecological condition of Rithet's Bog has been severely altered by agricultural use since 1880s (Arthur Locke, pers. comm. in Peden 1967) and more recently by urban development in the surrounding area. Despite negative impacts to vegetation and wildlife communities, several plant species associated with bog ecosystems remain. These include small populations of *Sphagnum pacificum*, *S. henryense*, northern starflower (*Trientalis arctica*), bog laurel (*Kalmia occidentalis*), and bog cranberry (*Vaccinium oxycoccos*).

The bog has been described as a "coniferous treed type basin bog" by the National Wetlands Working Group (Banner *et al.* 1988). The mature stand of shore pine (*Pinus contorta* var. *contorta*) is typical of drier, disturbed bogs. Labrador tea (*Ledum groenlandicum*), often the last bog-dependent species to remain in drained bogs (Rigg 1925), is common at Rithet's Bog. One of the most rare plants in B.C. (H. Roemer, pers. comm. 1996), *Betula pumila* var. *glandulifera* forma *hallii*, is also found at Rithet's Bog.

Surrounding the pine forest, a mosaic of wetland communities occur on previously

Figure 1.1
Location Map of Rithet's Bog



cultivated fields. Wetland community types reflect differences in hydroperiod, water chemistry, soil type, and the length of time since the area was cultivated. Wetland community types at the bog include forested bog, swamp, marsh, and developing fen (see Appendix I). Within these broad community types, different species assemblages are recognized.

1.2 Overview of Bog Characteristics

Bogs are wetland ecosystems that generally develop as a result of either *terrestrialization* (the infilling of shallow lakes), or *paludification* (the expansion of bogs into upland terrestrial ecosystems). A positive water balance (i.e., where inputs from precipitation exceed losses from evapotranspiration and runoff), is essential for bog development. Continuously wet, acidic conditions inhibit decomposition processes, resulting in peat accumulation (Mitsch and Gosselink 1993).

Most wetlands on the east coast of Vancouver Island are relatively small due to constraining topographic features and seasonal moisture deficits. Many bogs in the area are formed in depressions where drainage is impeded by bedrock, compact glacial till, or marine clay (Banner *et al.* 1988). Although it might be expected that water requirements are met by inputs from runoff from surrounding areas, the defining feature of *ombrotrophic* bogs is that the main source of water comes directly from precipitation. Mineral-rich runoff from surrounding areas is typically intercepted by a "lagg" or naturally occurring marginal ditch that supports swamp vegetation such as hardhack (*Spiraea douglasii*) (Rigg 1917, 1925; Rigg and Richardson 1934) and willow (*Salix* spp.).

Bog vegetation is characterized by plants adapted to continuously wet, acidic, and nutrient-poor conditions (van Breemen 1995), including *Sphagnum* mosses, ericaceous shrubs, and herbaceous plants. Dwarf coniferous trees, usually confined to hummocks, sometimes form a lesser component of the vegetation. Plant communities in undisturbed bogs differ distinctly from those found in drier, degraded bogs. Drained bogs in southwestern B.C. are usually characterized by: i) abundant conifer growth, especially shore pine and western hemlock (*Tsuga heterophylla*) (Rigg 1917, 1925; Pearson 1985; Banner *et al.* 1988); ii) dense growth of Labrador tea (Rigg 1922, 1925); and iii) only remnant patches of typical bog vegetation. Species like round-leaved sundew (*Drosera rotundifolia*) and bog cranberry commonly disappear when bogs are drained (Rigg 1925).

1.3 Why Manage and Restore Rithet's Bog?

In the past, bogs were often viewed as waste areas whose only use was for peat harvesting, farming, or development. Burns Bog, a very large bog in the Greater Vancouver area, is still being used as a landfill by the City of Vancouver. In Britain and Europe where very few undisturbed bogs remain, the value of conserving bog ecosystems is recognized, and restoration efforts are widely supported.

Although Rithet's Bog has been extensively disturbed, it provides the only remaining habitat for several species with limited local distribution, including some plant species that are near the southernmost extent of their range (Ceska 1978). Bog conservation is important for maintaining biodiversity. The wide variety of habitat types at Rithet's Bog support many species of birds, mammals, amphibians, insects, and fish. The bog's value as habitat is increasingly important in an area where the character of the surrounding landscape has rapidly changed from rural to urban.

Rithet's Bog should also be conserved for the paleoecological information preserved within the layers of undisturbed peat. Peat can be examined to determine the post-glacial history and development of the bog and its surroundings. Determining vegetation composition prior to disturbance enables researchers to reconstruct patterns of bog development (R. Hebda, pers. comm. 1996). Paleoecological information is also useful for understanding the effects of climate change; even small changes in climate will affect wetland plant communities within a very short period of time (Hebda 1994).

In areas where urban development dominates the landscape, conserving wetlands for their functional importance is essential. Bogs and fens act as carbon sinks, providing sources of oxygen that help regulate atmospheric quality (Bramyrd 1980). This is especially important when viewed on a world-wide scale (Vermeer and Joosten 1992). Wetlands also filter contaminants from run-off, and moderate flow conditions during storms and droughts (Mitsch and Gosselink 1993).

Rithet's Bog is well-situated for educational use as an "outdoor classroom" for local elementary and secondary students, and as a study site for post-secondary students. Its unique vegetation has been studied by several University of Victoria students over the past 30 years (e.g., Peden 1967; Zirul 1967; von Barloewen 1970; French and Lewis 1991; Chapman 1996). Bird life at the bog is also of interest to local birders (e.g., Stirling 1965b; Carson 1995).

1.4 Approaches to Bog Conservation

The goal of most bog restoration activities is to reduce the effects of previous damage, and to restore environmental conditions appropriate for maintaining or increasing populations of bog-associated species. There are two general approaches to bog restoration: i) internal, and ii) external (Vermeer and Joosten 1992). The internal approach addresses site-specific conditions, such as removing woody vegetation or blocking drainage ditches. It may include transplanting *Sphagnum*, and controlling invasive species. The external approach addresses functional processes, usually at the watershed scale. An example of outward management would be the creation of hydrological buffer zones, or a program to address the effects of air pollution (Vermeer and Joosten 1992). A local example that illustrates the importance of determining the most appropriate approach occurred at Richmond Nature Park, in Richmond, B.C., where restoration initiatives failed because water levels were kept low by an active drainage program in the surrounding area (K. Bauder, pers. comm. 1996).

2.0 RESTORATION

Ideally, ecological restoration refers to the process of returning an ecosystem to a pre-disturbance condition. Because former conditions are often unknown and ecosystems are dynamic and changing, however, the Society for Ecological Restoration (1995) adopted a more inclusive definition. Ecological restoration is defined as "the process of renewing and maintaining ecosystem health." Restoring wetland ecosystems requires that appropriate environmental conditions, characteristic biota, and features of ecosystem function and development be established (Wheeler 1995). Although there are no examples of bogs being completely restored, much research is being conducted throughout Canada, the UK, and Europe.

Research on bog restoration has focused on two central aspects of restoring functional processes required for continued bog development: i) determining appropriate hydrological conditions, and ii) testing methods of increasing *Sphagnum* cover. Both areas of research are of interest to conservation efforts at Rithet's Bog, although unlike many of the bogs being studied, the peat layers in the forested part of Rithet's Bog have not been damaged by peat harvesting.

The following sections outline preliminary restoration strategies for both the remnant bog and Garry oak communities surrounding the bog. For these communities, key restoration components include:

- restoring functional processes;
- increasing populations of characteristic plant and animal species; and
- managing invasive species.

A strategy to control the dominant invasive species at Rithet's Bog is outlined in Section 3.4.

2.1 Remnant Bog Community

Current Conditions

One of the main challenges at Rithet's Bog will be to determine whether current hydrological conditions are sufficient for maintaining or increasing the remnant bog community. Restoring *Sphagnum* cover is essential for continued bog development, because it acts as an "ecosystem engineer," maintaining wet, acidic, and nutrient-poor conditions (van Breemen, 1995). The forested condition of Rithet's Bog and changes to peat composition and structure present further challenges for restoration. In disturbed bogs, healthy coniferous trees increase water loss through evapotranspiration and rainfall interception (Wheeler and Shaw 1995; Burgess *et al.* 1995). Trees shade bog vegetation and smother it with leaf litter. Leaf litter also provides a source of nutrient enrichment. In drier sites, tree roots can cause the underlying peat layers to crack (Wheeler and Shaw 1995).

As described more fully in Golinski (1995), Rithet's Bog was severely damaged by agricultural use. Ditches excavated to increase drainage (Peden 1967) lowered water levels and introduced nutrient-rich water to the bog environment. At present, trees and shrubs dominate the wetland. While it is sometimes suggested that trees invade bogs as a result of natural successional processes (hydrosere succession), several authors have recently challenged the view that trees invade active, peat-forming *Sphagnum*-dominated communities (e.g., Burgess *et al.* 1995; Klinger 1996). They claim that trees only invade bog communities when the water balance is reduced, commonly through drainage, or in historical examples from changes in climate. Tree core analysis by University of Victoria dendrochronology students indicate that shore pine growth increased significantly about 80 years ago (C. Laroque, pers. comm. 1997), around the time when the bog was ditched.

Several species have been extirpated from Rithet's Bog, and some are now limited to small remnants of previously healthy populations. Extirpated species include Chamisso's cotton-grass (*Eriophorum chamissonis*) (Szczawinski and Harrison 1972), and round-leaved sundew (Rigg 1922; Stirling 1965a; Peden 1967; Szczawinski and Harrison 1972). Species with limited distribution at Rithet's Bog (less than 10 individual plants noted), include bog laurel (*Kalmia occidentalis*) and bog cranberry (*Vaccinium oxycoccos*).

Although most drainage ditches at the bog have been blocked, and water is no longer being pumped into the Colquitz River system, restoring the delicate water balance required to resume bog development will not be easy. Managing water regimes in bogs is not well understood (Burgess *et al.* 1995), and both the type of peat present and the degree to which it is decomposed affect water storage capacities (Wheeler and Shaw 1995). Water table instability severely inhibits *Sphagnum* regeneration (Money 1995), as does surface flooding (Mawby 1995). Research indicates that normal water level fluctuation in undisturbed bogs is limited to 300-400 mm (Schouwenaars and Vink 1992). Preliminary monitoring at Rithet's Bog near remnant patches of *Sphagnum pacificum* indicated that in 1996, water table levels fluctuated by about 600 mm between late summer and mid-fall. Monitoring hydrological conditions at other bogs in the region will help determine whether water levels at Rithet's Bog are within the range of water table fluctuation found in undisturbed reference bogs.

Prospects for Restoration

Creating hydrological conditions suited to further bog development may be difficult. Drainage alters environmental conditions in many ways, including:

- altered flow patterns;
- increased nutrient levels (caused by inflow of water from upland sources, decomposition of formerly saturated peat, and leaf litter inputs);
- lower surface elevation relative to surrounding land (caused by decomposition of formerly saturated peat layers);

- decreased water storage capacity, reduced depth, and possible damage to *Sphagnum* peat layers (these factors inhibit natural processes that regulate hydrological conditions); and
- decreased moisture levels due to increased evapotranspiration and rainfall interception by trees and shrubs.

Removing trees by hand-cutting and sky-hook logging has been used in an attempt to reduce moisture losses and litter-fall at Camosun Bog in Pacific Spirit Regional Park, Vancouver, B.C. One hundred and fifty large western hemlock were removed in 1991; it was found, however, that simply removing trees without accompanying measures to restore appropriate hydrological conditions was not enough to restore bog development (Brown 1996).

Another consideration for bog restoration is water quality. While every effort should be made to facilitate the hydrological requirements of bog ecosystems, controlling water quality within the catchment area may be difficult. It is interesting to note that some authors suggest that maintaining the required water *quantity* should take priority over concerns about water *quality* (Burgess *et al.* 1995).

Research on increasing *Sphagnum* cover has dominated the literature on bog restoration. Studies have examined whether fragments can be used to recolonize flooded pits in bogs degraded by peat-cutting (Money 1995), and the effect of water depth on regeneration (Clymo and Duckett 1986; Meade 1992; Mawby 1995; Rochefort *et al.* 1995; Campeau and Rochefort 1996). The unpublished results of experiments using fragments of *Sphagnum* to re-vegetate an area cleared of woody vegetation at Camosun Bog indicate that this method failed because the fragments were disturbed by rainfall. A more successful method involved transplanting small clumps of *Sphagnum* into 2 m^2 plots excavated to about 20 cm below ground level (T. Taylor, pers. comm. 1996). Other research on increasing *Sphagnum* cover examined the effect of covering *Sphagnum* with clear plastic to increase humidity (Rochefort *et al.* 1995), and the effect of reduced light levels on growth (Clymo 1973; Hayward and Clymo 1983; Clymo and Duckett 1986).

Restoring the remnant bog community will require further research at the local level, including a program to monitor hydrological conditions. Radical changes to bog hydrology (e.g., blocking drainage ditches to raise water levels), should not be made while current conditions are poorly understood. The Saanich Parks Department has made a positive step toward bog conservation by simply discontinuing agricultural use of the land surrounding the bog and the associated drainage program.

Radical changes to bog hydrology (e.g., blocking drainage ditches to raise water levels), should not be made while current conditions are poorly understood. If it becomes apparent that changes are necessary, restoration considerations might include:

- designing a weir system or other method of controlling drainage into the Colquitz River system; and

- blocking water flow into the central ditch through the bog forest.

Recommendations

1. Until the results of local research becomes available, restoration activities should focus on establishing baseline conditions through monitoring.

2. As major restoration initiatives may be expected to reduce forest cover at Rithet's Bog, it is suggested that support for bog restoration be gained from Saanich residents.

2.2 Garry Oak Community

While the conservation strategy focuses mainly on the wetland communities at Rithet's Bog, the upland areas are also important. These area have degraded by logging, grazing, and more recently by urban development. The earliest known map of the Rithet's Bog area (1887/88 Lang) indicates that the uplands were once characterized by Garry oak meadows, rock outcrops, coniferous forest, and what appear to be shrub thickets. A verbal account recorded by Peden (Arthur Locke, pers. comm. in Peden 1967) indicates that much of the area was cleared in the 1880s, and was subsequently grazed by cattle, horses, and sheep. Recent changes in vegetation and land-use patterns can be traced by examining aerial photographs of the area taken on a semi-regular basis from 1926 to 1992 (compiled in Golinski 1995).

In addition to direct physical disturbance, plant communities may have changed when traditional aboriginal management practices ceased. Garry oak meadows were seasonally burned in the Victoria area to increase production of food plants such as common camas (*Camassia quamash*), and to facilitate hunting (Turner 1994). Alternatively, naturally-occurring fires may have been common. The charred trunks of several Douglas-fir in the area surrounding the bog reflect burning in previous times (N. Turner, pers. comm. 1997). Burning, combined with grazing by large ungulate populations, would have reduced the extent of shrub layers (Roemer 1995).

All Garry oak plant communities in B.C. are considered to be endangered or threatened by the B.C. Conservation Data Center. By conservative estimates, only about 1% of Garry oak ecosystems remain in a natural state, and most support disproportionate numbers of exotic species (Hebda and Aitkins 1993; Roemer 1993). Scotch broom (*Cytisus scoparius*) and other invasive species suppress the growth of many small annuals, so that in disturbed areas, they are no longer visible (Roemer 1995). Scotch broom also alters edaphic conditions by increasing soil nitrogen, which facilitates the secondary invasion of nitrophilous (nitrogen-loving) species such as orchard grass (*Dactylus glomerata*) (Roemer 1995; R.T. Ogilvie, pers. comm. 1997).

Current Conditions

The upland area along the southern edge of Rithet's Bog supports fragmented stands of Garry oak (*Quercus garryana*), Douglas-fir (*Pseudotsuga menziesii*), and a mixture of native and exotic shrubs and herbaceous vegetation. Native shrubs include snowberry (*Symphoricarpos albus*), Nootka rose (*Rosa nutkana*), oceanspray (*Holodiscus discolor*), Saskatoon (*Amelanchier alnifolia*), Indian-plum (*Oemleria cerasiformis*), and trailing blackberry (*Rubus ursinus*). Bracken (*Pteridium aquilinum*) is also common. Invasive species include Scotch broom, gorse (*Ulex europaeus*), common hawthorn (*Crataegus monogyna*), Himalayan blackberry (*Rubus discolor*), and orchard grass. Common hawthorn is widespread throughout the area, and has invaded the old fields. Concentrated efforts to hand-pull and cut Scotch broom on a rock outcrop at the southeast end of the bog have resulted in a large patch of tall Oregon grape (*Mahonia aquifolium*) being "released" from competition (Linda Beare, pers. comm. 1995).

Prospects for Restoration

Restoring the original species composition of Garry oak communities is unlikely because there are few, if any, undisturbed communities that can be used as reference sites. Although there is little historic information on their original composition, careful control of the predominant invasive species, combined with reintroduction of key species, may result in near-natural species combinations being maintained (Roemer 1995).

The following goals are suggested for restoring the upland areas surrounding Rithet's Bog:

- encourage compositional and structural diversity;
- reduce fragmentation by restoring adjacent habitats to facilitate migration between community types along the moisture gradient in anticipation of climate change;
- reduce invasive species cover to lessen competition with native plants, and to reduce future seed sources; and
- establish a "buffer zone" between residential properties and the adjacent nature sanctuary using native vegetation.

Restoration activities in upland areas at the southern end of Rithet's Bog should include:

- enhancing current populations of Garry oak with acorns collected from nearby sources (e.g., the rocky knolls across Chatterton Way);
- mulching seedlings with oak leaves to add organic matter to eroded soils;
- staking Douglas-fir and arbutus seedlings to prevent trampling; and
- removing invasive species according to the strategy outlined in Section 3.4.

Sources of plant material should include locally collected seed, salvaged material, and locally grown container plants (where herbivores might consume smaller material).

Several management techniques have been suggested for restoring functional processes in oak-grassland ecosystems. These include:

- prescribed burns to reduce shrub and/or exotic plant cover (Packard 1988, 1993; Hyerczyk 1993);
- carefully timed mowing (i.e. mid- to late-summer) of aggressive grasses to reduce competition with native herbaceous plants (Ross 1991; Ingersoll and Wilson 1991; C. Brayshaw, pers. comm. 1996); and
- facilitating dispersal by planting carefully located clusters of larger trees and shrubs, to attract birds and provide perches, nest sites, and food sources (Robinson and Handel 1993).

There are several reasons why prescribed burning may be inappropriate for use at Rithet's Bog, including: i) increased fuel loads and an abundance of disturbance-adapted exotic species (Turner 1994; Agee 1994); ii) reduced organic soil layers as a result of former grazing; iii) liability issues concerning the nearby residential area; and iv) vulnerability of the bog forest to fire. Prescribed burning can only be recommended if a detailed proposal is approved by local scientific experts, and if safety concerns are carefully considered. Alternative techniques such as mowing should be tested in patches of approximately 10 m^2. Planting larger trees and shrubs should only be done after completion of a careful season-by-season inventory of the proposed planting location. This will avoid disturbance to the native flora and its seed bank, underground bulbs, and mycorrhizae. Trials to determine the best options for restoring the Garry oak community should be carefully recorded and monitored for success, then adapted as required.

Management considerations

Restored areas will require ongoing management to ensure that native species become well established, and invasive species are suppressed. This may include carefully removing competing vegetation from around seedlings, and mulching with oak leaves to enhance soils and provide protection from extreme temperatures. Continued planting until natural regeneration processes are established will result in a diversity of age structure. Damage to trees or shrubs by trampling or browsing can be addressed by using tree collars or other protection devices. Finally, seed sources of invasive species must be controlled if restoration efforts are to be successful.

Ensuring that Garry oak communities do not become dominated by trees and shrubs (other than oak) is another important consideration (Erickson 1996). At present, native shrub cover in the upland areas around the bog is definitely preferred over weed-dominated vegetation. Trees and shrubs provide structural diversity and shelter for birds and other wildlife. If woody vegetation begins to dominate, means of reducing its density can be considered.

Maintaining separation between the residential area and the park is desirable. Residents of Foxborough Hills should be encouraged to use nursery-grown shrubs like Nootka rose,

oceanspray, snowberry, Indian-plum, Saskatoon, mock orange (*Philadelphus lewsii*), red-flowering current (*Ribes sanguineum*), Oregon grape (*Mahonia* spp.), and kinnikinnick (*Arctostaphylos uva-ursi*) in their landscaping.

Recommendations

1. Conduct season-by-season inventories of native vegetation and wildlife in areas considered for restoration.

2. Manage invasive species to lessen competition with native vegetation and reduce future seed sources.

3. Enhance current populations of Garry oak by planting acorns collected from nearby sources, and by mulching seedlings with oak leaves to add organic matter to eroded soils.

4. Stake Douglas-fir and arbutus seedlings to prevent trampling.

5. Test alternatives to traditional management practices (e.g., carefully timed mowing of aggressive grasses).

6. Consider planting clusters of container-grown native trees and shrubs in areas with little remaining native vegetation to facilitate dispersal.

7. Maintain a "buffer zone" between residential properties and the adjacent nature sanctuary using native vegetation.

It is recommended that restoration initiatives be tested in small patches and monitored for successful results.

3.0 MANAGEMENT ISSUES

This section provides information and recommendations on key issues concerning the management of Rithet's Bog. Management issues that have been identified by researchers, local naturalists, Rithet's Bog Conservation Society members, and District of Saanich staff include:

- determining whether hydrological conditions are appropriate for continued bog development;
- path maintenance and flooding;
- perimeter path relocation;
- controlling invasive plant species;
- perceived changes to waterfowl and shorebird habitat;
- determining whether dogs belong in the nature sanctuary; and
- identifying sensitive plant communities and wildlife habitat.

Before implementing recommendations presented in this section, the Saanich Parks Department should seek input from the Rithet's Bog Conservation Society (RBCS). The society includes representatives from communities surrounding the bog, and from other groups such as the Victoria Natural History Society. The RBCS has asked members of the local scientific community to form a scientific advisory panel, which can address specific restoration and management concerns.

3.1 Hydrological Conditions

Hydrological conditions at Rithet's Bog have been stabilizing since 1994, when most of the drainage ditches in the old fields were blocked and the pump house was dismantled. It is still unclear, however, whether current conditions are sufficient for maintaining the remnant bog community. A preliminary survey of water table levels in August and September 1996, indicated that water levels measured in patches of *Sphagnum pacificum* fell to between 40.5-61.0 cm below ground level. Water levels measured in these areas were near or above ground level in late fall.

As stated in Section 2.1, water table instability and surface flooding severely inhibit *Sphagnum* regeneration. Establishing and maintaining appropriate hydrological conditions will be essential for conserving the bog. In addition to analyzing water levels throughout the year, it is important to identify water sources and flow patterns throughout the bog. Measures of water quality (e.g., pH, conductivity, temperature, nutrient analysis, ionic composition, heavy metals) should be measured to identify baseline conditions (Eliot *et al.* 1993). One particular concern at Rithet's Bog is that storm water entering the bog at the northeast end of the site may be contaminated with bacterial pathogens.

Recommendations

1. Examine hydrological conditions at the bog to determine whether current conditions are compatible with bog conservation goals. A baseline hydrological study will be useful for guiding future restoration and management decisions.

2. Concerns that storm water may be contaminated with bacterial pathogens should be addressed by the CRD Health Department. The Health Department should be requested take water samples for analysis.

3.2 Flooding of the Perimeter Path

The perimeter path along the southeast end of Rithet's Bog often floods in winter, resulting in water from upland sources flowing into the wetland. In addition to inconveniencing path users, flooding introduces water of unknown quality to the bog environment. Possible solutions to flooding include:

- clearing vegetation (e.g., *Typha latifolia*, *Salix* spp.) from the ditch and/or increasing its depth by hand-digging to improve flow;
- raising the elevation of the path using crushed granite or similar material, to create a barrier between the ditch and the wetland;
- installing a short section of boardwalk;
- installing drain pipes beneath the path to allow excess water to flow into the wetland, while keeping the path dry; and
- relocating the path further upland to avoid the area completely.

Deepening the ditch is undesirable because it may cause water to be drawn away from the bog. Removing vegetation and hand-digging are not recommended because vegetation in the ditch effectively acts as a bio-filtration swale, absorbing contaminants during low flows. The final three options do not prevent floodwater from reaching the wetland.

Recommendations

1. To ensure that water from upland sources does not reach the bog, it is recommended that the elevation of the perimeter path be raised where necessary.

2. PVC pipes temporarily located beneath the path should be removed when the path is raised.

3.3 Perimeter Path Relocation

The idea of relocating the path further upland near the southeast end of the site has been suggested. To relocate the path, land would have to be acquired from the Foxborough Hills properties. There are both advantages and disadvantages to relocating the path. Advantages include:

- lesser impacts of foot traffic near the wetlands at the southern end of the bog (some areas particularly sensitive to disturbance such as the small pond would not be avoided); and
- creation of an elevated vantage point for viewing the bog.

Disadvantages include:

- disturbance to vegetation alongside and beneath the proposed path location;
- increased proximity of foot traffic to adjacent residences, possibly raising concerns about security;
- significant outlay of funds by Saanich to relocate the path and revegetate the present route; and
- the path would no longer be "flat," which may limit accessibility for some users.

Recommendations

1. Before determining whether the path should be relocated, the proposed route should be marked, and all interested parties should meet to discuss their concerns and visit the site. If the path is to be relocated, the Rithet's Bog Conservation Society should be approached well in advance to organize a season-by-season inventory of vegetation and wildlife.

2. If the path is relocated, the present route should be revegetated.

3.4 Invasive Plant Species

Agricultural activities and urban development have disturbed native plant communities within and surrounding Rithet's Bog. Over half of the species included in Appendix II are non-native and the list does not include many of the agricultural weeds in the old fields at the southwest corner of the site.

Scotch broom, common hawthorn, and Himalayan blackberry are widespread at Rithet's Bog. European bittersweet is well-established in ditches throughout the bog, including the central ditch through the pine forest. Other invasive species such as Daphne-laurel (*Daphne laureola*), tree lupine (*Lupinus arboreus*), and English ivy (*Hedera helix*) are currently found in small numbers but may become widespread if not managed. Although it is not widely recognized as an invasive species, Daphne-laurel has invaded large areas of many parks including Cattle Point, Witty's Lagoon, and East Sooke Park. It is also common in residential gardens.

The Society of Ecological Restoration (SER) gives highest priority to controlling those species that pose the greatest ecological threats. These include exotics that: i) replace key indigenous species; ii) substantially reduce indigenous species diversity; or iii) significantly alter ecosystem or community structure or functions (Scherer 1994). Invasive species

often tolerate a wide range of site conditions, and are commonly adapted to produce many seeds or propagules, often with multiple methods of dispersal.

Invasive species successfully out-compete native plants that might otherwise re-colonize previously disturbed areas. Methods for controlling invasive species at the bog include cutting, hand-pulling, herbicides, and water level manipulation. Mechanical implements (e.g., the Weed Wrench) have been effective for removing Scotch broom, and bio-control methods (pathogenic fungi) are currently being developed for future use. Control methods such as pulling, digging, and herbicides must be used with caution. The effects of such potentially damaging methods on soil seed banks, bulbs, and mycorrhizae, for example, must be considered, and should only be used once a complete season-by-season inventory of the local area has been completed (R.T. Ogilvie, pers. comm. 1997).

Invasive species control should be combined with measures to restore native plant communities. Unless invasive species are simply suppressing native vegetation, removal from disturbed sites without subsequent restoration measures such as seeding, planting, and /or weeding can result in wasted time and effort. A strategy for controlling invasive plants at Rithet's Bog is outlined in Table 3.1. A brief description of each species, their distribution, dispersal mechanisms, and potential control methods is presented in Table 3.2.

Recommendations

1. Invasive species control efforts should be prioritized as outlined in Table 3.1. Management techniques should be tested in well-marked areas of approximately 2-4 m^2 for smaller plants, and about 10 m^2 for larger ones (e.g., Himalayan blackberry, Scotch broom).

2. Where invasive species are removed, efforts should be made to restore native vegetation.

3.5 Bird Habitat

Some birders and local residents have expressed concern about the reduced area of open water in the old fields alongside Chatterton Way (waterfowl and shore bird habitat). The old fields are being colonized by such species as *Typha latifolia*, *Salix* spp., *Polygonum amphibium*, and *Alisma plantago-aquatica*. There are varying opinions about whether the old fields should be actively managed for bird habitat or left to natural successional processes.

Carson (1995) documented the habitat use of Rithet's Bog by a wide variety of bird species. Shore birds and migrating waterfowl were often seen in the fields alongside Chatterton Way. The regional importance of agricultural areas like Rithet's Bog and Quick's Bottom for bird habitat was mentioned in another article by Carson (1996), who noted changes in the character of the habitat since these areas became parks. Although

Table 3.1
Invasive Species Control Strategy for Rithet's Bog

1. Set realistic goals:

- focus on areas with good potential for recovery; and
- recognize the limitations of volunteer time and energy.

2. Prioritize control efforts, focusing on areas with:

- satellite populations of few individuals;
- visibly suppressed native vegetation;
- rare or endangered species; and
- nearby uninvaded communities.

3. Conduct a thorough season-by-season survey of plants and wildlife in local areas to be considered for invasive species control. The survey area should be mapped, with clear reference to durable on-site markers.

4. Seek expert advice, and test management options in small patches to determine the most effective control method. Consider:

- avoiding disturbance to native vegetation (e.g., during flowering, seed production);
- avoiding disturbance to wildlife (e.g., during nesting season for birds, reptiles); and
- the effects of seasonal timing on treatment results (e.g., times of maximum moisture stress, energy stress during flowering).

5. Avoid soil disturbance, which may cause:

- further invasion;
- buried seeds to sprout; and
- destruction of fragile native species, including seeds, bulbs, and mycorrhizae.

6. Record methods and results using a standard format.

7. Replant areas where exotic species have been removed, as required, using locally obtained:

- seeds;
- salvaged material; and
- container-grown plants.

8. Plan for on-going management of cleared areas.

9. Monitor for re-invasion, and repeat or adapt control treatments where necessary.

Distribution at Rithet's Bog	Life Form	Density	Dispersal	Possible Control Methods*
SCOTCH BROOM (*Cytisus scoparius*)				
rock outcrops	shrub	locally dense patches	mechanical, birds, water	~Cut to ground level in summer, spring (R. Hebda pers. comm. 1997). ~Hand-pull young plants in winter to exhaust the seed bank and minimize disturbance.
GORSE (*Ulex europaeus*)				
rock outcrops	shrub	locally dense patches	mechanical, birds, water	~As with broom, above.
COMMON HAWTHORN (*Crataegus monogyna*)				
old fields, rock outcrops, hedgerows	small tree	heavily scattered	birds	~Cut to base.
ENGLISH HOLLY (*Ilex aquifolium*)				
pine forest	shrub/ small tree	scattered	birds	~Cut to base.
EUROPEAN MOUNTAIN-ASH (*Sorbus aucuparia*)				
pine forest	small tree	scattered	birds	~Cut to base.
DAPHNE-LAUREL (*Daphne laureola*)				
Douglas-fir forest (shaded areas)	shrub	scattered	mechanical, birds?	~Pull young plants. ~Herbicide.
HIMALAYAN BLACKBERRY (*Rubus discolor*)				
alongside path, old fields	shrub	dense thickets	vegetative, birds	~Cut stems every 2-3 weeks for 2 years. ~Apply Glyphosate to foliage in Sept./Oct. ~Apply Tryclopyr ester to foliage in mid-summer.
ENGLISH IVY (*Hedera helix*)				
alongside path in coniferous trees	vine	locally dense	vegetative birds	~Cut stems at base.
MORNING-GLORY (*Convolvulus sepium*)				
alongside path	vine	locally dense	vegetative	~Cut stems at base. ~Herbicide
EUROPEAN BITTERSWEET (*Solanum dulcamara*)				
ditches, along Chatterton Way, central ditch in pine forest, perimeter ditch	vine-like	locally very dense	water, birds?	~Clip -test for effectiveness. ~Pull ~Paint leaves with Round-up in late summer.
REED CANARY GRASS (*Phalaris arundinacea*)				
old fields, ditches with saturated soils	perennial grass	very dense patches	water	~Water level manipulation
ORCHARD GRASS (*Dactylis glomerata*)				
alongside path, rock outcrops	perennial grass	very dense patches	vegetative? seed	~Mow to prevent seed set. ~Pull/ dig out.

*** Some of the listed control methods (e.g., hand-pulling, digging, herbicide use) may negatively impact native flora, its seed bank, underground bulbs, mycorrhizae, etc. Before any control efforts begin, a season-by-season inventory of native species is required, and local scientific advisors should be consulted to comment on the proposed control plans.**

Table 3.2
Invasive Plant Species at Rithet's Bog

shore bird and waterfowl habitat has decreased in some places, it has increased in others such as Viaduct Flats. The importance of Rithet's Bog to seasonal and resident bird populations should not be ignored, however, maintaining a particular type of habitat should not come at the expense of the remnant bog community.

Possible solutions to the change in bird habitat include:

- resuming agricultural activities at the bog;
- selectively trimming colonizing vegetation to reduce evapotranspiration; and
- increasing the depth of water in the old fields by manipulating outflow from the bo.

There are several arguments against these "solutions." Further drainage will surely eliminate the remnant bog community. In addition, vegetation now colonizing the old fields is important for improving water quality. Before it is determined whether any of these options is feasible, a baseline study of hydrological conditions is required. Wetlands are very sensitive to change, and current qualitative observations over the past two or three years (since agricultural operations ceased) are insufficient for making major management decisions.

Recommendations

1. A baseline study of the hydrological conditions at the bog should be initiated, to be used (among other purposes) for making future recommendations about maintaining shore bird and waterfowl habitat.

2. Making and installing nesting boxes for various bird species around the perimeter of the bog should be considered. Such an activity could be coordinated by the Victoria Natural History Society if interest exists, and done in partnership with local schools. Bat boxes should also be considered.

3.6 Dogs, Cats, and Other Non-native Animals

As a designated nature sanctuary, Rithet's Bog supports a wide variety of bird species and other wildlife. The Saanich municipal park zoning P5 indicates that the park has significant value as a natural area. Unlike Swan Lake/Christmas Hill (the only other P5-zoned park in Saanich), dogs are not currently banned from Rithet's Bog. Carson (1995) noted that the perimeter path is located very close to sensitive bird habitat. The small pond at the southeast corner of the park, for example, recently supported locally rare bird species such as long-billed marsh wren (*Cistothors palustris*), Virginia rail (*Rallus limicola*), and sora (*Porzana carolina*). Muskrats (*Ondatra zibethicus*) and mink (*Mustela vison*) live in the ditches alongside the perimeter path, and are also sensitive to disturbance.

Other non-native animals that may be affecting wildlife and vegetation include feral cats, grey squirrels, and rabbits. Evidence of rabbits is widespread in the grassy areas at the southeast end of the bog.

Recommendations

1. To be consistent within the Saanich Parks system and to protect birds and other wildlife, dogs should be banned from Rithet's Bog.

2. It is recommended that the local humane society be asked to advise on the best approach for removing feral cats, non-native squirrels, and rabbits.

3.7 Special Conservation Areas at Rithet's Bog

Several plant communities and wildlife habitats in the Rithet's Bog area been identified as "special conservation areas" in this report (see Figure 3.1). The purpose of identifying and mapping these areas is to avoid inadvertent damage (e.g., by mowing, inappropriate placement of site furniture).

Special conservation areas at Rithet's Bog include:

- Garry oak communities;
- remnant bog community;
- population of Hall's birch;
- developing fen community;
- the small pond;
- ringlet habitat;
- great horned owl perch; and
- charred old-growth Douglas-firs.

Some form of barrier to access, or at minimum, informational signs should be considered for the rocky knolls along Chatterton Way. Since the area has been developed, delicate moss layers on the northern knoll have been damaged by trampling, and the amount of garbage found on the lower slopes has increased noticeably. This situation can only be expected to get worse as population pressures increase.

Recommendations

1. To avoid inadvertent damage to sensitive plant communities and wildlife habitat, Saanich Parks staff and members of the Rithet's Bog Conservation Society should familiarize themselves with "special conservation areas" at the bog.

2. To reduce damage to the Garry oak communities on the rocky knolls along Chatterton Way, access should be discouraged.

Figure 3.1
Special Conservation Areas at Rithet's Bog

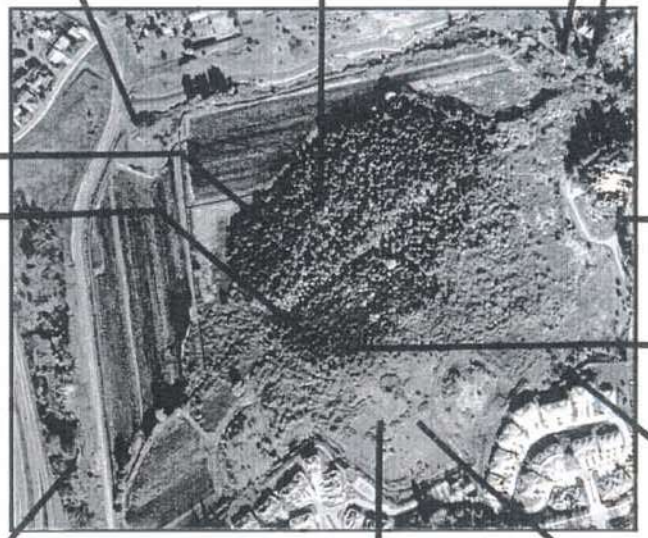
Garry oak community
~ harvest brodiaea (*Brodiaea coronaria*)
~ fool's onion (*B. hyacinthina*)
~ Indian celery (*Lomatium nudicaule*)

remnant bog community
~ *Sphagnum pacificum, S. henryense*
~ bog laurel (*Kalmia occidentalis*)
~ bog cranberry (*Vaccinium oxycoccos*)
~ Labrador tea (*Ledum groenlandicum*)

remnant bog community
~ Labrador tea (*Ledum groenlandicum*)

Garry oak community
~ well-developed Garry oak community
(see species list, Appendix III)

great horned owl perch
~ *Bubo virginianus*



developing fen community
~ Pacific tree frog (*Hyla regilla*) habitat
~ great blue heron (*Ardea herodias*)

Garry oak community
~ harvest brodiaea (*Brodiaea coronaria*)
~ Hooker's onion (*Allium acuminatum*)
~ common camas (*Camas quamash*)

Garry oak habitat
~ northern alligator lizard
(*Gerrhontus coeruleus principis*)
~ propertius dusky wing (*Erynnis propertius*)

charred old-growth Douglas-fir trees
~ near parking area along Fir Tree Glen
~ trail between Dalewood Lane, Fir Tree Glen

population of Hall's birch
~ *Betula pumila* var. *glandulifera* forma *hallii*

small pond
~ sora (*Porzana carolina*)
~ Virginia rail (*Rallus limicola*)
~ long-billed marsh wren (*Cistothors palustris*)

ringlet habitat
~ ringlet (*Coenonympha tullia insulana*)

4.0 MONITORING PROGRAM

This section outlines a monitoring program that can be used to provide information for managing the bog, and for evaluating restoration and management initiatives. Data collected through the monitoring program will be useful for indicating changes in the bog environment over time. The monitoring program will specifically be useful for:

- understanding hydrological conditions;
- determining whether wetland vegetation communities are changing;
- tracking populations of plant species with limited local distribution;
- detecting new populations or further spread of invasive species; and
- tracking bog habitat-use.

To objectively evaluate environmental conditions, plant communities, and habitat-use of the bog, quantitative or "hard" data must be collected. Each component of the monitoring program will require an explicit methodology for data collection.

Approaches to Monitoring

Monitoring can be divided into three types of activities: i) baseline studies; ii) routine assessments; and iii) comprehensive assessments. *Baseline studies* outline conditions at the start of a monitoring program, and provide a standard for future comparison. When compared to subsequently collected data, changes in vegetation composition, habitat-use, and functional processes can be evaluated. *Routine assessments* include visual comparisons of current conditions to maps, photographs, and recorded data (Hairston 1993). Routine assessments are useful for identifying problems that require correction, such as new populations of invasive species or flooding caused by blocked drainage pipes. *Comprehensive assessments* can be used to address questions that require quantitative data (Hairston 1993). They require careful planning to ensure that good quality data is collected. An example of a comprehensive assessment would be a program to measure water levels at the bog on a monthly basis.

Data Quality and Storage

It is important to collect high quality data, especially for comprehensive assessments. Using standard sampling procedures throughout the monitoring program will facilitate comparison between sampling periods. Standard sampling procedures should be developed for each monitoring activity, including data collection forms. Copies of sampling procedures, data collection forms, and collected data should be centrally stored for ease of access. It is suggested that for Rithet's Bog these documents be stored at the Saanich Parks Department office, with copies to the Restoration of Natural Systems Program (RNS) at the University of Victoria. It is important to make records available to people who will be doing further monitoring and research, to help maintain consistency over time and improve interpretation of results.

Monitoring Activity	Method	Frequency	When	Coordinated by:
HYDROLOGY				
water table levels	dipwells/ staff gauges	every 2 weeks	continuous	K.G., RBCS
storm events	dipwells/ staff gauges	as required	as required	RBCS
water quality (pH, temp., nutrient analysis, (ionic composition, heavy metals)	water samples	seasonal	summer, fall, winter, spring	K.G., RNS Program
water quality (bacterial pathogens)	water samples	as required	summer	CRD Health Department
VEGETATION				
wetland plant communities	photo record, fixed plots % cover	yearly	June-August	RNS Program, RBCS
plants with limited local distribution	map, population counts % cover	yearly	April-September	K.G., RNS program, Management Group,
invasive vegetation populations	map, photo record % cover	yearly	August	RBCS
results of control measures (invasive vegetation)	permanent plots	yearly	July-August	RBCS
detect new pops. of invasive exotic species	spot checks/ photo record	yearly	July-August	RBCS
WILDLIFE HABITAT-USE				
bird survey	species counts	weekly	every five years	VNHS
butterfly survey	species counts	monthly	April-October	CASE
surveys, other animals	species counts	occasional	occasional	local experts, university students

Table 4.1
Monitoring Program Recommended for Rithet's Bog

Data quality depends on precision, accuracy, completeness, representativeness, and comparability (Hairston 1993). Each addresses a different aspect of data quality. *Precision* is the degree of refinement in a measurement. *Accuracy* represents the degree to which a measurement represents the true value of the variable being measured. *Completeness* is determined by the amount of data collected compared to the amount that would have been collected under ideal circumstances. This is sometimes limited by time constraints, poor field conditions, or loss of samples or data. Developing standard sampling procedures and data collection forms can help ensure completeness. *Representativeness* refers to the degree to which a site or data collected is typical of the variety of sites or data available. Study sites, transects, and plots are normally selected to represent typical conditions. Finally, *comparability* addresses worker-caused differences between data sets. It is especially important to maintain comparability when several people will be collecting data on the same variable over time.

Data collected as part of the monitoring program should be compiled and presented in simple report form. Reports should include actual data collected (raw data), a summary of current conditions, and comparison with previous results. As previously noted, monitoring results should be stored at the Saanich Parks Department, with copies to the RNS Program. Results should be reviewed annually to determine whether restoration and management initiatives need to be revised. Copies of reports that indicate the status of species being tracked by the B.C. Conservation Data Center (CDC) should be forwarded directly to the CDC.

In developing a framework for a monitoring program for Rithet's Bog, the following questions were considered:

- What information is required to address management concerns and plan future restoration initiatives at the bog?;
- What type of data, including level of detail, frequency, and timing of collection will best illustrate results?;
- What areas, communities, or species should be targeted?; and
- What resources (people and equipment) are available?

It is suggested that data on vegetation, wildlife, and hydrological conditions be supplemented with photographs, maps, and graphs. Maps are useful for indicating such information as the location of study plots, plant community boundaries, and for delineating drainage patterns and structures. Major flooding, wind and snow storms, fire, or human-caused disturbances that might influence the results of restoration activities should be recorded. A table outlining monitoring tasks, including general methods, frequency, and timing is given in Table 4.1. The implementation of any management or restoration initiatives should also be documented. This type of information will be useful when evaluating whether similar efforts might be applicable elsewhere.

4.1 Hydrology

A series of dipwells located at regular intervals along transects throughout the bog can be used to measure water table depths. Measurements should be made on a monthly basis at minimum, to adequately illustrate patterns of hydroperiod (Brown 1996). Where possible, dipwells should be anchored to prevent movement, either by direct installation into the underlying mineral ground, or by attachment to anchor posts. Dipwells should be leveled to a fixed datum to enable absolute comparison of water levels. Water levels relative to the peat surface should also be assessed. In flooded areas, water levels can be measured using anchored staff gauges.

Baseline studies of water quality should include measures of pH, conductivity, temperature, nutrient analysis, ionic composition, and heavy metals. Samples should be taken over a period of at least one year to detect seasonal variation.

4.2 Vegetation

Methods of monitoring bog vegetation can include use of permanent and random plots, routine assessments, species counts, patch size measurements, and fixed point photographs. Recording the area of bare ground, open water, and plant cover within permanent plots will help determine whether species composition is changing. Permanent plots are also be useful for determining whether invasive species control efforts have been successful. Routine assessments can be used to detect new individuals or populations of invasive species. Species counts and patch size measurements to track the status of remnant populations of bog vegetation, as well as other species of interest to the CDC form another important component of the monitoring program.

Wetland Plant Communities

Wetland plant communities in the old fields should be monitored to determine whether vegetation composition is changing. Wetland plants reflect environmental conditions and successional development in previously disturbed areas. Permanent plots should be located along transects in the various wetland community types, and data collection should include cover estimates. Monitoring activities in wetlands must be carefully timed to ensure mature parts required for plant identification (especially sedges, rushes, and grasses), are present.

Populations of Species with Limited Local Distribution

Populations of *Sphagnum pacificum, S. henryense*, northern starflower, bog laurel, bog cranberry, and Hall's birch should be monitored to determine whether populations are stable, expanding, or decreasing. Recommended methods for monitoring small populations of species with limited local distribution include population counts, patch size measurements, and photographic records. Locations of species with limited local distribution should be mapped.

Invasive Species

Results of efforts to control invasive species should be monitored using permanent plots. Routine assessments can be used to detect invasive species formerly unknown at the bog, and to determine whether known species are spreading into new areas. Maps and photographs should be used to supplement numerical data and written information.

4.3 Bird Surveys

The survey initiated by Carson (1995) provides an excellent baseline study of bird habitat-use for Rithet's Bog. The survey can be used to compare habitat-use when the bog first became a park to its use in subsequent years. Carson's survey was conducted over a period of 12 months, effectively illustrating seasonal trends. Bird survey data can be used to prioritize local and regional habitat management concerns.

A full description of the baseline bird survey for Rithet's Bog is given in Carson (1995). While it is recognized that such studies are extremely time-consuming, VNHS members should be encouraged to repeat their study in about five years to determine whether habitat-use has changed significantly since the bog was made a park.

4.4 Butterfly Surveys

Detailed invertebrate surveys are time-consuming and expertise-intensive. One volunteer-based initiative being undertaken in Victoria is the monthly (April-October) butterfly survey coordinated by the community group Citizens Association to Save the Environment (CASE). The purpose of the survey is to provide an assessment of butterfly abundance in the Victoria area. The butterfly count is conducted in most parks, and in other areas that are surveyed as part of the local Christmas bird count. Informed amateurs visit the same site on a monthly basis throughout the season, recording all individuals of each butterfly species observed along a particular route. With additional training, this model might be followed to conduct surveys of dragonflies, damselflies, and other insect groups at Rithet's Bog. Changes in management regimes (e.g. water table level; vegetation change; creating, enlarging, or reducing areas of open water) may have significant effects on population levels and even survival of some invertebrate species.

4.5 Other Animals

Initial baseline studies of habitat use by bats, mammals, reptiles, and amphibians should be conducted by specialists or trained biology students. Suggested frequency of monitoring may be indicated by specialists.

Recommendation

1. Initiate a program to monitor various aspects of the bog environment, including: hydrological conditions; changes to wetland vegetation communities; the status of plant species with limited local distribution; invasive species populations; and bog habitat use.

5.0 EDUCATION AND INTERPRETATION

An important component of the conservation strategy is to raise public awareness of the importance of wetland ecosystems. This can be achieved by developing opportunities for educational use of the bog, and through initiatives such as newsletters, naturalist-led tours, and interpretive signs.

5.1 Educational Opportunities for Elementary and Secondary Students

The wetlands surrounding Rithet's Bog are well suited for use as an "outdoor classroom." To enable teachers to use the bog for study purposes, a package of background materials should be developed. Ideally one or more teacher's guides for Rithet's Bog would include:

- a trail map with descriptions of the various wetland community types and habitats;
- illustrated descriptions of interesting plants, birds, mammals, amphibians, and insects;
- an outline of the history of the bog, with reproductions of historical photographs;
- a list of volunteers who might be willing to guide nature walks or give informal lectures or slide shows; and
- a list of wetland-related educational materials (e.g., videos, books).

Study topics that might be of interest to upper-level students include:

- the influence of water levels on wetland plant distribution;
- adaptations for survival in wetlands;
- the character of successional sequences;
- the relationship between wetlands and uplands, including connections to other water bodies (e.g., Rithet's Bog and the Colquitz River system); and
- First Nations' plant uses.

Information on possible field trips to undisturbed bogs should also be provided.

Professors in the Faculty of Education at the University of Victoria should be approached to determine whether they might be interested in having their students develop a teacher's guide as a course assignment. Instructors at Camosun College could also be contacted to determine whether there is interest in producing a video to complement other educational materials.

5.2 Post-secondary Students

Rithet's Bog is well-situated as a study site for University of Victoria and Camosun College students. Access to site-specific background materials and the nearby location of the bog make it an ideal site for further study. Although somewhat farther afield, the bog may also be of interest to students at Royal Roads University. Various aspects of the bog environment have been studied by University of Victoria students over the past 30 years,

including: vegetation and ecology (Peden 1967); paleoecology (Zirul 1967, von Barloewen 1970); the relationship between floristic distribution and water levels (French and Lewis 1991); and wetland plant community composition in relation to water depth and pH (Chapman 1996). In 1996, University of Victoria dendrochronology students visited Rithet's Bog to determine the age of some pines in the bog forest. The bog is also the primary study site for current research on bog restoration, as described in Section 6.0.

While the above-mentioned studies have contributed to our understanding of past and present conditions at the bog, further research by classes or individuals is strongly encouraged. Baseline inventory work has yet to be done for insects, amphibians, reptiles, and mammals. Studies similar to Chapman's (1996), but using permanent plots, will help quantify successional changes in the wetland plant communities surrounding the bog. Students may also be interested in participating in the monitoring activities outlined in Section 4.0.

The Saanich Parks Department should continue to encourage students to use the bog as a study site. It is also recommended that Saanich work with the Rithet's Bog Conservation Society to develop a process for research approval, and guidelines for study site use to help ensure that research activities do not adversely affect the bog environment. The approval process should be quick and simple to acknowledge the usual time constraints placed upon students. A simple brochure with guidelines for site use should also be offered to students prior to project approval.

5.3 Access

Increasing wetland interpretation and education opportunities at the bog will have many benefits. It is important to ensure, however, that the bog is not damaged by overuse. Bringing people close enough to the bog to see and learn about its unique features must be balanced with protection from overuse and intentional damage (Kusler 1993). This may include physical disturbance, litter, and removal of native plant materials (i.e. plant poaching). The present location of the perimeter trail around the edge of the park and a deliberate decision not to develop trails into the bog forest keeps most people from entering the wetlands. Yet the perimeter trail comes very close to sensitive bird habitat in some areas, and Carson (1995) noted the disruptive effects of dogs on birds.

Because the remnant bog community is sensitive to damage, trails should not be developed to access the pine forest. Trampling compacts peat layers, understory vegetation in the forest is very thick, and accumulated plant-litter creates a potential fire hazard. In addition, some of the large pine trees in the forest are unstable, as evidenced by the number of trees that fell during wind storms last year.

5.4 Interpretation

The following ideas are suggested for increasing public awareness of the importance of wetland conservation:

- an "open house" at the bog with activities and displays by various groups;
- display boards for use at meetings (e.g., the annual Native Vegetation Symposium held at the University of Victoria);
- a quarterly newsletter;
- an internet webpage (this would require a "webmaster" to keep it updated); and
- illustrated signs strategically located around the perimeter of the bog.

An illustrated sign with a map of the trail system, and information on interesting features, should be located along the trail near the corner of Chatterton Way and Dalewood Lane. Signs located elsewhere along the perimeter trail could describe various wetland community types and associated wildlife.

A quarterly newsletter could include:

- results of monitoring activities;
- notices and reports of special events (e.g., annual open house, naturalist-guided walks, field trips to undisturbed bogs or other bogs being restored);
- announcements of work parties and meetings (a "community calendar");
- information on reducing negative impacts to the bog (e.g., excessive fertilizer use, garden waste disposal);
- information on plants and wildlife at the bog;
- reports of unusual sightings (e.g., birds, wildlife);
- First Nations' uses of bog-associated plants;
- artwork; and
- reports from other groups (e.g., the Burns Bog Conservation Society).

The Burns Bog Conservation Society publishes such a quarterly newsletter, which could serve as a model.

6.0 RESEARCH

The research suggested in this section will provide information that can be used to guide future conservation initiatives at Rithet's Bog. The research program suggested here focuses on three key components of bog restoration and management: i) determining appropriate environmental conditions, ii) maintaining characteristic bog vegetation, and iii) restoring functional processes. To determine success criteria (Pavlik 1996) for restoring bog vegetation, historical accounts and species lists for Rithet's Bog have been reviewed. To complement these descriptions, macrofossils preserved in peat layers at the bog should be examined, and compared to vegetation composition in undisturbed reference bogs. Baseline studies of hydrological conditions at Rithet's Bog should be completed, and also compared those in reference bogs. This will help determine whether conditions at Rithet's Bog are appropriate for maintaining or increasing the remnant bog community. Methods of increasing populations of key plant species should also be examined.

Proposed research includes:

- a study of the hydrological characteristics of Rithet's Bog;
- analysis of peat cores to determine pre-disturbance vegetation composition;
- a survey of undisturbed reference bogs to determine success criteria for restoration; and
- experiments to test methods of increasing populations of bog-associated plant species.

It is expected that at least some of the research activities outlined above will be conducted as part of the author's Ph.D. program.

6.1 Bog Hydrology

To better understand hydrological conditions at the bog, and to provide a basis of comparison with other bogs in the area, the following research initiatives are suggested:

- a program to monitor water table levels;
- measuring pH, conductivity, temperature, nutrients, ionic composition, and heavy metals; and
- identifying water flow patterns throughout the bog, including inflow and outflow.

6.2 Bog Sediments and Paleoecology

Plant material and pollen grains preserved within layers of peat can be used to reconstruct the history of the bog and its surroundings. Paleoecological information increases our understanding of bog development and successional processes, and is also useful for determining how drainage affected vegetation composition. By combining this information with historical accounts and data obtained from reference sites, the pre-disturbance state of the bog will become apparent.

6.3 Reference sites

Reference sites are essential for determining success criteria (Pavlik 1996). Examining reference sites can help determine, for example, whether the hydroperiod at Rithet's Bog is similar to that of other bogs in the area. Unless undisturbed bogs occurring under similar climatic conditions are studied, it will be necessary to rely on descriptions of bogs with different plant species, and that developed under different conditions.

Reference sites for the proposed research will be selected from bogs located at lower elevations on the east coast of Vancouver Island (south of Campbell River), and the adjacent mainland. Ideally, the following data should be collected from study sites:

- plant species lists;
- cover estimates for key plant species, based on 10 m^2 plots for tree and shrub layers, and 1m^2 plots for mosses and herbaceous species. (Plots should be located in areas of uniform cover, considered typical of the variety of vegetation types found in the area);
- peat core samples from the upper 1 meter of substrate to describe peat composition using macro-fossil identification;
- estimates of organic material depth, including layer sequences;
- estimates of organic matter decomposition using the "von Post scale"; and
- water table levels and pH.

6.4 Bog Vegetation

Another important research initiative involves propagating and transplanting *Sphagnum* and other species (e.g., bog laurel, bog cranberry), to increase remnant populations at the bog. Such research will help determine appropriate propagation methods, and can be used to identify the appropriate conditions for recipient sites. This is an important consideration when using material from remnant populations; if optimal methods and transplant site conditions can be identified, these sources can be conserved.

Specific research initiatives include:

- propagating and transplanting bog-associated species; and
- evaluating the effects of trimming vegetation surrounding remnant patches of *Sphagnum*.

Recommendations

1. Initiate a study to examine the hydrological characteristics of Rithet's Bog.

2. Analyze macrofossil contents of peat cores at Rithet's Bog to determine pre-disturbance vegetation composition.

3. Survey undisturbed reference bogs to determine success criteria for bog restoration.

4. Conduct experiments to test methods of increasing populations of bog plant species.

7.0 SUMMARY OF RECOMMENDATIONS

7.1 Restoration: Remnant Bog Community

Radical changes to bog hydrology (e.g., blocking drainage ditches to raise water levels), should not be made while current conditions are poorly understood. If it becomes apparent that changes are necessary, restoration considerations might include:

- designing a weir system or other method of controlling drainage into the Colquitz River system; and
- considering methods to block the central ditch through the bog forest.

1. Until the results of local research becomes available, restoration activities should focus on establishing baseline conditions through monitoring.

2. As major restoration initiatives may be expected to reduce forest cover at Rithet's Bog, it is suggested that support for bog restoration be gained from Saanich residents.

7.2 Restoration: Garry Oak Community

1. Conduct season-by-season inventories of native vegetation and wildlife in areas considered for restoration.

2. Manage invasive species to lessen competition with native vegetation and reduce future seed sources.

3. Enhance current populations of Garry oak by planting acorns collected from nearby sources, and by mulching seedlings with oak leaves to add organic matter to eroded soils.

4. Stake Douglas-fir and arbutus seedlings to prevent trampling.

5. Test alternatives to traditional management practices (e.g., carefully timed mowing of aggressive grasses).

6. Consider planting clusters of native trees and shrubs in areas with little remaining native vegetation to facilitate dispersal.

7. Maintain a "buffer zone" between residential properties and the adjacent nature sanctuary using native vegetation.

It is recommended that restoration initiatives be tested in small patches and monitored for successful results.

7.3 Management Issues

Hydrological Conditions

1. Examine hydrological conditions at the bog to determine whether current conditions are compatible with bog conservation goals. A baseline hydrological study will be useful for guiding future restoration and management decisions.

2. Concerns that storm water may be contaminated with bacterial pathogens should be addressed by the CRD Health Department. The Health Department should be requested take water samples for analysis.

Flooding of the Perimeter Path

1. To ensure that water from upland sources does not reach the bog, it is recommended that the elevation of the perimeter path be raised where necessary.

2. PVC pipes temporarily located beneath the path should be removed when the path is raised.

Perimeter Path Relocation

1. Before determining whether the path should be relocated, the proposed route should be marked, and all interested parties should meet to discuss their concerns and visit the site. If the path is to be relocated, the Rithet's Bog Conservation Society should be approached well in advance to organize a season-by-season inventory of vegetation and wildlife.

2. If the path is relocated, the present route should be revegetated.

Invasive Plant Species

1. Invasive species control efforts should be prioritized as outlined in Table 3.1. Management techniques should be tested in well-marked areas of approximately 2-4 m^2 for smaller plants, and about 10 m^2 for larger ones (e.g., Himalayan blackberry, Scotch broom).

2. Where invasive species are removed, efforts should be made to restore native vegetation.

Bird Habitat

1. A baseline study of the hydrological conditions at the bog should be initiated, to be used (among other purposes) for making future recommendations on the issue of maintaining shore bird and waterfowl habitat.

2. Making and installing nesting boxes for various bird species around the perimeter of the bog should be considered. Such an activity could be coordinated by the Victoria Natural History Society if interest exists, and done in partnership with local schools. Bat boxes should also be considered.

Dogs, Cats, and Other Non-native Animals

1. To be consistent within the Saanich Parks system and to protect birds and other wildlife, dogs should be banned from Rithet's Bog.

2. It is recommended that the local humane society be asked to advise on the best approach for removing feral cats, non-native squirrels, and rabbits.

Special Conservation Areas at Rithet's Bog

1. To avoid inadvertent damage to sensitive plant communities and wildlife habitat, Saanich Parks staff and members of the Rithet's Bog Conservation Society should familiarize themselves with "special conservation areas" at the bog.

2. To reduce damage to the Garry oak communities on the rocky knolls along Chatterton Way, access should be discouraged.

7.4 Monitoring Program

It is recommended that a monitoring program be initiated to monitor various aspects of the bog environment, including:

- hydrological conditions;
- changes to wetland vegetation communities;
- the status of plant species with limited local distribution;
- invasive species populations; and
- bog habitat use.

7.5 Education and Interpretation

1. One or more teacher's guides to Rithet's Bog should be developed to encourage age-appropriate wetland education opportunities.

2. The use of Rithet's Bog as an outdoor science lab for post-secondary students should be encouraged.

3. The Saanich Parks Department, in cooperation with the Rithet's Bog Conservation Society, should develop a process for approving research projects at the bog. In addition, general guidelines should be established for use of the bog by researchers.

4. To avoid disturbance to the remnant bog community, trails to access the bog forest should not be developed.

5. It is recommended that the Saanich Parks Department and other interested groups consider working on the following ideas to increase public awareness of wetland conservation:

- an "open house" at the bog, with activities and displays by various groups;
- informational display boards for use at public meetings;
- a quarterly newsletter;
- an internet webpage; and
- illustrated signs located strategically around the perimeter of the bog.

7.6 Research

It is recommended that research priorities for Rithet's Bog include:

- a study of the hydrological characteristics of Rithet's Bog;
- analysis of peat cores to determine pre-disturbance vegetation composition;
- a survey of undisturbed bogs to determine success criteria for bog restoration; and
- experiments to test methods of increasing populations of bog plant species.

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APPENDIX I
Wetland Community Types

Many terms have been used to describe the various types of wetland ecosystems (Gore 1983). These terms have often developed separately in different regions or continents (Mitsch and Gosselink 1993), reflecting the wetland communities found in the area and also the characteristics by which they have been classified. The result is that several terms may be used to describe a single wetland type, (e.g., *bog*, *mire*, *peatland*, *moor*, and *muskeg*), and some terms refer to more than one wetland type (e.g., *mire* refers to the peat-accumulating wetlands *bog*, and *fen*). The lack of standardization in wetland terminology, along with imprecise definitions, has led to difficulties in communication (Wheeler 1995).

To facilitate communication amongst various disciplines in Canada, the National Wetlands Working Group (NWWG) developed the Canadian Wetland Classification System (CWCS). The CWCS is based on ecological parameters that influence wetland growth and development (Zoltai 1988). The hierarchical structure of the CWCS proceeds from *wetland class* to *wetland form*, and finally to *wetland type*. Wetland classes are based on vegetation physiognomy, hydrology, and water quality. Each class is divided into wetland forms based on three criteria: i) surface form due to differences in water quality or peat thickness; ii) land form or drainage characteristics; and iii) proximity to water bodies. Wetland forms are divided into wetland types on the basis of vegetation morphology (Zoltai 1988).

Wetland inventories conducted in British Columbia (e.g., an inventory of wetlands in the Fraser River Lowland [Ward *et al.* 1992], and the Sensitive Ecosystem Inventory on Vancouver Island) have based their work on CWCS definitions. Difficulties of applying the CWCS to wetlands in southwestern B.C., however, were noted by Ward (1989). She found that similarities between categories sometimes resulted in more than one classification per wetland, or alternatively for some wetlands there was an absence of suitable categories. MacKenzie and Banner (in prep.) conclude that the system needs refinement, and are currently working to produce a new classification system to be used for research, conservation, and management of wetland and riparian areas in the province.

The wetland community types presented in Table A-1 are based on "hydrotopography" (i.e., topographic situation, "shape," and water supply). Hydrotopography is a characteristic wetland feature, with much importance for classification (Wheeler 1995).

Wetland Community Type / Hydrological Characteristics	Substrate	Vegetation Type	Characteristic Species
SHALLOW WATER			
~open expanses of standing or flowing water ~mid-summer water depths < 2 m	~variable	~submerged, floating aquatics emergent	*Nuphar polysepalum, Callitriche* spp. *Sagittaria latifolia, Scirpus lacustris* *Alisma plantago-aquatica, Utricularia* spp. *Potamogeton* spp., *Brasenia schreberi* *Polygonum amphibium, Sparganium* spp.
FRESH WATER MARSH			
~water levels vary seasonally ~saturation near the surface ~zonal, mosaic surface patterns pools, channels ~nutrient-rich water	~mineral soil or well-decomposed peat	~emergent herbaceous species	*Potentilla pacifica, Carex* spp. *Juncus* spp., *Eleocharis palustris* *Phalaris arundinacea, Aster* spp. *Typha latifolia, Scirpus microcarpus* *S. americanus*
SALT MARSH			
~regular inundation ~saline or brackish water, tidal sources ~low current velocities	~fine sediments	~herbaceous species ~tolerant of saline soils	*Distichlis spicata* var. *spicata* *Juncus arcticus, Triglochin maritimum* *Scirpus cernuus, Puccinellia* spp. *Plantago maritima* ssp. *juncoides* *Salcornia virginica, Glaux maritima*
FEN			
~nutrient-rich and minerotrophic groundwater ~runoff from adjacent uplands	~moderately decomposed sedge or brown moss peat ~variable thickness	~sedges and brown mosses ~may be scattered shrubs ~occasional sparse tree layer	*Carex* spp., *Aulacomnium palustre* *Calliergon giganteum, C. stramineum,* *Tomenthypnum nitens, Sphagnum spp.* *Menyanthes trifoliata, Gentiana spp.* *Eriophorum angustifolium*
WET MEADOW			
~periodically saturated, rarely inundated ~waterlogged soil near the surface ~without standing water for most of the year	~peat or mineral soil	~herbaceous species ~overall 'grassy' appearance ~mixed stands of grasses, sedges, rushes	*Hypericum anagalloides, Veronica spp.* *Mentha arvensis, Platanthera dilatata* *Deschampsia cespitosa, Glyceria elata* *Angelica genuflexa, Aster subspicatus* *Scutellaria galericulata, Carex spp.,*
BOG			
~water table at or near the surface ~water sources: precipitation ~no significant inflows/outflows ~isolated from nutrient-rich groundwater	~deep deposits of moderately decomposed peat	~*Sphagnum* mosses, ericaceous shrubs, herbaceous species, stunted conifers	*Sphagnum* spp., *Vaccinium* spp. *Ledum groenlandicum, Eriophorum* spp. *Drosera rotundifolia, Kalmia polifolia* *Empetrum nigrum, Rubus chamaemorus* *Pinus contorta* var. *contorta*
SWAMP FOREST			
~water table at or near the surface ~nutrient-rich water ~pronounced internal water movement	~mineral soil or peat ~Mesisols, Humisols, Gleysols	~dense cover of deciduous or coniferous trees, herbaceous species, and some mosses ~trees may grow on hummocks	*Alnus rubra, Thuja plicata, Salix* spp. *Populus balsamifera* ssp. *trichocarpa* *Carex obnupta, Oenanthe sarmentosa* *Lysichiton americanum, Urtica dioica* *Equisetum* spp., *Ranunculus repens*
SWAMP THICKET			
~periodically saturated, rarely inundated	~mineral soil ~well-aerated	~nearly continuous stand of shrubs/ small trees	*Spiraea douglasii, Rhamnus purshiana* *Lonicera involucrata, Myrica gale* *Physocarpus capitatus, Salix* spp. *Cornus stolonifera, Malus fusca* *Rosa* spp., *Ribes bracteosum*

Table A-1
Wetland Community Types

APPENDIX II

Rithet's Bog Plant Species Checklist

TREES	
Scientific Name	**Common Name**
Acer macrophyllum Pursh	bigleaf maple
*Aesculus hippocastanum** L.	horse-chesnut
Alnus rubra Bong	red alder
Arbutus menziesii Pursh	arbutus
Betula pendula Roth	European weeping birch
Betula pubescens Ehrh.	silver birch
Betula pumila L. var. *glandulifera* Regal forma *hallii* (Howell) Brayshaw	Hall's birch
*Laburnum anagyroides** Medicus	golden chain tree
Malus fusca (Raf.) Schnei.	Pacific crab apple
Picea sitchensis (Bongard) Carriere	Sitka spruce
Pinus contorta Dougl. var. *contorta*	shore pine
Populus balsamifera L. ssp. *trichocarpa* (Torr. & Gray) ex Hook. Brayshaw	black cottonwood
Populus tremuloides Michx.	trembling aspen
Pseudotsuga menziesii (Mirbel) Franco.	Douglas-fir
Quercus garryana Dougl.	Garry oak
Salix hookeriana Barratt (male and female)	Hooker's willow
Salix lasiandra Benth.	Pacific willow
Salix rigida Muhl. ?	yellow willow
Salix scouleriana Barratt	Scouler's willow
Salix sitchensis Bong.	Sitka willow
*Sorbus aucuparia** L.	European mountain-ash
Thuja plicata Donn.	western redcedar

SHRUBS	
Scientific Name	**Common Name**
Amelanchier alnifolia Nutt.	Saskatoon berry
Cornus stolonifera Michx.	red-osier dogwood
Crataegus douglasii Lindl.	black hawthorn
*Crataegus monogyna** Jacq.	common hawthorn
*Cytisus scoparius** (L.) Link.	Scotch broom
*Daphne laureola** L.	spurge laurel
Gaultheria shallon Pursh	salal
Holodiscus discolor (Pursh) Maxim.	oceanspray
*Ilex aquifolium** L.	English holly
Kalmia occidentalis Small	bog laurel
Ledum groenlandicum Oeder	Labrador tea
*Ligustrum vulgare** L.	privet
Lonicera ciliosa (Pursh) DC.	orange honeysuckle
Lonicera involucrata (Rich.) Banks	twinberry
Mahonia aquifolium (Pursh) Nutt.	tall Oregon-grape
Mahonia nervosa Pursh	dull Oregon grape
Oemleria cerasiformis (H.&A.) Landon	Indian plum
Rhamnus purshiana DC.	cascara
Rosa gymnocarpa Nutt.	baldhip rose

SHRUBS

Scientific Name	Common Name
Rosa nutkana Presl	Nootka rose
Rosa pisocarpa Gray ?	swamp rose
Rosa sp.*	a cultivated rose
*Rubus discolor** Weihe & Nees	Himalayan blackberry
*Rubus laciniatus** Willd.	cutleaf blackberry
Rubus ursinus Cham. & Schlecht. var. *macropetalus* (Dougl.) Brown	trailing blackberry
Sambucus racemosa var. *leucocarpa* (T. & G.) Cronq.	red elderberry
Spiraea douglasii Hook. var. *douglasii*	hardhack
Symphoricarpos albus (L.) Blake	snowberry
Vaccinium oxycoccus L.	bog cranberry

HERBS

Scientific Name	Common Name
Alisma plantago-aquatica L.	water-plantain
Allium acuminatum Hook.	Hooker's onion
*Anthemis cotula** L.	mayweed
*Bellis perennis** L.	English daisy
Bidens amplissima Greene	Vancouver Island beggarticks
Bidens cernua L.	nodding beggarticks
*Brassica campestris** L.	field mustard
*Brassica kaber** (DC.) Wheeler	wild mustard
Brodiaea coronaria (Salisb.) Engl.	harvest brodiaea
Brodiaea hyacinthina (Lindl.) Baker	fool's onion
*Callitriche stagnalis** Scop.	pond water-starwort
Camassia quamash (Pursh) Greene	common camas
*Centaurium erythraea** Rafn	common centaury
*Cirsium arvense** (L.) Scop.	Canada thistle
*Cirsium vulgare** (Savi) Tenore	bull thistle
*Conium maculatum** L.	poison-hemlock
*Convolvulus arvensis** L.	field bindweed
*Convolvulus sepium** L.	hedge bindweed
*Conyza canadensis** (L.) Cronq.	horseweed
*Daucus carota** L.	Queen Anne's lace
Daucus pusillus Michx. ?	American wild carrot
Epilobium angustifolium L.	fireweed
Epilobium ciliatum Raf.	purple-leaved willow-herb
Epilobium watsonii Barbey	Watson's willow-herb
Epilobium sp.	willow-herb
*Epipactis helleborine** (L.) Crantz	helleborine
*Erodium cicutarium** (L.) L'Her.	common stork's bill
*Erysimum cheiranthoides** L.	wormseed mustard
*Eschscholzia californica** Cham.	California poppy
Galium aparine L.	cleavers
Galium trifidum L.	small bedstraw
Galium triflorum Michx.	sweet-scented bedstraw
Geranium bicknellii Britt. ?	Bicknell's geranium
Geranium pratense L.	
Geum macrophyllum var. *macrophyllum* Willd.	large-leaved avens
*Gnaphalium uliginosum** L.	marsh cudweed

HERBS	
Scientific Name	**Common Name**
*Heracleum mantegazzianum** Sommier & Levier?	giant cow-parsnip
Hypericum anagalloides C.&S.	bog St. John's-wort
*Hypericum androsaemum** Rehd.	
*Hypericum calycinum** L.	St. John's-wort
*Hypochaeris radicata** L.	hairy cat's-ear
*Lactuca muralis** (L.) Fresen.	wall lettuce
*Lactuca serriola** L.	prickly lettuce
Lemna minor L.	duckweed
*Lepidium campestre** (L.) R. Br.	field peppergrass
*Leontodon autumnalis** L.	autumn hawkbit
*Leucanthemum vulgare** Lam.	oxeye-daisy
*Lotus corniculatus** L.	birdsfoot-trefoil
*Lupinus arboreus** Sims	tree lupin
Lycopus uniflorus Michx.	northern bugleweed
Lysichitum americanum Hulten & St. John	skunk cabbage
Madia sativa Mol.	Chilean tarweed
*Matricaria inodora** L. ?	scentless may-weed
*Matricaria matricarioides** (Less.) Porter	pineapple weed
Mimulus guttatus DC.	yellow monkey-flower
*Medicago lupulina** L.	black medic
Mentha arvensis L.	field mint
Montia sibirica (L.) Howell	Siberian miner's-lettuce
Myosotis laxa Lehm.	small-flowered forget-me-not
*Nasturtium officinale** R. Br.	watercress
Oenanthe sarmentosa Presl	Pacific water parsley
Osmorhiza chilensis H. & A.	mountain sweet-cicely
*Plantago lanceolata** L.	English plantain / ribwort
Plantago major L.	plantain
Polygonum amphibium L.	water smartweed
*Polygonum aviculare** L.	prostate knotweed
*Polygonum persicaria** L.	common smartweed
Potentilla anserina L. ssp. *pacifica* (Howell) Rousi	silverweed
Prunella vulgaris L.	self-heal
Pyrola asarifolia Michx.	pink wintergreen
*Ranunculus repens** L.	creeping buttercup
Rorippa palustris (L.) Bess.	marsh yellow cress
*Rumex acetosella** L.	sheep sorrel
*Rumex conglomeratus** Murr.	clustered dock
*Rumex crispus** L.	curled dock
*Rumex obtusifolius** L.	bitter dock
Sanicula crassicaulis Poepp.	Pacific sanicle
*Solanum dulcamara** L.	European bittersweet
*Sonchus asper** (L.) Hill	prickly sow-thistle
Stachys cooleyae Heller	Cooley's hedge-nettle
*Symphytum officinale** L.	comfrey
*Taraxacum officinale** Weber	common dandelion
Tellima grandiflora (Pursh) Dougl.	fringecup
Trientalis arctica Fisch.	northern starflower
*Trifolium campestre** Schreber	low hop-clover
*Trifolium dubium** Sibth.	small hop-clover
*Trifolium hybridum** L.	alsike clover

HERBS	
Scientific Name	**Common Name**
*Trifolium pratense** L.	red clover
*Trifolium repens** L.	white clover
Typha angustifolium L.?	narrow leaf cattail
Typha latifolia L.	cattail
Urtica dioica L.	stinging nettle
Veronica americana Schwein.	American brooklime
Veronica scutellata L.	marsh speedwell
*Vicia hirsuta** (L.) S.F. Gray	hairy vetch
*Vicia sativa** L.	common vetch
*Vicia villosa** Roth	woolly vetch

GRASSES, RUSHES, & SEDGES	
Scientific Name	**Common Name**
Agrostis capillaris L.	colonial bentgrass
*Alopecurus geniculatus** L. ?	water foxtail
*Anthoxanthum odoratum** L.	sweet vernalgrass
Carex arcta Boott	northern clustered sedge
Carex athrostachya Olney	slenderbeaked sedge
Carex cusickii Mack.	Cusick's sedge
Carex deweyana Schw.	Dewey's sedge
Carex kelloggii Boott in S. Wats.	Kellogg's sedge
Carex obnupta Bailey	slough sedge
Carex viridula Michx.	green sedge
*Cynosurus echinatus** L.	hedgehog dogtail
*Echinochloa crus-galli** (L.) Beauv.	large barnyard-grass
Eleocharis palustris (L.) R. & S.	creeping spike-rush
*Holcus lanatus** L.	common velvet-grass
Juncus articulatus L.	jointed rush
Juncus bolanderi Engelm.	Bolander's rush
*Juncus bufonius** L.	toad rush
Juncus effusus L.	common rush
Juncus tenuis Willd.	slender rush
*Lolium perenne** L.	perennial ryegrass
Phalaris arundinacea L.	reed canary grass
Poa spp.	bluegrass
Scirpus maritimus L. var. *paludosus* (Nels.) Kuekenth.	seacoast bulrush
Scirpus validus Vahl [syn. *S. lacustris* L. ssp. *validus* (Vahl) T. Koyama]	tule
*Setaria lutescens** (Weigel) Hubb.	yellow bristle grass

FERNS & ALLIES	
Scientific Name	**Common Name**
Athyrium filix-femina (L.) Roth	lady fern
Polypodium glycyrrhiza DC. Eat.	licorice fern
Polystichum munitum (Kaulf.) Presl	sword fern
Pteridium aquilinum L.	bracken

MOSSES and LIVERWORTS

Scientific Name	Common Name
Aulacomnium androgynum (Hedw.) Schwaegr.	lover's moss
Calliergon cordifolium (Hedw.) Kindb. ?	
Ceratodon purpureus (Hedw.) Brid.	red roof moss
Dicranoweisia cirrata (Hedw.) Milde	curly thatch moss
Dicranum scoparium Hedw.	broom moss
Drepanocladus sp.?	
Frullania nisquallensis Sull.	hanging millipede liverwort
Homalothecium fulgescens (C. Muell.) Lawt.	yellow moss
Homalothecium nuttallii (Wils.) Jaeg. & Sauerb.	
Homalothecium pinnatifidum (Sull. & Lesq.) Lawt.	
Hylocomium splendens (Hedw.) B.S.G.	step moss
Hypnum circinale Hook.	coiled-leaf moss
Isothecium myosuroides Brid.	cat-tail moss
Kindbergia oregana (Sull.) Ochyra	Oregon beaked moss
Kindbergia praelonga (Hedw.) Ochyra	slender beaked moss
Metaneckera menziesii (Drumm.) Steere	Menzies' neckera
Orthotrichum consimile Mitt.	
Orthotrichum lyellii Hook. & Tayl.	Lyell's bristle moss
Polytrichum piliferum Hedw.	awned haircap moss
Porella navicularis (Lehm. & Lindenb.) Lindb.	tree-ruffle liverwort
Racomitrium canescens (Hedw.) Brid.	roadside rock moss
Radula complanata (L.) Dum.	flat leaf liverwort
Rhytidiadelphus loreus (Hedw.) Warnst.	lanky moss
Rhytidiadelphus triquetrus (Hedw.) Warnst.	electrified cat's-tail moss
Sphagnum henryense Warnst.	
Sphagnum pacificum Flatb.	

LICHENS

Scientific Name	Common Name
Cladonia bellidiflora (Ach.) Schaer.	
Cladonia macilenta Hoffm.	lipstick cladonia
Evernia prunastri (L.) Ach.	antlered perfume/ oakmoss
Hypogymnia inactiva (Krog) Ohlsson	forking bone
Hypogymnia physodes (L.) Nyl.	hooded bone
Melanelia subaurifera (Nyl.) Essl.	
Parmelia hygrophila Goward & Ahti	
Parmelia saxatilis (L.) Ach.	
Peltigera membranaceae (Ach.) Nyl.	dog lichen
Pertusaria sp.	a crustose lichen
Physcia sp. (*P. aipolia*?)	
Platismatia glauca (L.) W. Culb. & C. Culb.	ragbag
Platismatia herrei (Imsh.) W. Culb. & C. Culb.	tattered rag
Usnea subfloridana Stirton	
Xanthoparmelia cumberlandia (Gyeln.) Hale	questionable rock-frog
Xanthoria ramulosa (Tuck.) Herre	

FUNGI	
Scientific Name	**Common Name**
Endocronartium harknessii	rust gall
Entoloma sp.?	
Lactarius luculentus	
Russula sp.	
Trichaptum abietinum	a polyspore fungus
Xylaria hypoxylon	candlesnuff fungus

Note:
* Introduced species

Many of the plant species listed here were collected by Karen Golinski and identified by Brenda Costanzo (Assistant Curator, University of Victoria Herbarium). Dr. W. B. Schofield (Professor Emeritus of Botany, University of British Columbia) identified the two *Sphagnum* mosses. Terry Taylor contributed the moss, lichen, liverwort, and fungi sections (excluding *Sphagnum henryense* and *S. pacificum*), and significantly expanded the list of vascular plants during a field visit in 1997. Dr. Adolf Ceska identified several sedges during a field visit in 1997.

APPENDIX III

Chatterton Way Garry Oak Checklist

TREES	
Scientific Name	**Common Name**
Acer macrophyllum Pursh	bigleaf maple
Arbutus menziesii Pursh	arbutus
Prunus emarginata (Dougl.) Walp.	bitter cherry
Quercus garryana Dougl.	Garry oak

SHRUBS	
Scientific Name	**Common Name**
Amelanchier alnifolia Nutt.	saskatoon
Crataegus monogyna Jacq.*	common hawthorn
Cytisus scoparius (L.) Link.*	Scotch broom
Daphne laureola L.*	spurge laurel
Holodiscus discolor (Pursh) Maxim.	oceanspray
Lonicera involucrata (Rich.) Banks	black twinberry
Mahonia aquifolium (Pursh) Nutt.	tall Oregon-grape
Oemleria cerasiformis (H.& A.) Landon	Indian plum
Rosa gymnocarpa Nutt.	baldhip rose
Rosa nutkana Presl.	Nootka rose
Rubus discolor Weihe & Nees*	Himalayan blackberry
Rubus ursinus Cham. & Schlecht.	trailing blackberry
Salix scouleriana Barratt	Scouler's willow
Solanum dulcamara L.*	European bittersweet
Symphoricarpos albus (L.) Blake	common snowberry

HERBS	
Scientific Name	**Common Name**
Achillea millefolium L.	yarrow
Allium sp.	onion (not yet flowering)
Anthriscus scandicina (Weber) Mansfeld.	bur chervil
Aphanes occidentalis (Nutt.) Rydb.	western lady's-mantle
Arabis glabra (L.) Bernh.	towermustard
Arenaria macrophylla Hook.	sandwort
Brodiaea coronaria (Salisb.) Engl.	harvest brodiaea
Camassia leichtlinii (Baker) Wats.	great camas
Camassia quamash (Pursh) Greene	common camas
Cardamine oligosperma Nutt.	few-seeded bitter-cress
Cerastium arvense L.	field chickweed
Cirsium vulgare (Savi) Tenore*	bull thistle
Clarkia sp.	
Collinsia parviflora Lindl.	small-flowered blue-eyed Mary
Daucus carota L.*	Queen Anne's lace
Dodecatheon hendersonii Gray	broad-leaved shootingstar
Epilobium minutum Lindl.	small-flowered willowherb
Erodium cicutarium (L.) L'Her.*	common stork's-bill
Erythronium oregonum Applegate	white fawn lily
Fritillaria lanceolata Pursh	chocolate lily

Galium aparine L.*	cleavers
Geranium carolinianum L.*	Carolina geranium
Geranium molle L.*	dovefoot geranium
Heuchera micrantha Dougl.	small-flowered alumroot
Hypochaeris radicata L.*	hairy cat's-ear
Lamium amplexicaule L.	common dead-nettle
Lamium purpureum L.*	purple dead-nettle
Lithophragma parviflora (Hook.) Nutt.	smallflowered woodland star
Lomatium nudicaule (Pursh) Coutl. & Rose	Indian celery
Lotus denticulatus (Drew) Greene	meadow bird's-foot trefoil
Lupinus bicolor Lindl.	two-coloured lupine
Melilotus alba Desr.*	sweet-clover
Montia linearis (Dougl.) Greene	narrow-leaved montia
Montia perfoliata (Donn) Howell	miner's-lettuce
Myosotis discolor Pers.*	common forget-me-not
Perideridia gairdneri (H. & A.) Math.	wild caraway
Plantago lanceolata L.*	English plantain
Potentilla recta L.*	upright cinquefoil
Rumex acetosella L.*	sheep sorrel
Sanicula crassicaulis Dougl.	Pacific sanicle
Sanicula sp.	sanicle
Saxifraga integrifolia Hook.	grassland saxifrage
Sedum spathulifolium Hook.	broad-leaved stonecrop
Senecio vulgaris L.*	common groundsel
Sisymbrium officinale (L.) Scop.*	hedge mustard
Sisyrinchium douglasii A. Dietr.	satin-flower
Sonchus oleraceus L.*	sow-thistle
Stellaria media (L.) Presl.*	chickweed
Taraxacum officinale Weber*	common dandelion
Trifolium dubium Sibth.*	small hop-clover
Trifolium oliganthum Steud.	few-flowered clover
Trifolium variegatum Nutt.	white-tipped clover
Triteleia hyacinthina (Lindl.) Baker	fool's onion
Veronica arvensis L.*	wall speedwell
Vicia americana Muhl.	North American vetch
Vicia sativa L.*	common vetch
Vicia hirsuta (L.) S.F. Gray*	hairy vetch

GRASSES, RUSHES, & SEDGES

Scientific Name	**Common Name**
Aira praecox L.*	early hairgrass
Aira caryophyllea L.*	silver hairgrass
Anthoxanthum odoratum L.*	sweet vernalgrass
Arrhenatherum elatius (L.) Presl.*	tall oatgrass
Bromus hordeaceus L.* (*B. mollis*)	soft brome
Bromus inermis Leys.*	smooth brome
Bromus rigidus Roth.*	ripgut brome
Bromus sterilis L.*	barren brome
Bromus tectorum L.*	cheatgrass
Dactylis glomerata L.*	orchard grass
Elymus glaucus Buckl.	blue wildrye
Holcus lanatus L.*	common velvet-grass
Hordeum sp.*	wild barley

Lolium perenne L.*	perennial ryegrass
Poa pratensis L.*	Kentucky bluegrass
Poa sp.*	bluegrass
Vulpia bromoides (L.) S.F. Gray*	barren fescue
Vulpia myuros (L.) Gmel.*	rat-tail fescue

FERNS & ALLIES

Scientific Name	**Common Name**
Polypodium glycyrrhiza D.C. Eat.	licorice fern
Pteridium aquilinum (L.) Kuhn.	bracken
Selaginella wallacei Hieron.	small clubmoss

MOSSES & LICHENS

Scientific Name	
Bryum sp.	
Eurhynchium oreganum (Sull.) Jaeg. [*Kindbergia oregana*]	Oregon beaked moss
Peltigera polydactylon (Necker) Hoffm.	frog's pelt
Polytrichum juniperinum Hedw.	juniper moss
Racomitrium canescens (Hedw.) Brid.	roadside rock moss
Rhytidiadelphus triquetrus (Hedw.) Warnst.	electrified cat's-tail moss

Note:
* Introduced species

This list was assembled by Dr. Nancy Turner, Dr. R.T. Ogilvie, and Karen Golinski.

APPENDIX IV

Rithet's Bog Butterfly Checklist

Family HESPERIIDAE	**Skippers**
Erynnis propertius (Scudder & Burgess)*	propertius dusky wing*
Ochlodes sylvanoides sylvanoides (Boisduval)	woodland skipper
Thymelicus lineola (Ochsenheimer)	European skipper
Family PAPILIONIDAE	**Swallowtails and Parnassians**
Papilio eurymedon (Lucas)	pale swallowtail
Papilio rutulus rutulus (Lucas)	western tiger swallowtail
Papilio zelicaon zelicaon (Lucas)	anise swallowtail
Family PIERIDAE	**Whites and Sulphurs**
Neophasia menapia tau (Scudder)	pine white
Pieris rapae (Linnaeus)	cabbage butterfly
Anthocharis sara flora (W.G. Wright)	Sara orange tip
Family LYCAENIDAE	**Gossamer Wings**
Epidemia helloides (Boisduval)	purplish copper
Epidemia mariposa penroseae (Field)	Reakirt's copper
Strymon melinus atrofasciatus (McDunnough)	grey hairstreak
Celastrina argiolus echo (W.H. Edwards)	spring azure
Family NYMPHALIDAE	**Brushfoots**
Phyciodes mylitta mylitta (W.H. Edwards)	mylitta crescent
Polygonia satyrus (W.H. Edwards)	satyr anglewing
Nymphalis antiopa antiopa (Linnaeus)	mourning cloak
Vanessa cardui (Linnaeus)	painted lady
Vanessa atalanta rubria (Fruhstorfer)	red admiral
Basilarchia lorquini burrisoni (Maynard)	Lorquin's admiral
Family SATYRIDAE	**Satyrs, Browns, and Wood Nymphs**
Coenonympha tullia insulana (McDunnough)*	ringlet*

Notes:

Butterflies observed by Karen Golinski (1995-97 C.A.S.E. Butterfly Surveys). An additional species of butterfly was observed in 1996 and 1997, but was not identified (therefore not listed). For a complete checklist of the butterflies of Vancouver Island see Guppy (1992).

* Considered vulnerable by Guppy *et al.* 1995.