An Environmental Overview of

Rithet's Bog

Saanich, B.C.

Prepared for:

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Executive Summary

Rithet's Bog is the last remaining bog ecosystem in the Greater Victoria area, providing important habitat for several native plant and wildlife species with limited local distribution. The bog community has been extensively modified due to rapid successional change resulting from agricultural use and urbanization. Several plant species typical of bog ecosystems are still found at Rithet's Bog. However some species have been extirpated, or have been reduced to remnant populations. In 1994, Rithet's Bog was donated to the Corporation of the District of Saanich by the Guinness family.

This report provides a summary of the findings of a four-month study commissioned by the Corporation of the District of Saanich and is intended to provide background information for conservation-oriented studies of the ecology of Rithet's Bog. In addition to an environmental overview outlining history, climate, soils, topography, drainage, and land use, the report includes detailed discussions of both vegetation and wildlife, and identifies specific research priorities and management concerns.

Rithet's Bog is classified as a coniferous treed type basin bog. Basin bogs in the Pacific Temperate Wetland Region are typically small, with accumulations of organic peat that are essentially saucer-shaped in vertical section. Whereas limnic peat normally constitutes the major component of peat accumulations, at Rithet's Bog sedge peat predominates. The rapid succession of Rithet's Bog to shrub- and tree-dominated vegetation is attributable to disruptions to local hydrology and nutrient regimes that have resulted from agricultural activities undertaken in the area since the 1880's.

An important focus of this report is the history, composition, and stability of the vegetation mosaic of the bog and surrounding areas. Rithet's Bog provides habitat for a number of plant species with restricted distribution on southern Vancouver Island such as *Sphagnum palustre*, *S. recurvum*, northern starflower (*Trientalis arctica*), dwarf birch (*Betula pumila* var. *glandulifera*), and Labrador tea (*Ledum groenlandicum*). The central forest, which is dominated by shore pine (*Pinus contorta* var. *contorta*) represents a late-successional stage of bog development. While bogs are successionally dynamic, it is the *rate* at which Rithet's Bog has changed from an open and largely treeless bog to the current closed-canopy forest that is cause for concern. Characteristic bog species such as round-leaved sundew (*Drosera* spp.), bog cranberry (*Oxycoccus oxycoccus*), Chamisso's cottongrass (*Eriophorum chamissonis*), and western bog-laurel (*Kalmia polifolia*) have declined, and at present only a few small patches of *Sphagnum* remain.

The vegetation communities at Rithet's Bog can be broadly categorized according to dominant species composition and previous land use and include: 1. shore pine forest; 2. cottonwood stands; 3. tall deciduous shrub thicket in old abandoned fields; 4. marsh vegetation in recently abandoned fields; 5. Garry oak -rock outcrops on the perimeter of the park; 6. hedgerow; 7. Douglas-fir forest; 8. hardhack thicket/grass wetland in old abandoned fields; and, 9. 'disturbed' areas dominated by exotic vegetation. These categories are further refined in Section 4.3 of the report. The wide variety of plant

communities and terrain at Rithet's Bog supports diverse resident and migratory bird populations. Evidence of the use of the area by several mammal species was found throughout the site, particularly within the pine forest and along the surrounding drainage ditches. Three-spine sticklebacks (*Gasterosteus aculeatus*) were observed in the creek that enters the site near Fir Tree Glen and throughout the interceptor channel that follows the perimeter trail.

While a large body of information pertaining directly to Rithet's Bog exists, further research is required to identify the most viable options for conserving the unique feaures of the bog ecosystem. The applicability of restoration techniques being employed at Camosun Bog and Richmond Nature Park in Vancouver should be evaluated and compared to the concepts and techniques being used in bog restoration efforts throughout the UK, Germany, and The Netherlands. By combining techniques tested on other bog ecosystems with a body of local knowledge regarding Rithet's Bog, informed management and conservation decisions can be made.

Specific research priorities that were identified during the study include:

- a hydrological study to determine both the quantity and quality of water flowing into the bog from surrounding areas;
- long-term monitoring program to ascertain ground-water levels and flow, and identify chemical parameters, including pH and nutrient concentrations, within the shore pine forest;
- research which considers the ecology of remaining patches of *Sphagnum* which may include experimental transplanting of *Sphagnum* into other areas of the bog;
- a program to monitor the abundance and spread (or decline) of *Sphagnum*;
- paleoecological research to determine short- and long-term shifts in the bog vegetation;
- dendrochronological studies to determine the age and growth characteristics of shore pine;
- a comprehensive vegetation study to determine changes in vegetation composition since D. Peden's (1967) study; and,
- research focusing on exotic plant species, including estimates of potential spread and feasible control measures.

It is important to point out that regardless of the management approach taken, the restoration of Rithet's Bog will require a long-term commitment. Effective restoration is likely to be a long-term process, with no guarantees of success. With that said, restoration

efforts continue to be successful elsewhere, in situations where bogs have sustained much greater damage than at Rithet's Bog. To measure changes at the bog, and to enhance our current knowledge of bog restoration, a strong monitoring program will be essential. At Richmond Nature Park, monitoring is done by a small but dedicated group of volunteers.

Because of uncertainty as to the response of the bog, and due to the sensitive nature of the habitat, a conservative approach to management issues should be taken. Activities that would physically disturb the bog ecosystem are not recommended. These include reinstating agricultural activities, significantly altering the perimeter path system, and creating path access into the pine forest. Dumping of household garden wastes at several locations on the perimeter of the park should be addressed, as should the harvest of plant materials from within the park. Because the area supports significant bird populations, and given the status of Rithet's Bog as a nature sanctuary, it is recommended that dogs be prohibited.

Finally, it is suggested that a volunteer committee with local, academic, and government representation be established to consider various issues related to the management of Rithet's Bog. As research proceeds, and in particular if restoration activities are undertaken, decisions regarding various aspects of conservation and management will be necessary. A well-informed committee can help make these decisions and determine priorities for conservation activities at Rithet's Bog.

1.0 Introduction

1.1 Introduction to the Report

Rithet's Bog is the only remaining bog ecosystem in the Greater Victoria area of British Columbia. Due to the desirability of organic soils for crop production (Van Ryswyk *et al.* 1992), bogs, which are rare on southern Vancouver Island, have historically been developed for agriculture (Dearden *et al.* 1976). Seven large bogs were formerly found on the Saanich Peninsula (McMinn *et al.* 1976). In 1956, the bog at Blenkinsop Lake was drained, and Turner's Bog, near Langford, was drained between 1976 and 1979 (Ceska 1983). Four other bogs were destroyed earlier this century. Rithet's Bog is described as a coniferous treed basin bog by Banner *et al.* (1988), which is an advanced successional stage of bog development attributed to drainage and disturbance. 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 (Dearden *et al.* 1976; McMinn *et al.* 1976; Ceska 1983; Turner and Hebda 1991; various speakers noted in Saanich C/W meeting minutes March 25, 1991).

In 1965, the "Committee for the Rithet Lowland Park" was formed to try to secure Rithet's Bog and the adjacent uplands as a park. Despite its efforts, a motion to Council which proposed that Saanich acquire Rithet's Bog was defeated on October 4, 1965 (Mothersill 1991). In 1990, the "Rithet's Bog Task Force" was established to investigate potential funding sources for the acquisition of the bog, and to act in an advisory role to Saanich regarding matters related to it. After lengthy negotiations between Saanich and Broadmead Farms Ltd. which bought the property in 1965, the 42 hectare parcel containing Rithet's Bog was donated to Saanich by the Guinness family of Great Britain in 1994. In 1995, two additional small parcels located on the north-east corner and the west side of the site were purchased by Saanich.

1.2 Purpose and Objectives

To ensure that Rithet's Bog is managed in a sensitive way, the Corporation of the District of Saanich, in cooperation with the University of Victoria, has decided to support research that can be used to help guide conservation and restoration efforts at the bog. The main purpose of this initial report is to summarize what is currently known about the ecology of Rithet's Bog, and to identify future research priorities.

Other objectives of this initial study of Rithet's Bog are to:

- critically analyze the usefulness of existing studies on Rithet's Bog;
- identify areas where there is insufficient information;

- collect information on other bogs or wetlands within urban areas as precedents for future initiatives at Rithet's Bog;

- undertake an ecological inventory of the bog including plant and animal communities, basic hydrology, soils, and geography; and,

- provide specific recommendations regarding further research and ongoing management of the bog and surrounding lands.

1.3 Environmental Setting

Due to surficial geology and climate, bogs are relatively rare in the Pacific Temperate Wetland Region of B.C. (Banner *et al.* 1988). Unlike the wetter and cooler outer coast, where the accumulation of organic matter is greater and bog ecosystems are more common, summers here are typically warm and dry, and winters are wet and cool (Nuszdorfer *et al.* 1991). Of the limited number of bogs that were once found in the region, many were destroyed due to the concentration of settlement and the desirability of the land for agriculture. Many of those remaining have been modified by agriculture, resource extraction, and urbanization. Only recently have bog ecosystems become the focus of widespread conservation efforts for both their paleoecological interest and their biological importance.

In classifying the Pacific coastal wetlands of B.C., the National Wetlands Working Group (1986) identified two regions and two subregions (Banner *et al.* 1988) based on wetland form and vegetation. Rithet's Bog is located within the Pacific Temperate Wetland Region (TP) of B.C. and is classified as a coniferous treed type basin bog (Banner *et al.* 1988). Geological processes and climate also influence both wetland form and type. Basin bogs are formed when relatively small basins fill in with organic deposits to create a substrate for primary peat accumulation and bog development (Rigg 1925; Moore and Bellamy 1974; Banner *et al.* 1988). Most bogs in the region are found in depressions where drainage was impeded by bedrock, compact glacial moraine, or marine clay (Banner *et al.* 1988).

Basin bogs in the Pacific Temperate Wetland Region are typically small, with accumulations of organic peat essentially saucer-shaped in vertical section (Banner *et al.* 1988). Whereas limnic peat (or peat derived from organic materials deposited within a lake) normally constitutes the major component of peat accumulations in basin bogs, sedge peat predominates at Rithet's Bog (Zirul 1967). Organic thickness in basin bogs varies from about one to ten meters. The surface patterns of basin bogs located in the warmer, drier climate of the Pacific Temperate Wetland Region are characterized by a peripheral lagg (Rigg 1925).

2.0 Study Methodology

The majority of the biophysical and written information used in this report was gathered between May and September 1995. Written work with direct reference to Rithet's Bog includes: published research (Rigg 1922a; Banner *et al.* 1988); student papers (Peden 1967; Zirul 1967; van Barloewen 1970; French and Lewis 1991); consultant reports (Thurber 1970, 1982; McCrae 1978; Lombard North Group 1981; Talisman 1981; Walmsley 1981, 1982; Zirul 1983); studies undertaken by local naturalists (Carson 1995; Gaskin *et al.* 1994; Gaskin 1995); and a local area land-use plan (Corporation of the District of Saanich 1993). Corporation of the District of Saanich minutes of Committee of the Whole meetings summarize ongoing Council discussions concerning Rithet's Bog, and include comments and recommendations of local experts (Ceska 1981, 1983; Turner and Hebda 1991). Reports commissioned by Saanich include a biophysical inventory and evaluation of potential land usage (Dearden *et al.* 1976) and an assessment of drainage management options for Rithet's Bog (McCrae 1978). The latter contains useful, if somewhat dated information on soils, drainage patterns, meteorology, and hydrology.

At the onset of this study, Dr. Nancy Turner of the University of Victoria kindly offered her personal collection of documents regarding Rithet's Bog as a starting point for further investigations. Many people familiar with the bog and its surroundings were interviewed as part of the study, and provided valuable insight and information.

Historical photographs and newspaper articles were made available by the Saanich Archives. Aerial photographs for the years 1926 (National Airphoto Library), 1946, 1954, 1964, 1976, 1980, and 1992 (B.C. Government Air Photos) were first located at the University of British Columbia Geographic Information Center and the University of Victoria Cartographic Resource Center. Large-scale changes in vegetation and land-use patterns in recent history can be traced by examining these photographs (Figure 2.1-2.6). Maps delineating drainage patterns, sewer, and water lines in the area were provided by the Engineering Department of the Corporation of the District of Saanich.

Several reports commissioned by Broadmead Farms Ltd. during the 1970's and 1980's, outlining various development proposals for the bog forest and surrounding areas, contain useful background information. These include a study by Associated Engineering Services Ltd. (Zirul 1973) in which an artificial lake, equestrian center, swimming facility, and market gardens are proposed. In 1981, an environmental impact study coordinated by Thurber Consultants Ltd. was undertaken to determine the feasibility of a golf course development at Rithet's Bog. Various consultants contributed to this study, which included a visual assessment (Lombard North Group 1981), and an assessment of agricultural capacity and native plant community distribution (Talisman 1981). The results of these studies were critically reviewed by Walmsley (1981, 1982) on behalf of the Corporation of the District of Saanich.

Throughout the four-month period when this study was undertaken, qualitative field surveys of the site were made to assess vegetation, soils, and drainage patterns. A

comprehensive inventory of the vegetation at Rithet's Bog has been initiated, with voucher specimens located at the University of Victoria herbarium. This inventory will be updated as further plant species are found. As part of an ongoing regional butterfly survey by Citizens to Save the Environment (C.A.S.E.), a monthly census of local butterfly populations was conducted.

Reports on the restoration work being done at Camosun Bog, in Vancouver, were obtained from the Pacific Spirit Park office of the Greater Vancouver Regional District Parks Department. Recently a comprehensive text entitled *Restoration of Damaged Peatlands* (Wheeler and Shaw 1995) has been published. This invaluable document describes the cumulative results of many years of bog restoration research undertaken by workers in the UK and Europe.

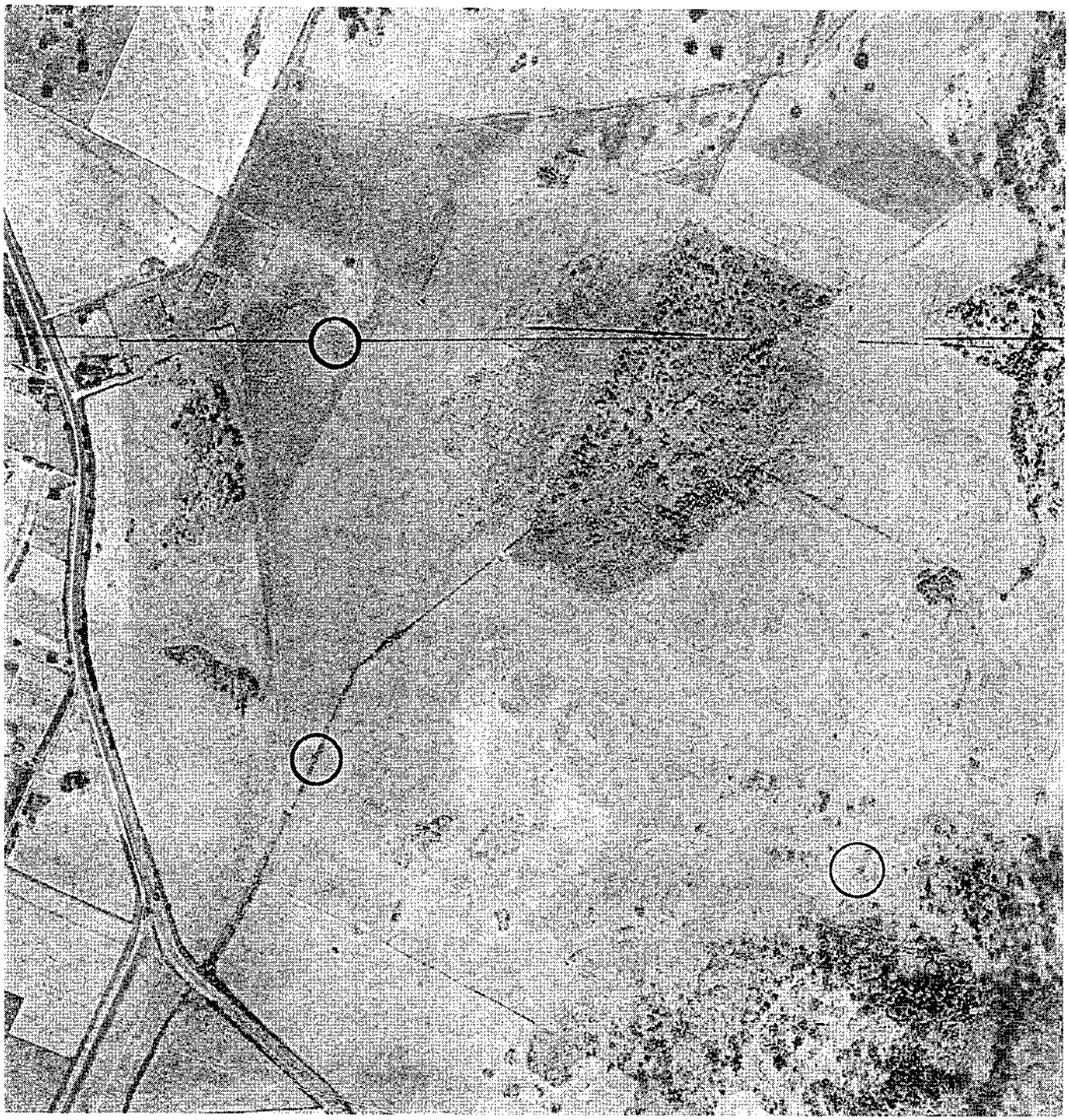

Figure 2.1
1926 Air photo of Rithet's Bog

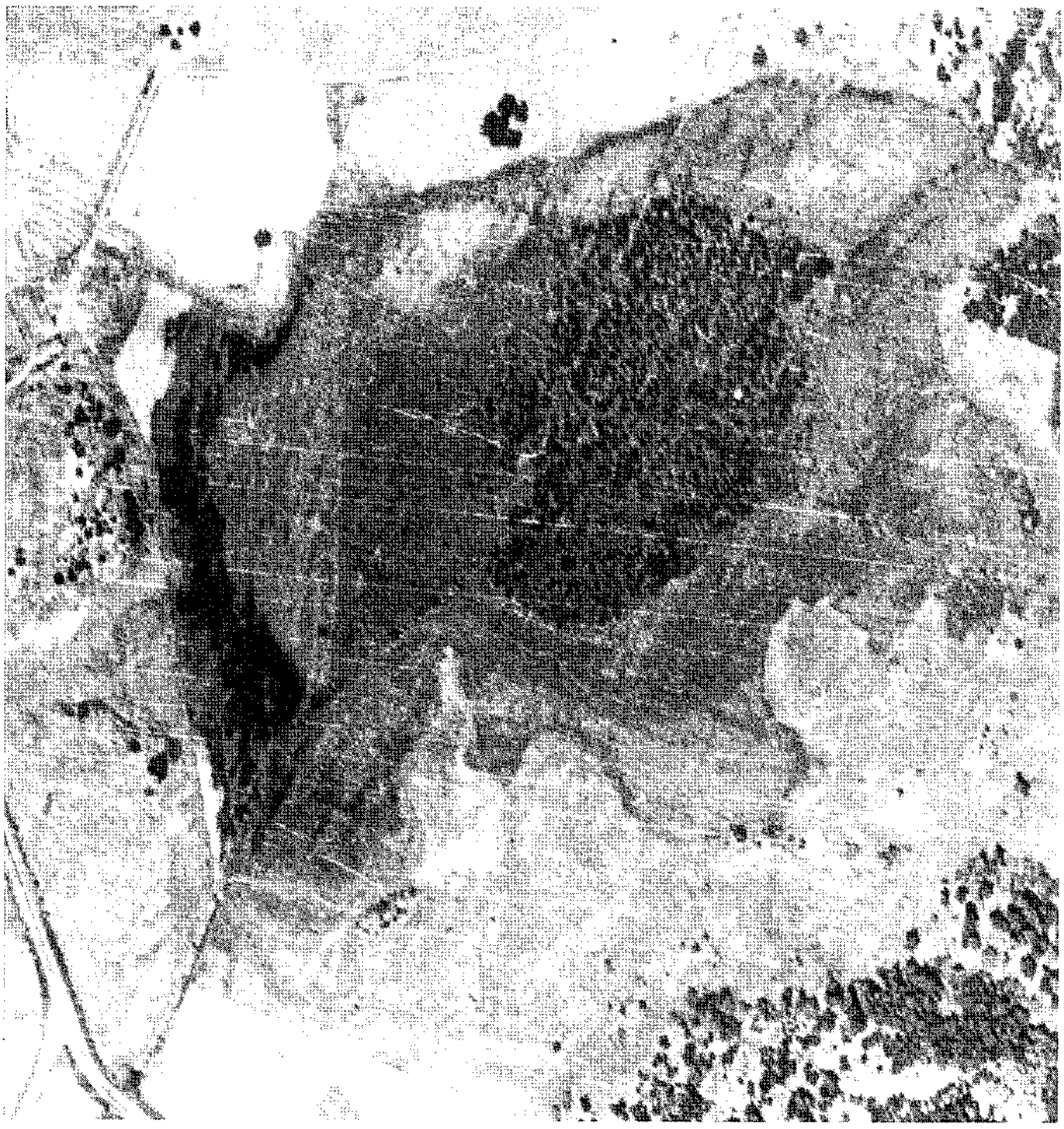

Figure 2.2
1946 Air photo of Rithet's Bog

Figure 2.3
1954 Air photo of Rithet's Bog

RITHET'S BOG

AERIAL PHOTOGRAPHY 1964

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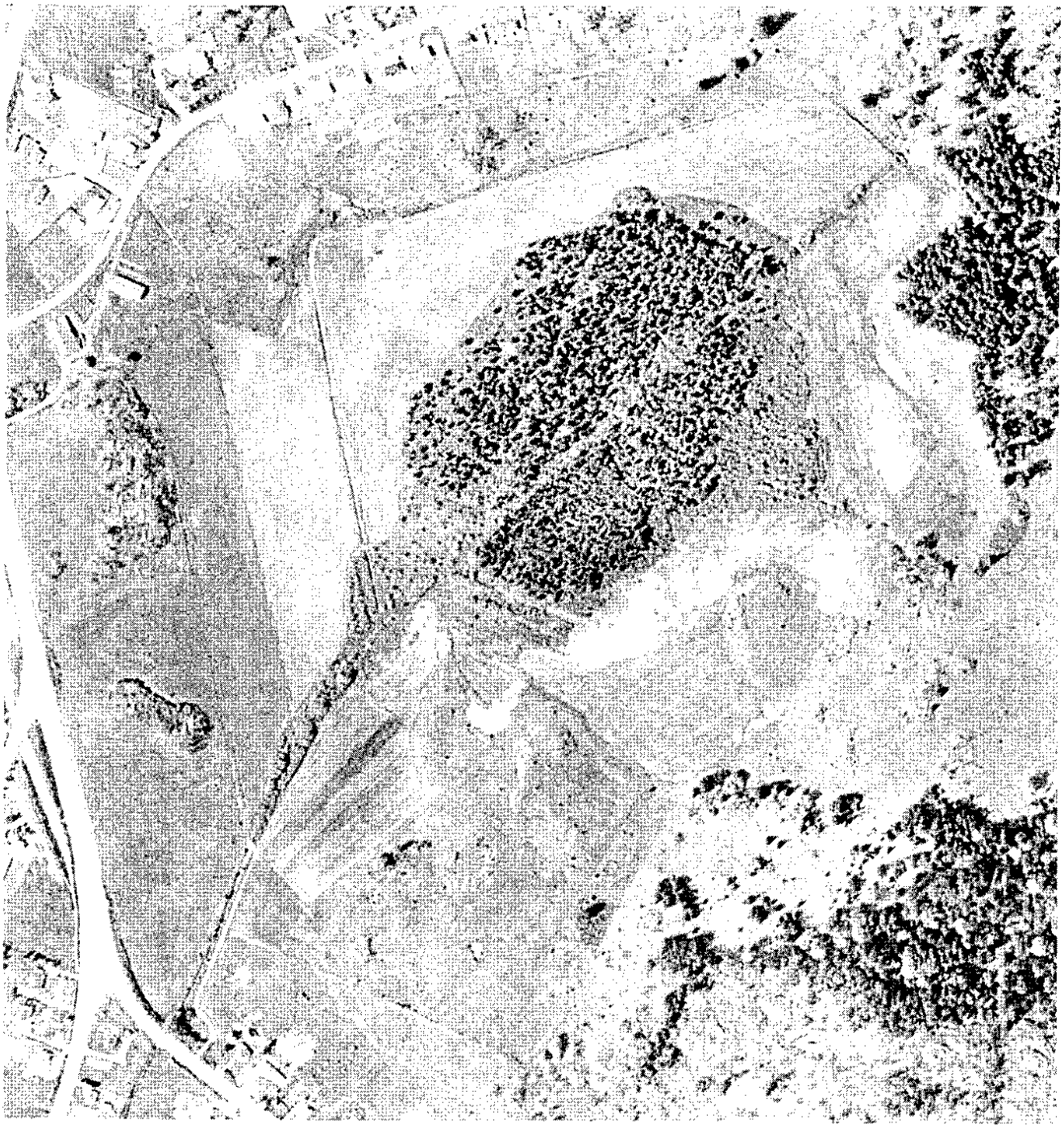

Figure 2.4
1964 Air photo of Rithet's Bog

RITHET'S BOG

AERIAL PHOTOGRAPHY 1976

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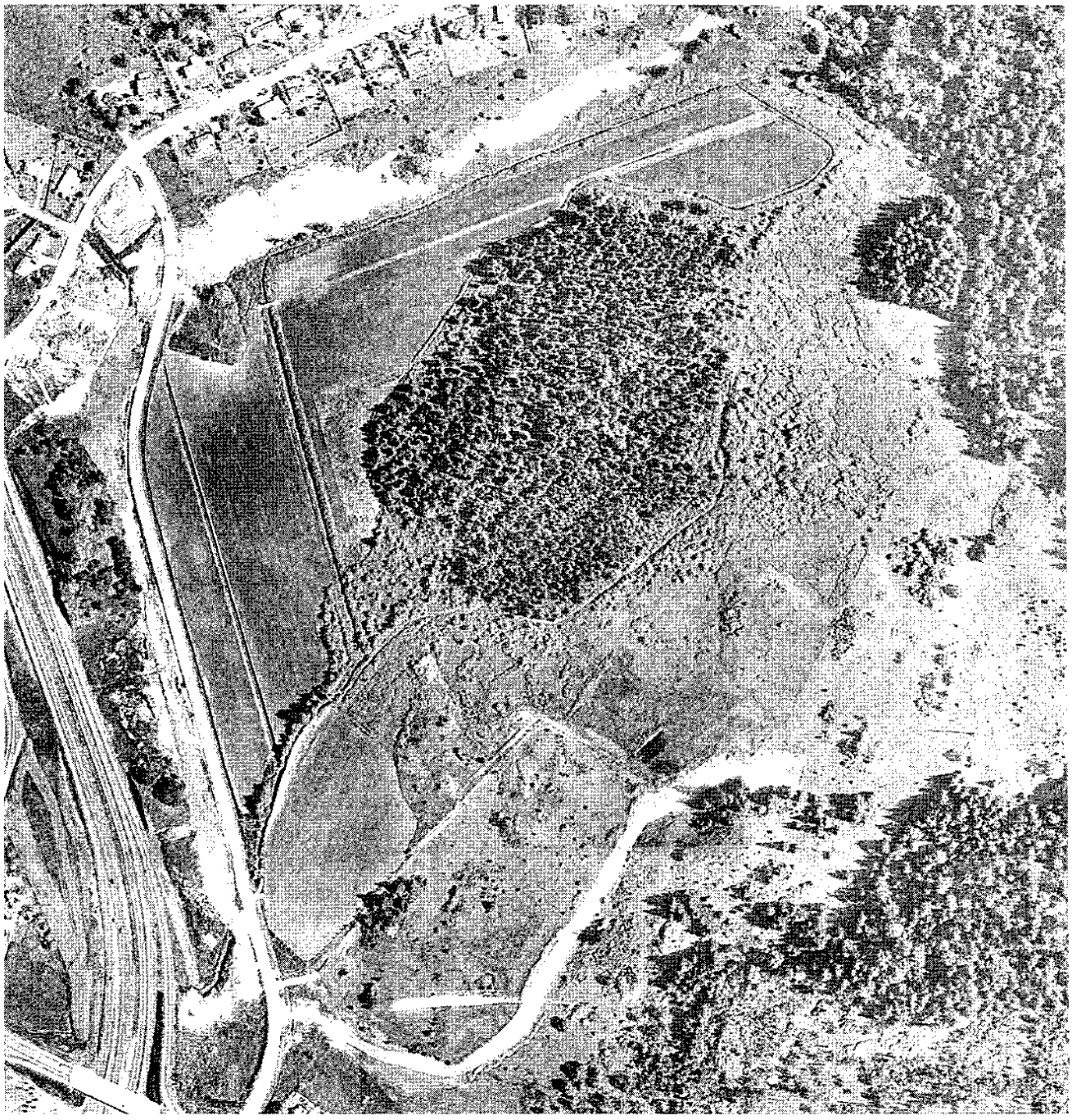

Figure 2.5
1976 Air photo of Rithet's Bog

Figure 2.6
1980 Air photo of Rithet's Bog

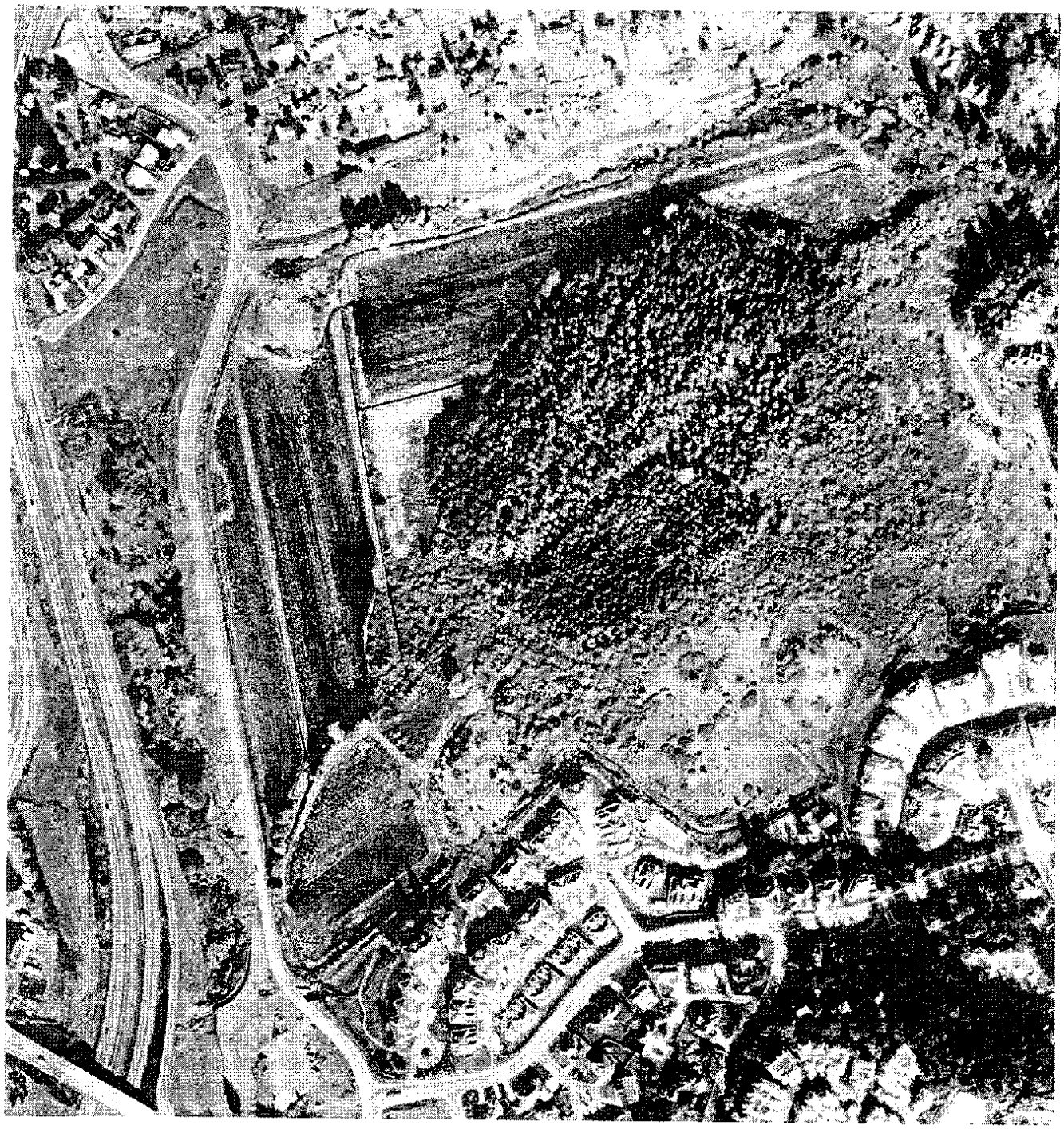

Figure 2.7
1992 Air photo of Rithet's Bog

3.0 Environmental Overview

3.1 Location and Status

Rithet's Bog is located in the southwest corner of the Broadmead area of Saanich, near Victoria, B.C. (Figure 3.1) It occupies the lowland between the Patricia Bay Highway, Quadra Street, and Royal Oak Avenue, and is bounded by residential streets Chatterton Way to the west, Dalewood Lane to the north, Fir Tree Glen to the east, and Emily Carr Drive to the south. A perimeter trail surrounds the site, and is connected to a network of trails and open spaces in the northeast corner. Public parking and access to the perimeter trail is available along Chatterton Way, Dalewood Lane, and Fir Tree Glen.

Rithet's Bog is one of two municipally zoned (P5) nature sanctuaries in Saanich, the other being Swan Lake/Christmas Hill. The 42 hectare park, including the central shore pine forest, surrounding wetlands, abandoned fields, and portions of the adjacent upland areas, is owned and administered by the Corporation of the District of Saanich. Local bylaws currently prohibit horses and bicycles at Rithet's Bog, and restrict dogs on leashes to the perimeter trail.

3.2 History

Rithet's Bog is named after Robert Patterson Rithet, an early resident in the area, and a prominent local businessman and breeder of thoroughbred race horses (Mothersill 1991). Rithet bought the large piece of land that included the bog in 1893 from A. P. Dallas, the owner since 1859 (Mothersill 1991). According to Arthur Locke (pers. comm. in Peden 1967), the land surrounding the bog was cleared during the 1880's for crop production and grazing of cattle, horses, and sheep. In the 1930's, drainage ditches were cut though the cultivated fields west of the pine forest in an attempt to lower the water table. Water which accumulated in these ditches was pumped into the Colquitz Creek drainage system (Peden 1967).

Following Rithet's death in 1954, his holding company, Rithet Consolidated, sold the 39 hectare parcel of land which included the bog to Mr. Burge, a farmer (Mothersill 1991). In 1956, after progressive soil subsidence resulting from the decay of exposed peat, ditches were again cut for drainage (Peden 1967). Eventually, flooding in the agricultural land closest to the bog forest increased to the point where those areas were released from production (Peden 1967). Soon after, cultivated areas on both the east and south sides of site were abandoned due to excessive flooding (Zirul 1973).

In 1965, Broadmead Farms Ltd. purchased the 243 hectares which surrounded but did not include the bog, from Rithet Consolidated for a residential subdivision (Mothersill 1991). When the Burge property was offered for sale later that year, Saanich Council failed to support a motion that sought to acquire Rithet's Bog and the adjacent uplands as a park (Mothersill 1991). At that time, Broadmead Farms purchased the property (Mothersill

RITHET'S BOG

LOCATION MAP

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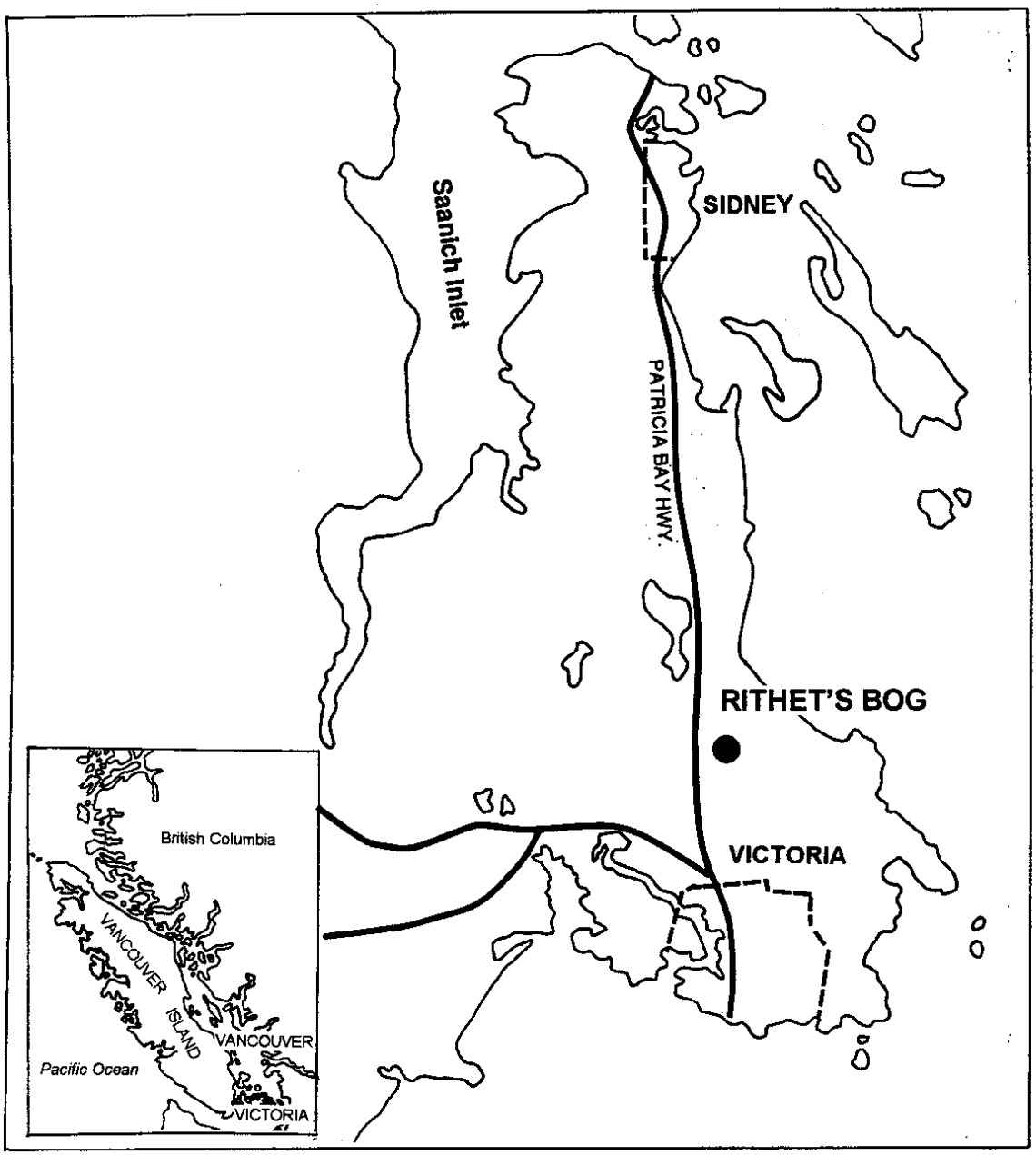


Figure 3.1
Location Map

1991). Broadmead Farms proposed several development schemes for the bog and surrounding lowlands, and despite numerous consultants' reports advocating development, none progressed beyond the planning stage. Protection from development was afforded in part by Agricultural Land Reserve designation in 1973.

In 1994, following several years of negotiations, the 42 hectare parcel containing Rithet's Bog was donated to Saanich by the Guinness family, owners of Broadmead Farms Ltd. At this time agricultural activities, which required artificial lowering of the water table and fertilization, ceased. In 1995, two additional small parcels located on the north-east corner and the eastern edge of the site were purchased by Saanich.

3.3 Climate

Rithet's Bog is situated within the moist maritime subzone of the Coastal Douglas-fir (CDF) biogeoclimatic zone (Nuszdorfer *et al.* 1991). Krajina's original classification of the CDF (1969) recognized both wet and dry subzones, and Rithet's Bog was located within the drier subzone. Revisions to the classification system have resulted in the wet subzone being re-classified as the Coastal Western Hemlock Zone (Eastern Very Dry Maritime [CWHxm1] variant), and thus within the CDF only one 'maritime' subzone is now recognized (Nuszdorfer *et al.* 1991).

The Coastal Douglas-fir biogeoclimatic zone lies in the rain shadow of Vancouver Island and the Olympic Mountains. Climate in the region, which is characterized by warm, dry summers and mild, wet winters (Nuszdorfer *et al.* 1991), is influenced by the Pacific Ocean which serves as a reservoir of heat and moisture (Pojar and Meidinger 1991). A summary of the climatic characteristics for the Coastal Douglas-fir biogeoclimatic zone is presented in Table 3.1. Minimum and maximum values are given for each climate variable, obtained from long-term climate stations within the region. Climate values obtained from the Victoria International Airport on the Saanich Peninsula are included. While generally representative of the climate at Rithet's Bog, the airport values may differ slightly due to differences in microclimate. In winter, the low-lying bog receives cold air drainage and may be much colder than the surrounding hills (Carson 1995). As well, in the morning, much of the bog remains in the shadows of the hills to the south and east (Carson 1995).

Pearson (1985) noted a pronounced mid-summer water deficit in the region, which occurs when evapotranspiration exceeds precipitation. This deficit may make the climate somewhat marginal for the existence of bogs. She cited a study by Terasme (1977) which suggests that as water balance and biomass accumulation/deposition ratios decrease, bogs must rely on their 'residual powers' such as low pH, microclimate, and the 'sponge effect' of *Sphagnum* for continued existence. From this she concluded that "a bog that depends on its residual powers for its existence is at a marginal survival level and is particularly sensitive to disturbances from which it cannot recover" (Pearson 1985) .

Table 3.1
Climatic Characteristics of the Coastal Douglas-fir Biogeoclimatic Zone

Range and reference station	Lat. (° ')	Long. (° ')	Elevation (m)	Mean annual precip. (mm)	Mean summer precip. (mm)	Mean precip. of driest month (mm)	Mean precip. of wettest month (mm)
Max.			223	1262.6	238.3	38.6	232.9
Min.			8	647.2	107.3	13.4	119.2
Victoria Intl. A.	48 39	123 26	19	872.9	141.9	18.1	157.3

Range and reference station	Driest month	Wettest month	Mean annual snowfall (cm)	No. of months with snow	Mean annual temp. (°C)	Mean temp. coldest month (°C)	Extreme min. temp. (°C)
Max.			95.2	6	10.5	4.1	-11.7
Min.			17.2	5	9.2	1.8	-21.1
Victoria Intl. A.	July	Dec.	49.9	6	9.5	3.1	-15.6

Range and reference station	Mean temp. warmest month (°C)	Extreme max. temp. (°C)	No. of months with mean temp. > 10°C	No. of months with mean temp. < 0°C	No. of frost free days	Frost free period (days)	Accumulated degree (°C) days above 5°	Accumulated degree (°C) days below 0°
Max.	18	40.6	6	0	349	304	2121	43
Min.	15.4	31.1	5	0	260	155	1794	9
Victoria Intl. A.	16.3	36.1	5	0	305	201	1863	25

Source: Pojar and Meidinger 1991.

3.4 Soils

Soils in the Rithet's Bog area are extremely variable, ranging from stony soils overlying exposed bedrock, to sands, silts, clays, loams, and peats (Table 3.2 and Figure 3.2) (McCrae 1978). Agricultural use, widespread residential development, and the construction of roads and trails have altered soil structure in several places. An early soil survey of southeast Vancouver Island and the Gulf Islands identified the organic soil at Rithet's Bog as Metchosin muck (Day *et al.* 1960). This peat-derived soil also has been disturbed in many places. Agricultural practices such as tilling, fertilization, drainage canal excavation, and pumping of water from the lowland into the Colquitz Creek drainage

system, have influenced the decomposition of organic components and altered soil structure.

Within the shore pine forest, soils are relatively undisturbed, except where ditches were cut prior to 1926. Surrounding these shallow ditches are patches of peat-derived muck. During peak flows, *in situ* material is supplemented by sediments carried in with runoff. These sediments, which likely derive from upland mineral soils and add nutrients to what is ideally a nutrient-poor, acidic substrate, support deciduous shrub vegetation found growing alongside the old ditches within the forest.

Undisturbed soil within the forest is composed primarily of organic fibrous peat and leaf litter. In 1967, Peden found that in those areas where salal (*Gaultheria shallon*) was the dominant understory shrub, the litter layer ranged in depth from 8-10 cm. Beneath this, partially decomposed material extended to a depth of 20-25 cm., below which was almost pure *Sphagnum* peat. Many tree and shrub roots were found within the decomposed litter and peat. In wet areas dominated by *Sphagnum*, Peden (1967) found unmodified *Sphagnum* peat. Currently, decomposition of organic matter within the forest is extremely variable, and may be influenced by water-table levels and vegetation composition.

Soils in the abandoned agricultural fields surrounding the forest are variable, but are primarily composed of peat-derived muck. Peden (1967) found great variability in the litter layer of these areas, and noted that the partially decomposed horizon was almost entirely absent. The decomposed litter and peat layer reached an average depth of 35 cm, below which undecomposed peat extended to an unknown depth (Peden 1967). Zirul (1973) speculated that because the soils are purely organic with very little mineral material (estimated to be approximately 3 to 10 percent), they could be expected to subside at a rate of approximately 2.5 to 3.8 cm per year with cultivation.

The soils found in the areas south and northwest of the pine forest are well-drained, while other soils in the area have variable to poor drainage (McCrae 1978). "The available literature revealed no indication as to permeability of the specific soils in the basin. A review of published data for similar soils yielded saturation infiltration rates which ranged from 1.5 to 5.0 cm/hr." (McCrae 1978).

Table 3.2
Soil Characteristics

SOIL SERIES/TYPE	Soil Group	Drainage	Dominant Topography	Stoniness
Saanichton Clay	Acid Dark Brown Forest	well drained	gently sloping	few to stone free
Rock Outcrop		variable	steep/variable	very stony
Peat	Peat	poorly drained	depressional	stone free
Tolmie Sandy Loam	Dark Grey Gleisolic	poorly drained	level to depressional	stone free
Cowichan Clay Loam	Dark Grey Gleisolic	poorly drained	level to depressional	stone free
Langford Loam	Black	well drained	sloping to gently sloping	stone free

Adapted from McCrae 1978.

RITHET'S BOG

SOILS

SCALE=1:5000 OCT. '95

LEGEND:

- **S** Saanichton Clay
- **R** Rock outcrop
- **P** Peat
- **M** Metchosin Muck
- **C** Cowichan Clay Loam
- **T** Tolmie Sandy Clay Loam
- EMILY Roads

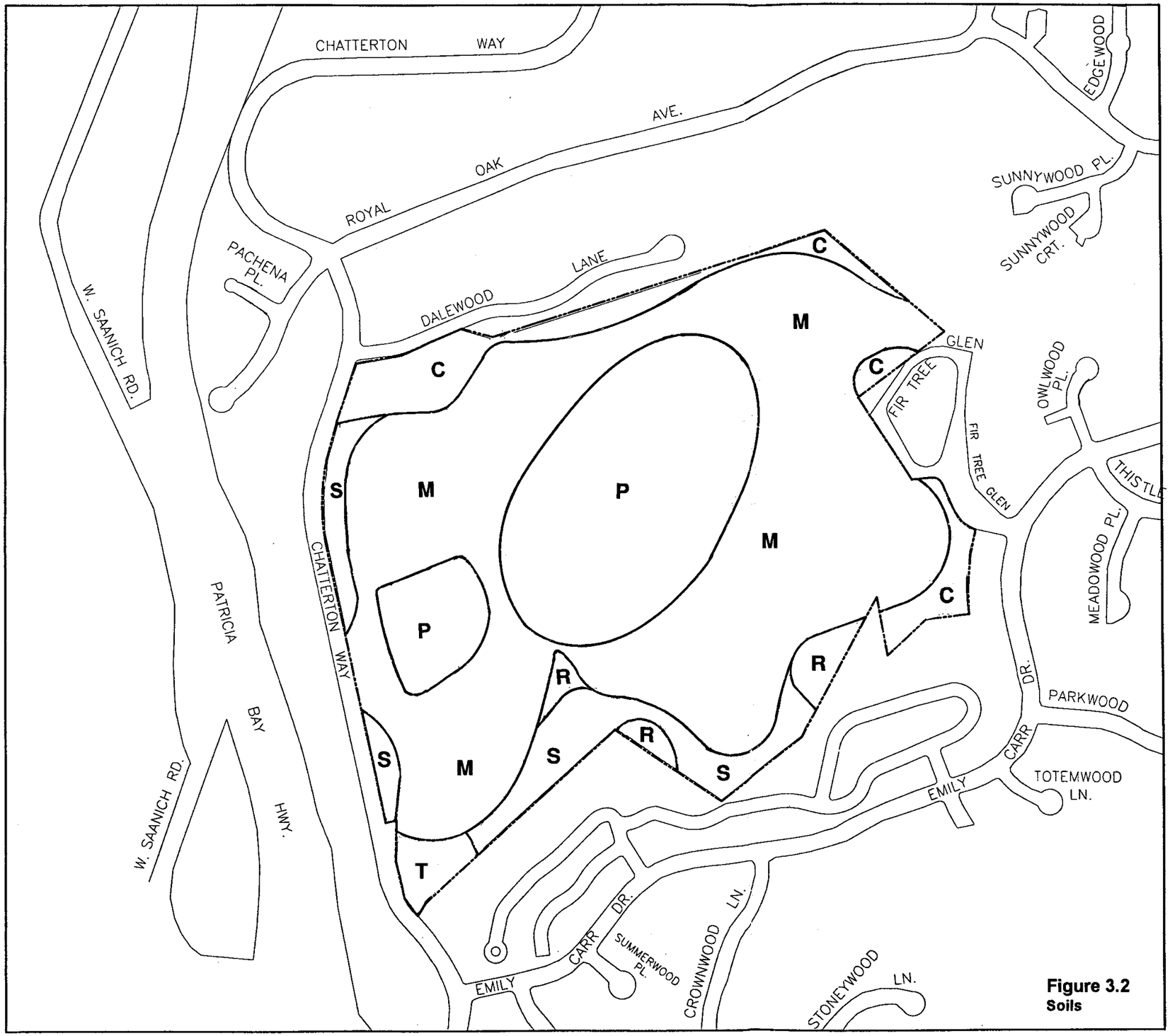


Figure 3.2
Soils

Source: Modified from McCrae 1978; Day et al. 1959

To date, there have been no comprehensive studies of soil acidity at Rithet's Bog, however Peden (1967) found that there were significant differences in pH between horizons of preserved and decomposed peat.

3.5 Topography and Drainage

Rithet's Bog lies in a depression surrounded by hilly terrain and rock outcrops. It is the lowest part of a 243 hectare sub-basin of the Colquitz Creek watershed (Zirul 1973, McCrae 1978). The central bog forest is slightly higher in elevation than the surrounding lowland, which is less than 46 meters above sea level (Aero Surveys Ltd. 1956). Surface topography within the bog forest is heterogeneous, with microtopographical features that include hummocks, hollows, and pools.

The natural topographical transition between the bog and surrounding areas has been obliterated in many places by drainage ditches. When examining the exposed banks of the drainage ditches which in many places mark the transition between the bog forest and the surrounding lowlands, it is unclear whether the higher banks on the bog side are indicative of a steep and abrupt transition, or whether the lowlands have subsided. Another possible explanation for the high banks could be that they are actually berms created by deposition of the excavated material. Whether these drainage ditches followed a natural 'lagg' or marginal ditch, characteristic of bogs in the region (Rigg 1925, 1934), is unclear. Along the southeastern edge of the forest however, the transition is gentle, lacking notable changes in elevation.

Prior to development, the basin functioned as a natural hydrological regulator, detaining excessive flows and recharging groundwater (McCrae 1978). Drainage ditches established prior to 1926 and in 1956 for agricultural purposes had limited success at lowering the water table (Peden 1967); this was accomplished by seasonally pumping water from the fields into the Colquitz Creek system. Seasonal pumping, which ceased in 1994 when Rithet's Bog was designated as a park, effectively lowered the water table in the cultivated land to approximately 1 meter below ground level during June, July, and August (Zirul 1973). It significantly altered the hydrology of the area, and in combination with other agricultural practices such as tilling and fertilization, is believed to have influenced the present vegetation distribution (Peden 1967).

As land-use in the area surrounding Rithet's Bog has changed from agricultural to residential, the proportion of impervious surface area has also increased, reducing potential infiltration and increasing storm run-off (McCrae 1978). Typical of residential development is physical disruption to natural drainage patterns caused by structures and fill deposition. Soil quality is often destroyed, and irrigation of lawns and gardens results in altered seasonal moisture regimes. The net result is a significant increase in runoff rates (McCrae 1978). Within the Rithet's Bog catchment area, this runoff has been directed into underground storm drains or open channels (Figure 3.3), most of which are connected to the Colquitz Creek system via large diameter culverts beneath Chatterton Way and the

Figure 3.3
Drainage

RITHET'S BOG

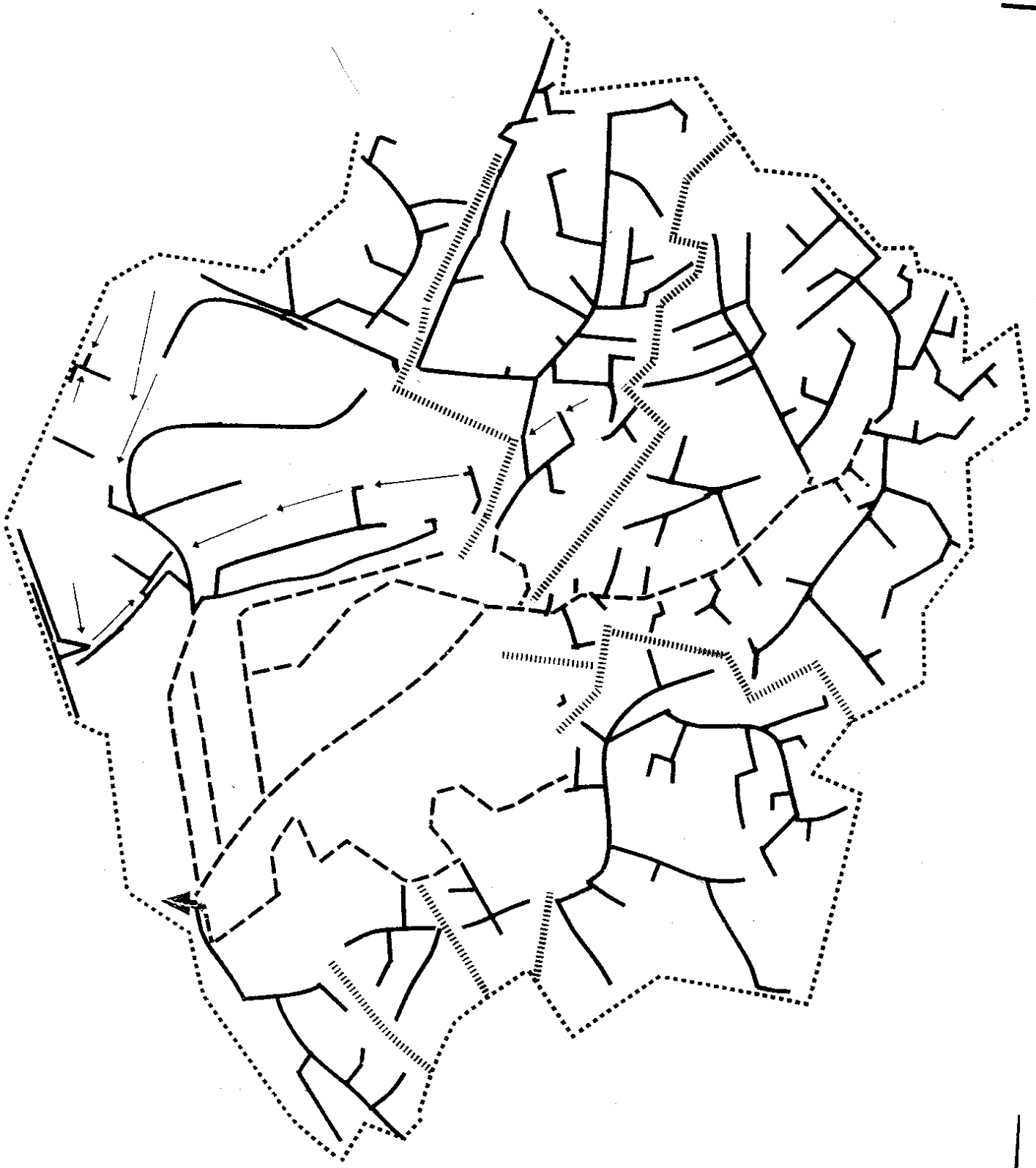
DRAINAGE

SCALE=1:10,000 OCT. '95

LEGEND:

- Subsurface drainage
- Open channel
- Swale
- Catchment boundary
- Catchment sub-boundary
- Roads (EMILY)

Source: B.C. Government Air Photo
Drainage Survey: District of the Corp. of Saanich



Quadra Street-Patricia Bay Highway interchange (Zirul 1973). At several locations between Dalewood Lane and Fir Tree Glen, runoff is channeled through underground pipes directly into the lowlands surrounding the bog. The ultimate destination of this runoff is difficult to determine by simple observation, but it is suspected that at least some of it reaches the bog. On several occasions large quantities of surface foam originating from the outlet below the homes between Dalewood Lane and Fir Tree Glen was observed on the bog side of the path which may indicate detergent contamination.

Perimeter Interceptor Channel

To address concerns that nutrient-rich residential storm water run-off was contributing to negative impacts on the bog ecosystem (Saanich C/W minutes, July 10, 1989), a 'lagg' or perimeter interceptor channel was installed by Broadmead Farms Ltd. A lagg, which normally supports fen vegetation (Wheeler and Shaw 1995), directs nutrient rich water around and away from a bog. The interceptor channel was intended to mimic the function of a lagg by channeling runoff entering the site on the east and south sides into the culvert beneath Chatterton Way.

Recently, local residents have become concerned about water from the interceptor channel rising over the perimeter path and into the wetland (L. Beare, D. Mothersill, and J. Olafson, pers. comm. 1995). To temporarily rectify the problem of flooded sections of the path, small lengths of PVC pipe were installed beneath the path (D. DeShane and D. Nyloff pers. comm. 1995). However it has since been suggested by engineers at Saanich (R. Lloyd pers. comm. 1995) that drainage pipes beneath the path work against the original design of the channel, which was intended to carry water away from the central wetland in the event of heavy storm-flow conditions. Long-term correction of this problem will depend upon the outcome of a detailed hydrological study. In the interim, temporary measures should be investigated.

3.6 Land Use

Land-use pressures associated with suburban development have led municipal planners in Saanich to develop community plans based on a five-year review process. Development in the Royal Oak local area, which includes Broadmead and Rithet's Bog, is guided by the policies and development guidelines contained within the Royal Oak Local Area Plan (Corporation of the District of Saanich 1993). The most recent plan (1993) advocated outright acquisition of the bog for environmental reasons, a goal that has now been reached.

During the last decade, the rural character of the Royal Oak area has been transformed by relatively rapid residential development. Prior to 1981, development in Broadmead focused on single-family residential development, whereas over the past few years the emphasis has shifted to multiple-family residences (Corporation of the District of Saanich

1993). Land use bordering three sides of Rithet's Bog is primarily residential. Multiple residential developments occupy the land directly adjacent to the bog along the southeastern side, and are also found to the west across Chatterton Way. While the 1993 Royal Oak Local Area Plan identified much of the area located between the bog and the Patricia Bay Highway as "view protection areas" it has been suggested that a large retail and office complex will soon occupy much of the area (D. Hunter pers. comm. 1995), increasing recreational use of the bog.

4.0 Vegetation

4.1 Overview

The vegetation at Rithet's Bog was first described by Rigg (1922a) who compared it to the nearby successionally advanced bog at Lost Lake, now known as Blenkinsop Lake. Rigg noted that although "the *Sphagnum* in the bog is mostly dead...there are a good many small areas on which it grows during the rainy season and dries up in summer." At the time of his visit, Rigg observed that Labrador tea (*Ledum groenlandicum*) and bog birch (*Betula glandulosa*) were very common, occurring with abundant populations of western bog-laurel (*Kalmia polifolia*), round-leaved sundew (*Drosera rotundifolia*), bog cranberry (*Oxycoccus oxycoccus*), cottongrass (*Eriophorum* sp.), and shore pine (*Pinus contorta* var. *contorta*). Other plants observed at Rithet's Bog but not believed by Rigg (1922a) to be part of bog succession were bracken (*Pteridium aquilinum*), fireweed (*Epilobium angustifolium*), hardhack (*Spiraea douglasii*), and salal (*Gaultheria shallon*).

Peden (1967) analyzed the vegetation of Rithet's Bog using the vegetation analysis methods of Ellensberg (1954). Four major vegetation communities were identified: 1). *Pinus contorta-Gaultheria shallon* association; 2). *Sphagnum capillaceum* variant; 3). *Spiraea douglasii* typicum sub-association; and, 4). *Cornus stolonifera* sub-association. In the '*Pinus contorta-Gaultheria shallon* association', shore pine, salal, and Labrador tea were the dominant plant species. Soils within the association were acidic with very little decomposition, and water table fluctuations were moderate. Within the '*Sphagnum capillaceum* variant', remnants of a wetter bog community were dominated by *S. capillaceum*, cottongrass, bog rosemary, and western bog-laurel. In this varient, intact *Sphagnum* peat was found in all soil horizons, and the water table level did not fluctuate. In the '*Spiraea douglasii* typicum sub-association', hardhack was dominant. In both this sub-association and the '*Cornus stolonifera* sub-association', water table fluctuations were large, and the soil nutrient levels were high.

Peden (1967) speculated that the major environmental factors influencing vegetation distribution at Rithet's Bog were pH, soil nitrate content, water table fluctuation, and history of disturbance. Low pH in undisturbed areas was believed to maintain high undecomposed peat content which could thereby support "typical high moor vegetation." Peden concluded from his work that peat decomposition increased soil richness and caused increased flooding and water table fluctuation. He also noted that while a new edaphic climax had not yet been reached at Rithet's Bog, it would probably lead to a *Thuja plicata*-hardwood forest (Peden 1967).

In a poorly described analysis of shore pine growth rings, Peden (1967) failed to detect any patterns in age or productivity. Of those trees he sampled, the oldest were approximately 65 years. Many small and stunted pines were found to be between 50 and 60 years old, while large fallen trees throughout the forest reached a maximum of 60 years in age. Peden (1967) believed that both soft substrates and a shallow root system provided insufficient support for older trees, thereby limiting the maximum attainable age.

4.2 Plants with Limited Local Distribution

Several authors have prepared species lists or made partial analyses of the vegetation at Rithet's Bog (Rigg 1922a; Stirling 1965a; Peden 1967; Talisman 1981; Ussery 1988). These lists are presented in tabular form in Appendix II: Summary of Rithet's Bog Plant Species Records, to facilitate comparison. The bog provides habitat for a number of plant species with limited distribution on southern Vancouver Island. Those identified between May and September 1995 include *Sphagnum palustre*, *S. recurvum*, northern starflower (*Trientalis arctica*), dwarf birch (*Betula pumila* var. *glandulifera*), Labrador tea (*Ledum groenlandicum*), and Bolander's rush (*Juncus bolanderi*). Several bog plant species listed by earlier authors were not found during the most recent study. These include western bog-laurel (*Kalmia polifolia*), bog cranberry (*Oxycoccus oxycoccus*), Chamisso's cottongrass (*Eriophorum chamissonis*), and round-leaved sundew (*Drosera rotundifolia*). While it is possible that these species were simply not seen during this study, it appears that either their populations within the bog are greatly reduced from what once existed or they have been extirpated from the Rithet's Bog.

The B.C. Conservation Data Center "rare element" report (1995) for Rithet's Bog has identified what they call the *Pinus contorta - Sphagnum girgensohnii* community as "critically imperiled". This designation indicates extreme rarity within the province, or vulnerability to extirpation or extinction. A community which is ranked as 'S1', is represented by five or fewer extant occurrences or very few individual occurrences within the province. A 'Red listed' community is a candidate for legal designation as endangered or threatened (B.C. Conservation Data Center, 1995). While *Pinus contorta* clearly dominates the bog forest at Rithet's Bog, *Sphagnum girgensohnii* was not found during the May-September vegetation survey.

Also identified by the B.C. Conservation Data Center (1995) as S1 'Red' at Rithet's Bog is Lemmon's willow (*Salix lemmonii*), collected in 1973 by G. W. Argus. Other plants ranked in the report on the basis of their abundance and distribution include dense spike-primrose (*Epilobium densiflorum*), western mannagrass (*Glyceria occidentalis*), Bolander's rush (*Juncus bolanderi*), purple sanicle (*Sanicula bipinnatifida*), and yellow montane violet (*Viola praemorsa* ssp. *praemorsa*). Of those plants listed above, only Bolander's rush (*J. bolanderi*) was identified during the 1995 vegetation survey.

In addition to these plants, Turner and Hebda (1991) noted that western white birch (*Betula papyrifera* var. *commutata*) is found nowhere else in the Victoria area. Cusick's sedge (*Carex cusickii*) has restricted distribution within B.C., while *Riccia crystalina*, a liverwort, is found in few other localities in Canada (Ceska 1983; Turner and Hebda 1991). Again, these plants were not found during the 1995 vegetation survey, but will perhaps be located as the inventory of the plant species at Rithet's Bog progresses.

4.3 Vegetation Communities

The landscape at Rithet's Bog is dominated by two prominent features: the central shore pine forest, and the surrounding abandoned agricultural fields. Based on qualitative observations, the vegetation found at the bog can be divided into nine vegetation communities according to vegetation structure and composition (See Figure 4.1: Vegetation). The communities are: 1. shore pine forest; 2. cottonwood stands; 3. tall deciduous shrub thicket; 4. marsh; 5. Garry oak -rock outcrop; 6. hedgerow; 7. Douglas-fir forest; 8. hardhack thicket/grass wetland; and 9. 'disturbed' areas dominated by exotic vegetation.

The shore pine forest, which has suffered fewer physical impacts than the surrounding areas, supports more plant species with limited local distribution than all of the other vegetation communities, except perhaps the Garry oak -rock outcrops, which were not well inventoried (See Table 4.1: Vegetation Communities at Rithet's Bog). Bog species include *Sphagnum palustre*, *S. recurvum*, *Trientalis arctica*, *Betula pumila* var. *glandulifera*; and *Ledum groenlandicum*. These plants are apparently all that remain of a previously wetter bog ecosystem that supported a larger number of typical bog plants. The forest is dominated by *Pinus contorta* var. *contorta* with an understory of *L. groenlandicum* and *Gaultheria shallon*. *Pteridium aquilinum* is also common within the forest.

Reminders of previous land use are found throughout the bog. In some places decaying fence posts support diverse moss and lichen populations. Rows of black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) are seen in several places, and remnant hedgerows composed primarily of common hawthorn (*Crataegus monogyna*) and Nootka rose (*Rosa nutkana*) are found along the south side of the site beyond the perimeter path and interceptor channel.

Recently abandoned fields are rapidly becoming colonized by flood-tolerant vegetation. Pioneers in this environment include cattail (*Typha latifolia*), water smartweed (*Polygonum amphibium*), water-plantain (*Alisma plantago-aquatica*), beggarticks (*Bidens* spp.), and willow (*Salix* spp.). Fields on the eastern side of the park are similar in vegetation structure, but are characterized by silverweed (*Potentilla anserina* ssp. *pacifica*), creeping buttercup (*Ranunculus repens*), rushes (*Juncus* spp.) and sedges (*Carex* spp. and *Scirpus* spp.). One area along the perimeter path between Chatterton Way and Fir Tree Glen is dominated by watercress (*Nasturtium officinale*).

The old fields generally support two taller plant community types: tall deciduous shrub thicket, and hardhack thicket/grass wetland. Tall deciduous shrub thicket consists of shrubs that are characteristic of nutrient-rich, wetter areas and including willows (*Salix* spp.), red-osier dogwood (*Cornus stolonifera*), cascara (*Rhamnus purshiana*), twinberry (*Lonicera involucrata*), and Pacific crabapple (*Malus fusca*). The hardhack thicket/grass

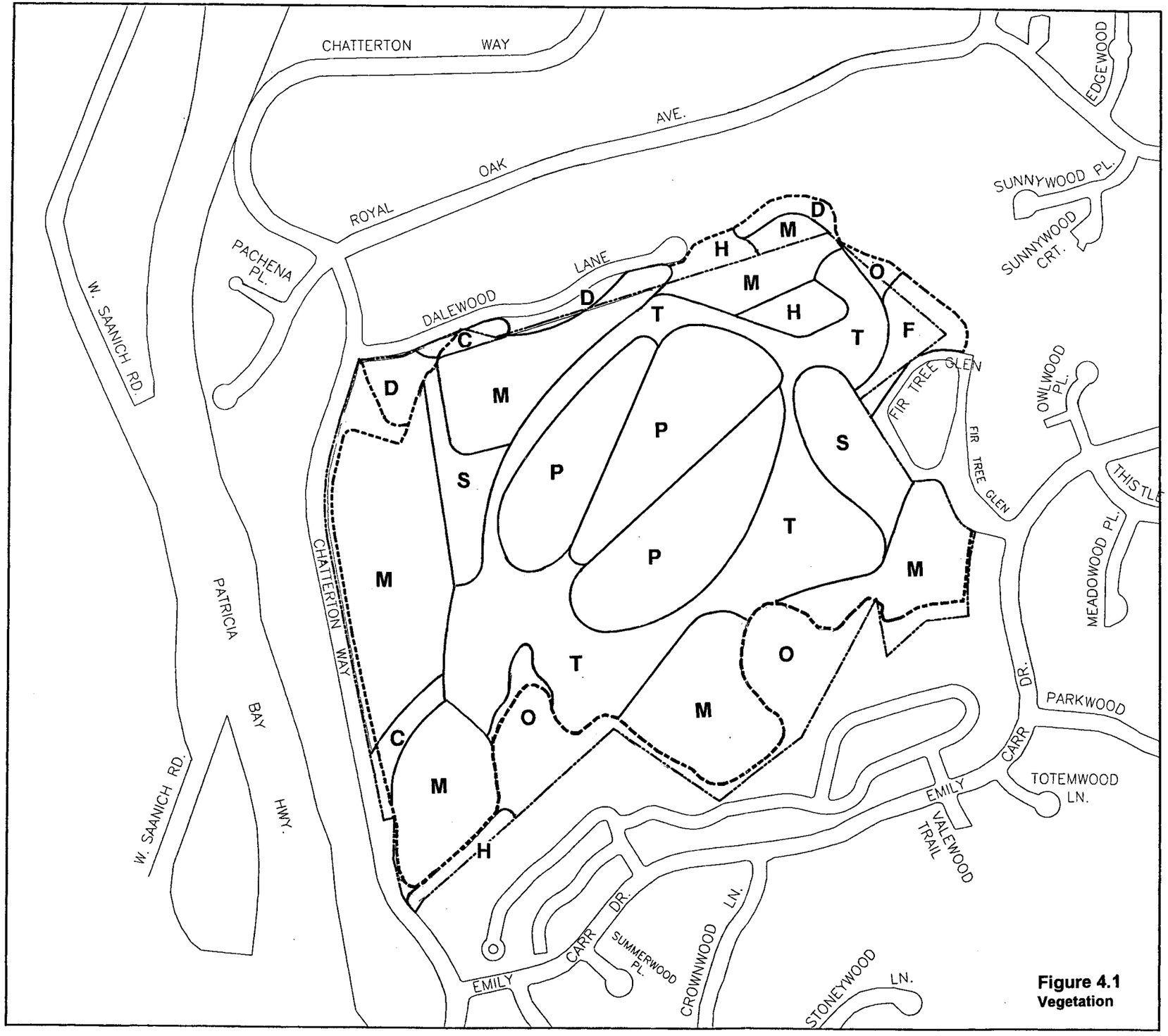


Figure 4.1
Vegetation

RITHET'S BOG

VEGETATION

SCALE=1:5000 OCT. '95

LEGEND:

- P — Shore pine forest
- C — Cottonwood stand
- T — Tall deciduous shrub thicket
- M — Marsh
- O — Garry oak -rock outcrop
- S — Hardhack thicket/grass wetland
- F — Douglas-fir forest
- H — Hedgerow
- D — 'Disturbed' area/ Exotic vegetation
- Perimeter trail
- EMILY — Roads

Source: Aerial Photo Mapping 1992

Table 4.1
Vegetation Communities at Rithet's Bog

Community	Representative plant species	Plants with limited local distribution
Shore pine forest	shore pine (*Pinus contorta* var. *contorta*); salal (*Gaultheria shallon*); bracken (Pteridium aquilinum); Labrador tea (*Ledum groenlandicum*)	*Sphagnum recurvum*; *Sphagnum palustre*; Labrador tea (*Ledum groenlandicum*); northern starflower (*Trientalis arctica*) dwarf birch (*Betula pumila* ssp. *glandulifera*)
Cottonwood stand	black cottonwood (*Populus balsamifera* ssp. *trichocarpa*)	
Tall deciduous shrub thicket	willow (*Salix* spp.); hardhack (*Spiraea douglasii*); red-osier dogwood (*Cornus stolonifera*); cascara (*Rhamnus purshiana*); Nootka rose (*Rosa nutkana*); twinberry (*Lonicera involucrata*); Pacific crabapple (*Malus fusca*)	
Marsh	cattail (*Typha latifolia*); rushes (*Juncus* spp.); sedges (*Carex* spp., *Scirpus* spp.); buttercup (*Ranunculus repens*); Pacific silverweed (*Potentilla anserina*) water smartweed (*Polygonum amphibium*); willow (*Salix* spp.); watercress (*Nasturtium officinale*)*	Bolander's rush (*Juncus bolanderi*)
Garry oak-rock outcrop	Garry oak (*Quercus garryana*); various grasses; snowberry (*Symphoricarpos albus*); dull Oregon grape (*Mahonia nervosa*); Nootka rose (*Rosa nutkana*)	Note: Plants were not collected from the Garry oak community during this study, but it likely contains plants with limited local distribution.
Hedgerow	common hawthorn (*Crataegus monogyna*)*; Nootka rose (*Rosa nutkana*)	
Douglas-fir forest	Douglas-fir (*Pseudotsuga menziesii*); red alder (*Alnus rubra*); oceanspray (*Holodiscus discolor*); arbutus (*Arbutus menziesii*); snowberry (*Symphoricarpos albus*); trailing blackberry (*Rubus ursinus*); swordfern (*Polystichum munitum*)	
Hardhack thicket/ grass wetland	hardhack (*Spiraea douglasii*); tufted hairgrass (*Deschampsia cespitosa*); reed canary grass (*Phalaris arundinacea*)	
Disturbed/ exotic vegetation	Scotch broom (*Cytisus scoparius*)*; Himalayan blackberry (*Rubus discolor*)*	

Note: *Introduced

wetland is dominated by hardhack (*Spiraea douglasii*) and grasses, especially tufted hairgrass (*Deschampsia cespitosa*) and reed canary grass (*Phalaris arundinacea*). Common hawthorn (*Crataegus monogyna*) is spreading throughout the old fields and the drier Garry oak -rock outcrop areas.

Adjacent to the lowlands are three vegetation communities not associated with wetlands. These are: the Douglas-fir forest along the north-eastern edge of the park; the Garry oak - rock outcrops on perimeter of the wetland and across Chatterton Way; and, non-native vegetation which dominates drier disturbed areas including the *de facto* parking lot near the intersection of Dalewood Lane and Chatterton Way, and several sections of the perimeter path. Exotic species include Himalayan blackberry (*Rubus discolor*) and Scotch broom (*Cytisus scoparius*).

4.4 Succession

Alterations to natural drainage can significantly affect bog ecosystems. Major changes in vegetation composition and structure occurred within a short period of time at both Rithet's Bog and Camosun Bog in Vancouver, B.C., and historically at the bog at Blenkinsop Lake (Rigg 1922a). Drier conditions allow shore pine, western hemlock (*Tsuga heterophylla*), and paper birch (*Betula papyrifera*) to expand at the expense of *Sphagnum* and other characteristic bog species (Hebda and Biggs 1981). Often associated with altered drainage is the introduction of nutrient-rich waters from surrounding uplands (Banner *et al.* 1988). "This combination of disturbances increases the nutrient flux and decomposition of organic matter, particularly along drainage channels. Flora characteristic of bogs are replaced by fen and swamp plants such as *Spiraea* spp., *Salix* spp., *Pyrus* spp. [syn. *Malus* spp.], *Juncus* spp., and *Carex* spp." (Banner *et al.* 1988).

In 1922, Rigg visited the bog at Blenkinsop Lake to conduct a study of successional processes. At the time of his visit, that bog had been actively drained for many years. Rigg observed that within the bog, a pure stand of shore pine, *Pinus contorta* was the dominant vegetation, and *Sphagnum* was no longer found living. The trees were observed to be "good size for this species, many of them being 20 to 30 feet [6 to 9m] tall and 6 to 10 inches [15 to 25 cm] thick at the base." The dense stand of trees had straight and slender trunks; the shrub layer below was dominated by a dense thicket of Labrador tea (*Ledum groenlandicum*), and salal (*Gaultheria shallon*).

The above description of the bog at Blenkinsop Lake reflects the current state of succession at Rithet's Bog. Like Rithet's Bog, water levels at Blenkinsop Lake were lowered by means of drainage ditches for agricultural development. Rigg (1922a) made the following observations: "These areas are...stated to have been formerly covered with water and to be still very wet during the rainy season. It is probable that forest succession has been hastened somewhat by this drainage, though it seems impossible that the dense pine forest can be entirely due to this."

Due to natural successional processes, *Sphagnum* bogs are commonly invaded by trees, and in the later stages of succession, the trees may become so numerous as to form a forest (Rigg 1922b). Coniferous trees are commonly the first and most successful invaders of bogs in the region (Rigg 1917). Since the cessation of agricultural activities at Rithet's Bog in 1994, substrates in both the shore pine forest and surrounding lowlands remain wet throughout much of the year. It is expected that with increased moisture, some shifts within vegetation communities will occur, especially with plants that have a narrow moisture tolerance range (Rigg 1917; Zimmerman 1983; Smart *et al.* 1989; Meade 1992; Wheeler and Shaw 1995). Some plant species that developed rapidly under drier conditions may be replaced by species better adapted to wetter conditions. This process is expected to proceed slowly however.

5.0 Wildlife

5.1 Overview

Few comprehensive studies of the wildlife at Rithet's Bog have been undertaken. In 1965, Stirling compiled a list of birds found in the area, and recently Carson (1995) published the results of a detailed survey of the birds at the bog (See Appendix III: Summary of Rithet's Bog Bird Species Records). While many invertebrates are found in the area, they have never been systematically inventoried. At least one rare invertebrate, however, a subspecies of silk moth endemic to British Columbia and rare on Vancouver Island (*Hyalophora euryalus* ssp. *kasloensis*), has been reported in the past (Ceska 1983; Turner and Hebda 1991). The bog has been monitored annually for butterflies since 1993, as part of a Victoria-region butterfly survey (Gaskin *et al.* 1994; Gaskin 1995) (See Appendix IV: Results of Rithet's Bog Butterfly Survey, May-Sept. 1995).

Peden (1967) stated that squirrels, owls, and pheasants were observed at the bog during the time of his study, but did not provide further details. Between May and September 1995, deer (*Odocoileus hemionus*) tracks were observed on many occasions throughout the shore pine forest, and muskrats (*Ondatra zibethica*) were seen around the perimeter interceptor channel and ditches surrounding the forest. On one occasion a dead rat (*Rattus* sp.) was found alongside a ditch near the forest. Eastern cottontails (*Sylvilagus floridanus mearnsi*) were frequently observed on the south and west sides of the site. On one occasion, elk (*Cervus canadensis*) were reported in the vicinity of the bog (D. Mothersill pers. comm. 1995); there was no evidence to indicate that the elk had entered the bog however. In late spring, Pacific tree-frogs (*Hyla regilla*) were abundant throughout the recently abandoned fields west of the shore pine forest, and were also seen within the forest. Three-spine sticklebacks (*Gasterosteus aculeatus*) were found in the creek that enters the site near Fir Tree Glen and in the interceptor channel that follows the perimeter trail.

5.2 Birds

As Wheeler and Shaw (1995) report: "Open areas of little-damaged bogs typically have low bird density and low species richness, and very few birds are considered to be particularly characteristic of raised bogs." This largely results from the limited food supply offered by typical bog plants; perching and nesting sites are also limited by the homogeneous structure of low-growing bog plants. Within degraded bog ecosystems such as Rithet's Bog, however, heterogeneous vegetation structure offers a wider variety of habitat, resulting in greater species richness and density (Wheeler and Shaw 1995).

Between June 1993 and May 1994, a weekly survey of the bird life at Rithet's Bog was conducted by members of the Victoria Natural History Society (Carson 1995). The following summary is based on the results of that survey. Bird species reported by Stirling

(1965b) and Carson (1995) are listed in tabular form to facilitate comparison in Appendix III: Summary of Rithet's Bog Bird Species Records.

Survey work reported by Carson (1995) primarily focused on the old fields visible from the perimeter path rather than the inaccessible shore pine forest. A great horned owl (*Bubo virginianus*) was seen flying into the forest on several occasions, and both purple finch (*Carpodacus purpureus*) and western tanager (*Piranga ludoviciana*) were observed within the forest (Carson 1995). The abandoned fields east of the shore pine forest were densely populated by both woodland species and perching birds. Virginia rail (*Rallus limacola*) and sora (*Porzana carolina*) were observed by the small pond along the perimeter trail near Fir Tree Glen (Carson 1995). Also found in this area were Anna's hummingbird (*Calypte anna*), red-winged blackbird (*Agelaius phoeniceus*), American goldfinch (*Carduelis tristis*), long-billed marsh wren (*Cistothorus auratus*), and Lincoln's sparrow (*Melospiza lincolnii*) (Carson 1995). Virginia rail (*R. limacola*) and long-billed marsh wren (*C. auratus*), said to be relatively rare in the region, reportedly nest in the area (Ceska 1983; Turner and Hebda 1991). Birds of prey found here included northern shrike (*Lanius excubitor*), merlin (*Falco colombarius*), and Cooper's hawk (*Accipiter cooperii*) (Carson 1995).

The seasonally flooded fields on the western and northern sides of the site provide habitat for many waterfowl species including mallard (*Anas platyrhynchos*), American widgeon (*Anas americana*), green-winged teal (*Anas carolinensis*), trumpeter swan (*Cygnus buccinator*), and tundra swan (*Cygnus columbianus*) (Carson 1995). British Columbia Conservation Data Center records (1995) indicate that both trumpeter swan and tundra swan are uncommon within the province. Great blue herons (*Ardea herodias*) also frequent the area. Gulls occupy the flooded fields in mid-winter (Carson 1995). In spring, several species of shorebird can be found in both the flooded southern fields and the field along Chatterton Way. Least sandpiper (*Calidris minutilla*), western sandpiper (*Calidris mauri*), killdeer (*Charadrius vociferus*), greater yellow-legs (*Tringa melanoleuca*), lesser yellow-legs (*Tringa flavipes*), solitary sandpiper (*Tringa solitaria*), spotted sandpiper (*Actitis macularia*), and long-billed dowitcher (*Limnodromus scolopaceus*) were all observed in the area (Carson 1995). Solitary sandpipers (*T. solitaria*) nest in the smaller southwestern field (Carson 1995).

In comparing his study with Stirling's observations made thirty years earlier, Carson (1995) notes that several bird species including mourning dove (*Zenaida macroura*), meadowlark (*Sturnella neglecta*) and skylark (*Alauda arvensis*) have disappeared from the area. Remarking on the results of the 1993-1994 bird survey Carson (1995) states:

> ...it is probably no longer valid to claim that wading birds are still here in good numbers. The evidence seems to point to a substantial decline in the number of shorebirds even though there has apparently been little change in the immediate shorebird habitat. It seems likely, but difficult to prove, that elimination of the buffer zone of natural vegetation on the lower slopes (and their replacement by condominiums, parking lots and roads) may have contributed to this decline in bird

life in the bog itself. There are also concerns about the quality of water in those parts of the ditch system that receive storm runoff from the adjacent road network, and the impact that this might have on wildlife that use the ditches.

Species noted by Stirling (1965b) but not reported by Carson (1995) include lesser scaup (*Aythya affinis*), goshawk (*Accipiter gentilis*), American coot (*Fulica americana*) (but reported by others in some previous winters), western bluebird (*Sialia mexicana*), western screech-owl (*Otus kennicottii*), short-eared owl (*Asio flammeus*), common nighthawk (*Chordeiles minor*), olive-sided flycatcher (*Nuttallornis borealis*), tree swallow (*Iridoprocne bicolor*), purple martin (*Progne subis*), chipping sparrow (*Spizella passerina*), and Townsend's warbler (*Dendroica townsendi*) (See Appendix III: Summary of Rithet's Bog Bird Species Records). Carson (1995) notes that the decline in some of these species appears to have occurred throughout southern Vancouver Island. Regarding the impact of the perimeter trail on bird life at Rithet's Bog, Carson (1995) states: "Waterfowl, rails, and snipe frequently use the ditches that flank the trail system and seem to be sensitive to disturbance. This is especially true of the small pond area, which has now been opened up a great deal by trail construction."

5.3 Butterfly Surveys

Since 1991, monthly butterfly surveys have been undertaken throughout the Greater Victoria area during the summer months; Rithet's Bog is one of approximately twenty areas which have been included in these surveys. Coordinated by a local naturalist group, the Citizens Association to Save the Environment (CASE), the purpose of the counts is to provide a benchmark assessment of butterfly abundance in the Victoria area. Gaskin *et al.* (1994) note that "Butterfly surveys represent a new area of amateur naturalist activity. As a result...the identification skills of many of the observers are somewhat limited. In many ways therefore, these early butterfly surveys should be regarded as comparable to the earliest Christmas Bird Counts."

In 1993, the only two (male) Reakirt's coppers (*Epidemia mariposa charlottensis*) observed in the Greater Victoria region were found at Rithet's Bog, and a sizable colony of European skipperlings (*Thymelicus lineola*) was also reported (Gaskin *et al.* 1994). In 1994, high numbers of mylitta crescents (*Phyciodes mylitta mylitta*) and purplish coppers (*Epidemia helloides*) were recorded at Rithet's Bog, and the colony of European skipperlings (*T. lineola*) was again noted (Gaskin 1995). The European skipperlings favoured weedy thistle species for nectaring along the south end of the perimeter trail.

Butterflies observed at Rithet's Bog during May to September 1995 are listed in Appendix IV: Results of Rithet's Bog Butterfly Survey, May-Sept. 1995. Purplish coppers (*E. helloides*) were particularly abundant in the abandoned fields south of the pine forest where they were frequently found nectaring on clover. In July, pine whites (*Neophasia menapia tau*) could be seen high in the canopy of the shore pine forest. Lorquin's admirals (*Basilarchia lorquini burrisoni*) were readily visible throughout the bog area in the early

summer months until August, when they virtually disappeared. In August and September ringlets (*Coenonympha tullia insulana*) were observed throughout the Garry oak -rock outcrop plant communities along the perimeter of the park. Described as 'vulnerable' in Canada by Guppy (1993) due to habitat destruction,

> ...the subspecies has two generations per year, and can only exist in areas which are damp enough to maintain green grass (the larval food plant) throughout the driest part of summer, but which does not flood excessively in the winter and does not become overgrown with brush and trees (Guppy 1993).

Also characteristic of Garry oak communities and observed during the 1995 survey were Sara orange tip (*Anthocharis sara flora*) and anise swallowtail (*Papilio zelicaon zelicaon*).

6.0 Research Priorities

6.1 Bog Restoration

Once any site has been degraded, it is never possible to return it *exactly* to its former condition. However, it may be possible to repair or regenerate a bog by restoring conditions similar to those under which it originally developed and hence encourage the return of typical bog plant and wildlife species (Wheeler and Shaw 1995). As bog restoration is a relatively new activity and many techniques are experimental, there are no guarantees of success. However, carefully planned restoration efforts based on a solid understanding of the system are more likely to produce the desired results than work that proceeds in a haphazard manner.

Bog restoration is currently being undertaken at both Camosun Bog and Richmond Nature Park in the Lower Mainland. Documentation of restoration activities at Camosun Bog includes an early comprehensive report by Pearson (1985) outlining recommendations for restoration; a summary of restoration work undertaken (Watmough and Pearson 1990); a restoration and monitoring program developed for the bog (EcoLeaders Nature Interpretation 1991a); and an interpretive plan (EcoLeaders Nature Interpretation 1991b). Restoration activities have drawn from the results of research that examined various aspects of the ecology of Camosun Bog including: a study of water levels and water chemistry by Marowich (1982); vegetation classification and ordination by Comeau (1983); accelerated forest succession as related to hydrological and biogeochemical factors by Jull (1983); foliar analysis of western hemlock and lodgepole pine by Catt (1983); peat stratigraphy, palynology and plant succession by Pearson (1983); and, hydrogeological assessments by Piteau Associates (1989, 1991).

Rithet's Bog and Camosun Bog are similar in many ways. Both have been classified as coniferous treed basin bogs (Banner *et al.* 1988) and the ecology of each has been influenced by surrounding urban development including significant changes in hydrology and nutrient regimes. In addition, both are now located within parks. Any future restoration efforts at Rithet's Bog should draw on the experience gained at Camosun Bog. Restoration programs established at Richmond Nature Park should also be considered, although less extensive pre-restoration analysis has been done there.

The results of research which examined the revegetation of degraded bog ecosystems in other areas is presented by Zimmerman (1983), Smart *et al.* (1989), and Meade (1992). A comprehensive volume by Wheeler and Shaw (1995), which summarizes the concepts and practical aspects of restoration work being done in the UK and Europe, is an excellent resource. Because the functional requirements of basin bog ecosystems in both Europe and North America are similar, the European literature can be very useful.

Research priorities for Rithet's Bog should focus on better understanding the bog's ecology. This will facilitate the restoration process by allowing parallels to be drawn between what is known from the literature, and what is directly applicable to Rithet's Bog.

Although a large body of information pertaining directly to Rithet's Bog exists, many critical aspects of the bog ecosystem are still not well understood.

6.2 Hydrology and Groundwater Chemistry

Of primary importance to developing a plan for bog restoration is a comprehensive hydrological study to determine both the quantity and quality of water flowing into the bog from surrounding areas. Within the pine forest, both ground water levels and flow, and chemical parameters including pH and nutrient concentrations should be determined and monitored over a number of years.

6.3 Vegetation History

Restoration activities require the formulation of realistic goals in terms of ecosystem structure, function, and composition. To determine a target vegetation community toward which restoration efforts can proceed, paleoecological research to determine shifts in the bog vegetation over time, should be considered. As well, to determine the effects of physical disturbance and recent changes in hydrology and nutrient regimes on tree growth, dendro-chronological techniques should be used to examine the age and growth characteristics of the trees within the pine forest.

6.4 Vegetation Composition

The only comprehensive study of the vegetation of Rithet's Bog was done by University of Victoria biology student D. Peden in 1967. Since that time vegetation composition has changed significantly and an up-dated study is needed. Exotic plant species, which often fill niches unoccupied by native species in degraded ecosystems, can be difficult to control and can delay the re-establishment of native plant communities. A survey which maps the occurrence and abundance of non-native plants at Rithet's Bog should also be undertaken, and their potential for further spread should be estimated. An investigation of safe and effective control measures for invasive exotic plant species would be useful not only for Rithet's Bog, but for other parks in the municipality of Saanich as well.

6.5 Sphagnum Patches

Research that focuses on the remaining patches of *Sphagnum* will also be useful. As *Sphagnum* is a plant that facilitates the establishment of other bog species by modifying the local environment, research on its ecology is important. Research which tests the success of experimental transplanting of *Sphagnum* into other areas of the bog is also useful. As an indicator of the ecological health of the bog, a program which monitors the location, abundance, and spread (or decline) of *Sphagnum* is essential.

6.6 Recommendations

In order to better understand the ecology of Rithet's Bog it is recommended that research priorities include:

- a hydrological study to determine both the quantity and quality of water flowing into the bog from surrounding areas;
- a long-term monitoring program to ascertain ground water levels and flow, and identify chemical parameters, including pH and nutrient concentrations, within the shore pine forest;
- paleoecological research to determine short- and long-term history of the bog vegetation;
- dendrochronological studies to determine the age and growth characteristics of shore pine;
- comprehensive vegetation analysis to determine changes in vegetation composition since D. Peden's (1967) study;
- research focusing on exotic plant species, including estimates of potential spread, and feasible control measures;
- research which considers the ecology of remaining patches of *Sphagnum* which may include experimental transplanting of *Sphagnum* into other areas of the bog; and,
- a program to monitor the abundance and spread (or decline) of *Sphagnum*.

7.0 Management Issues

7.1 Areas of Concern

Through discussions with various groups and individuals, and review of the available background information, several management issues have been identified. Areas of management concern include:

- the process by which management decisions at Rithet's Bog nature reserve will be made;
- land use within the reserve and specifically the possibility of reinstating agricultural activities;
- the quantity and quality of runoff entering the wetlands;
- depth of the perimeter interceptor channel and its influence on water table position;
- the effects of flood conditions on the perimeter path system; reconfiguration of the path for ease of maintenance; and method and materials for path repairs;
- the development of a formal path system into the bog forest;
- dumping of household garden wastes at several locations on the perimeter of the park;
- the effects of invasive exotic plant species on the native plant community;
- the issue of dogs within the nature sanctuary; and,
- the effects of rabbits, and both feral and domestic cats on plant and wildlife populations.

7.2 Recommendations

It is recommended that a volunteer committee with local community, academic, and government representation be established to consider various issues related to the management of Rithet's Bog. Such a committee has been effective in coordinating research, management, and restoration efforts at Musqueam Creek in Vancouver, B.C. (N. Page pers. comm. 1995). An additional mandate of the Musqueam Creek Committee is community education; an annual 'open house' is organized, where members make presentations and discuss the results of recent research. As research proceeds at Rithet's Bog, and in particular if restoration activities are undertaken, decisions regarding various

aspects of conservation and management will be necessary. A well-informed committee can help make these decisions and determine priorities for conservation activities.

Because Rithet's Bog is a nature sanctuary (zoned P5 by Saanich), all management decisions should reflect the primacy of conservation values associated with this designation. Any activities that could be considered detrimental to the bog ecosystem should be prohibited. Although some management recommendations can be made on the basis of what is already known about the bog ecosystem, other management decisions should be made only after the results of further research become known.

A conservative approach to management issues should be taken due to the sensitive nature of the habitat, and uncertainty as to the response of the bog. Specific recommendations include:

- Prohibit further agricultural use. The impact of agricultural use on bog ecosystems is well known. Further use would likely result in continued local extirpation of bog plant species, and physical degradation of the bog. Rithet's Bog is a nature sanctuary, and management priorities should reflect this designation.

- Initiate a hydrological study to determine the quantity and quality of water flowing into the site from surrounding areas, including an analysis of the potential impacts of runoff on the bog ecosystem. The study should encompass the entire sub-basin.

- Investigate potential solutions to concerns related to the perimeter interceptor channel and the path system. The perimeter interceptor channel was designed to prevent nutrient-rich run-off from entering the central bog area. Modifications to the path (by building it up) and/or the channel (by increasing its depth or width) should be considered to prevent the extensive spill-over which occurs in fall and winter. In addition, the length of the channel should be expanded if necessary to prevent runoff from entering the bog from the north and northeast sides of the site.

- Do not develop formal path access into the pine forest. Despite potential for educational activities, the fragile nature of the peat soils would require the construction of a raised walkway. Easy access must be balanced against vulnerability of the forest (which contains much debris and is very dry in summer) to fire; peat fires are known to be difficult to extinguish. There is also concern that the few remaining patches of *Sphagnum* could become physically damaged by trampling. At present, few people seek entry to the forest, perhaps due to limited access opportunities. Within the forest, dense shrub growth makes movement difficult. As research activities proceed however, the public may desire access to the area, and at that time, the management committee should reconsider this recommendation.

- Inform residents along Dalewood Lane and Fir Tree Glen of the illegality of dumping garden wastes. Waste currently found in the area should be removed by the owners

under instructions of Saanich By-law Enforcement Officers. If the offenders are unknown, the waste should be directly removed by Saanich.

- Initiate a study to determine exotic plant distribution at the bog, and identify feasible measures to control those species displacing native vegetation. Volunteer removal efforts should be fostered and supported.

- Develop a series of signs and other education materials to inform local residents and park users about the sensitive ecology and regional importance of Rithet's Bog.

- Prohibit dogs. Rithet's Bog is a nature sanctuary with large resident and migratory bird populations which are sensitive to disturbance. Despite the present requirement that dogs be kept on leashes, it has been noted that not all dog owners comply.

- The removal of rabbits and feral cats from Rithet's Bog should be considered as required.

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Appendix I
Results of Rithet's Bog Vegetation Survey, May-Sept. 1995

TREES

Scientific Name	Common Name
Acer macrophyllum Pursh	bigleaf maple
Alnus rubra Bong	red alder
Arbutus menziesii Pursh	arbutus
Betula pubescens Ehrh.[1]	silver birch
Betula pumila L. var. *glandulifera* Regal[1]	dwarf birch
Malus fusca (Raf.) Schnei.	Pacific crab apple
Pinus contorta Dougl. var. *contorta*	shore pine
Populus balsamifera L. ssp. *trichocarpa* (Torr. & Gray) Fosberg	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 sitchensis Bong.	Sitka willow
Sorbus aucuparia L.*	European mountain-ash
Thuja plicata Donn.	western redcedar

SHRUBS

Scientific Name	Common Name
Cornus stolonifera Michx.	red-osier dogwood
Crataegus douglasii Lindl.	black hawthorn
Crataegus monogyna Jacq.*	common hawthorn
Cytisus scoparius (L.) Link.*	Scotch broom
Gaultheria shallon Pursh	salal
Holodiscus discolor (Pursh) Maxim.	oceanspray
Ilex aquifolium L.*	English holly
Ledum groenlandicum Oeder	Labrador tea
Ligustrum vulgare L.*	privet
Lonicera involucrata (Rich.) Banks	twinberry
Mahonia nervosa Pursh	dull Oregon grape
Oemleria cerasiformis (H.&A.) Landon	Indian plum
Rhamnus purshiana DC.	cascara
Rosa gymnocarpa Nutt.	baldhip rose
Rosa nutkana Presl	Nootka rose
Rubus discolor Weihe & Nees*	Himalayan blackberry
Rubus laciniatus Willd.*	cutleaf blackberry
Rubus ursinus Cham. & Schlecht.	trailing blackberry
Spiraea douglasii Hook. var. *douglasii*	hardhack
Symphoricarpos albus (L.) Blake	snowberry

Note:
[1] Tentative identification: no cones/nutlets.
* Introduced

HERBS

Scientific Name	Common Name
Alisma plantago-aquatica L.	water-plantain
Anthemis cotula L.*	mayweed
Bidens amplissima Greene	Vancouver Island beggarticks
Bidens cernua L.	nodding beggarticks
Brassica campestris L.*	field mustard
Camassia quamash (Pursh) Greene	common camas
Cirsium arvense (L.) Scop.*	Canada thistle
Cirsium vulgare (Savi) Tenore*	bull thistle
Conyza canadensis (L.) Cronq.*	horseweed
Epilobium ciliatum Raf.	purple-leaved willow-herb
Epilobium watsonii Barbey	Watson's willow-herb
Epilobium sp.	willow-herb
Erodium cicutarium (L.) L'Her.*	common stork's bill
Erysimum cheiranthoides L.*	wormseed mustard
Eschscholzia californica Cham.*	California poppy
Galium trifidum L.	small bedstraw
Galium triflorum Michx.	sweet-scented bedstraw
Gnaphalium uliginosum L.*	marsh cudweed
Hypericum anagalloides C.&S.	bog St. John's-wort
Hypericum androsaemum Rehd.*	
Hypochaeris radicata L.*	hairy cat's-ear
Lactuca serriola L.*	prickly lettuce
Lemna minor L.	duckweed
Leontodon autumnalis L.*	autumn hawkbit
Lupinus arboreus Sims*	tree lupin
Lysichitum americanum Hulten & St. John	skunk cabbage
Mimulus guttatus DC.	yellow monkey-flower
Mentha arvensis L.	field mint
Myosotis laxa Lehm.	small-flowered forget-me-not
*Nasturtium officinale**	watercress
Oenanthe sarmentosa Presl.	Pacific water parsley
Osmoriza chilensis H. & A.	mountain sweet-cicely
Plantago lanceolata L.*	English plantain / ribwort
Plantago major L.	plantain
Polygonum amphibium L.	water smartweed
Polygonum persicaria L.*	common smartweed
Potentilla anserina L. ssp. *pacifica* (Howell) Rousi	silverweed
Prunella vulgaris L.	self-heal
Ranunculus repens L.*	creeping buttercup
Roripa palustris (L.) Bess.	marsh yellow cress
Rumex acetosella L.*	sheep sorrel
Rumex conglomeratus Murr.*	clustered dock
Solanum dulcamara L.*	European bittersweet
Symphytum officinale L.*	comfrey
Tellima grandiflora (Pursh) Dougl.	fringecup
Trientalis arctica Fisch.	northern starflower
Trifolium dubium Sibth.*	small hop-clover
Trifolium pratense L.*	red clover
Trifolium repens L.*	white clover
Typha latifolia L.	cattail

HERBS

Scientific Name	Common Name
Urtica dioica L.	stinging nettle
Veronica americana Schwein.	American brooklime

GRASSES, RUSHES, & SEDGES

Scientific Name	Common Name
Agrostis tenuis Sibth.*	colonial bentgrass
Anthoxanthum odoratum L.*	sweet vernalgrass
Carex deweyana Schw.	Dewey's sedge
Carex obnupta Bailey	slough sedge
Carex viridula Michx.	green sedge
Cynosurus echinatus L.*	hedgehog dogtail
Echinochloa crusgalli (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. *palodosus* (Nels.) Kuekenth.	seacoast bulrush
Scirpus validus Vahl (syn. *S. lacustris* L. ssp. *validus*)	tule
Setaria lutescens (Weigel) Hubb.*	yellow bristle grass

FERNS & ALLIES

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

MOSSES & LICHENS

Scientific Name
Sphagnum palustre s.l. (*Sphagnum henryense*)
Sphagnum recurvum s.l. (*Sphagnum pacificum*)

Approximately 50 moss and lichen specimens were collected during the vegetation survey and were being identified at the time this report was submitted.

Note:
Plant specimens 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 *Sphagnum* mosses.

Appendix II
Summary of Rithet's Bog Plant Species Records

	Rigg 1922	Stirling 1965	Peden 1967	Talisman 1981	Ussery 1988	Golinski 1995
TREES						
Abies grandis		x				
Acer macrophyllum						x
Alnus rubra		x	x	x	x	x
Arbutus menziesii						x
Betula glandulosa	x	x	x		x	
Betula papyrifera			x	x	x	
Betula papyrifera var. *commutata*		x				
Betula pubescens						x
Betula pumila var. *glandulifera*				x		x
Malus fusca		x	x	x	x	x
Picea sitchensis				x		
Pinus contorta var. *contorta*	x	x	x	x	x	x
Pinus monticola		x				
Populus balsamifera ssp. *trichocarpa*		x	x	x	x	x
Populus tremuloides		x	x	x	x	x
Prunus emarginata		x				
Pseudotsuga menziesii		x	x		x	x
Quercus garryana			x		x	x
Salix geyeriana			x	x	x	
Salix hookeriana		x				x
Salix lasiandra		x				x
Salix mackenziana		x				
Salix scouleriana		x	x		x	
Salix sitchensis		x	x		x	x
*Sorbus aucuparia**			x		x	x
Sorbus sitchensis		x				
Thuja plicata			x		x	x
SHRUBS						
Cornus stolonifera		x	x	x	x	x
Crataegus douglasii		x				x
*Crataegus oxyacantha**		x	x		x	
*Crataegus monogyna**						x
*Cytisus scoparius**						x
Gaultheria shallon	x	x	x	x	x	x
Holodiscus discolor						x
*Ilex aquifolium**			x			x
Kalmia polifolia	x	x	x		x	
Ledum groenlandicum	x	x	x	x	x	x
*Ligustrum vulgare**						x
Lonicera involucrata		x	x	x	x	x

Note: *Introduced

	Rigg 1922	Stirling 1965	Peden 1967	Talisman 1981	Ussery 1988	Golinski 1995
SHRUBS						
Mahonia nervosa		x				x
Myrica gale				x		
Oemleria cerasiformis						x
Oxycoccus oxycoccus	x	x	x	x	x	
Physocarpus capitatus		x				
Rhamnus purshiana		x	x	x	x	x
Rosa gymnocarpa						x
Rosa nutkana		x	x		x	x
Rosa pisocarpa		x	x		x	
*Rubus discolor**						x
*Rubus laciniatus**						x
Rubus spectabilis		x				
Rubus ursinus		x	x		x	x
Spiraea douglasii	x	x	x	x	x	x
Symphoricarpos albus		x				x
HERBS						
Adenocaulon bicolor		x				
Alisma plantago-aquatica						x
*Anthemis cotula**						x
Aster subspicatus						
Bidens amplissima						x
Bidens cernua						x
*Brassica campestris**						x
Camassia quamash						x
Cardamine oligosperma		x				
Chimaphila umbellata		x				
*Cirsium arvense**						x
Cirsium edule			x		x	
*Cirsium vulgare**						x
*Conyza canadensis**						x
Dicentra formosa		x				
Drosera rotundifolia	x	x	x		x	
Epilobium adenocaulon		x				
Epilobium angustifolium	x		x		x	
Epilobium ciliatum						x
Epilobium watsonii						x
Epilobium sp.						x
*Erodium cicutarium**						x
*Erysimum cheiranthoides**						x
*Eschscholzia californica**			x		x	x
Galium trifidum		x				x
Galium triflorum		x	x		x	x
Geum macrophyllum		x				
*Gnaphalium uliginosum**						x
Goodyera oblongifolia		x				
*Hedera helix**			x		x	
Hieracium albiflorum			x		x	
Hypericum anagalloides						x

	Rigg 1922	Stirling 1965	Peden 1967	Talisman 1981	Ussery 1988	Golinski 1995
HERBS						
*Hypericum androsaemum**						x
Hypericum sp.		x				
*Hypochaeris radicata**						x
*Lactuca serriola**						x
Lemna minor						x
*Leontodon autumnalis**						x
*Lupinus arboreus**						x
Lycopus labiatae			x			
Lycopus sp.					x	
Lysichiton americanum		x	x		x	x
Maianthemum dilatatum		x				
Mentha arvensis						x
Mimulus guttatus						x
Mimulus langsdorfii		x				
Montia sibirica		x				
Myostis laxa			x		x	x
Myosotis sp.		x				
*Nasturtium officinale**		x				x
Oenanthe sarmentosa			x		x	x
Osmoriza chilensis						x
*Plantago lanceolata**						x
Plantago major						x
Polygonum amphibium		x				x
*Polygonum persicaria**						x
Potentilla anserina			x		x	
Potentilla anserina ssp. *pacifica*						x
Prunella vulgaris		x				x
Pyrola asarifolia			x		x	
Pyrola sp.		x				
*Ranunculus repens**		x				x
Ranunculus sp.			x	x	x	
Rorripa palustris						x
*Rumex acetosella**						x
*Rumex conglomeratus**						x
Sanguisorba spp.			x		x	
Sium cicutaefolium		x				
Sium sp.		x				
*Sisymbrium officinale**			x			
*Solanum dulcamara**						x
Stachys mexicana		x				
*Stellaria media**			x		x	
*Symphytum officinale**						x
Tellima grandiflora						x
Tiarella trifoliata		x				
Trautvetteria carolinensis		x				
Trientalis arctica		x	x	x	x	x
*Trifolium dubium**						x

	Rigg 1922	Stirling 1965	Peden 1967	Talisman 1981	Ussery 1988	Golinski 1995
HERBS						
*Trifolium pratense**						x
*Trifolium repens**						x
Typha latifolia						x
Urtica dioica						x
Urtica lyallii		x				
Veronica americana		x				x
Veronica scutellata			x		x	
Viola glabella		x				
Viola palustris		x				
Viola sp.			x		x	
GRASSES, SEDGES, & RUSHES						
Agrostis tenuis						x
*Anthoxanthum odoratum**						x
Calamagrostis sp.			x		x	
Carex deweyana						x
Carex flava			x		x	
Carex obnupta						x
Carex viridula						x
Carex sp.			x	x	x	
*Cynosurus echinatus**						x
*Echinochloa crusgalli**						x
Eleocharis palustris						x
Eriophorum chamissonis		x	x	x	x	
Eriophorum sp.	x					
*Holcus lanatus**						x
Juncus articulatus						x
Juncus balticus			x		x	
Juncus bolanderi						x
*Juncus bufonius**						x
Juncus effusus				x		x
Juncus tenuis						x
*Lolium perenne**						x
Phalaris arundinacea						x
Poa sp.			x		x	x
Scirpus maritimus var. *paludosus*						x
Scirpus validus						x
*Setaria lutescens**						x
FERNS & ALLIES						
Athyrium felix-femina		x				x
Equisetum arvense		x	x		x	
Equisetum hyemale		x				
Polypodium glycyrhhiza						x
Polystichum munitum						x
Pteridium aquilinum	x	x	x	x	x	x

	Rigg 1922	Stirling 1965	Peden 1967	Talisman 1981	Ussery 1988	Golinski 1995
MOSSES & LIVERWORTS						
Dicranum scoparium		x	x			
Euryhnchium oreganum		x	x			
Homalothecium sp.		x				
Hylocomium splendens		x	x	x		
Isothecium stoloniferum			x			
Mnium menziesii		x				
Pleurozium schreberi				x		
Polytrichum juniperinum		x				
Porella sp.			x			
Rhizomnium punctatum			x			
Rhytidiadelphus loreus			x			
Rhytidiadelphus triquetrus		x	x	x		
Sphagnum capillaceum			x	x		
Sphagnum palustre						x
Sphagnum recurvum			x			x
Sphagnum sp.	x	(3)		x		
Trachybryum megaptilum			x			
LICHENS						
Cetraria glauca		x				
Cetraria herri		x				
Cladonia sp.		(6)				
Lecanora sp.		x				
Ochrolechia sp.		x				
Parmelia physodes		x				
Parmelia tubulosa		x				
Peltigera canina		x				
Sphaerophorus globosus		x				
Stereocaulon evolutum		x				
Usnea sp.		x				

Note:
Botanical names have been updated to facilitate comparison.

References

Peden, D.G. 1967. *Vegetation and Ecology of Rithet's Bog, Royal Oak, B.C.* B.Sc. Thesis, University of Victoria, Victoria, B.C.

Rigg, G.B. 1922. *A Bog Forest.* Ecology 3:207-213.

Stirling, D. 1965. *Plants in Rithet's Peat Bog, Royal Oak.* Unpublished list.
(Stirling notes: There are many other species of grasses, sedges, fungi, mosses, and lichens not listed here.)

Talisman Land Resource Consultants. 1981. *Overview assessment of Rithet's Bog.* Report for Broadmead Farms Ltd.

Ussery, J. 1988. Unpublished list.

Appendix III

Summary of Rithet's Bog Bird Species Records

Scientific Name	Common Name	Sterling 1965	Carson 1995
Accipiter cooperii	Cooper's hawk	x	x
Accipiter gentilis	goshawk	x	x
Accipiter striatus	sharp-shinned hawk	x	x
Actitis macularia	spotted sandpiper	x	x
Agelaius phoeniceus	red-winged blackbird		x
Alauda arvensis	skylark	x	
Anas acuta	northern pintail	x	x
Anas americana	American wigeon	x	x
Anas crecca	green-winged teal	x	x
Anas clypeata	northern shoveler	x	x
Anas platyrhynchos	mallard	x	x
Ardea herodias	great blue heron	x	x
Asio flammeus	short-eared owl	x	
Aythya affinis	lesser scaup	x	
Bombycilla cedrorum	cedar waxwing		x
Branta canadensis	Canada goose	x	x
Bubo virginianus	great horned owl		x
Buteo jamaicensis	red-tailed hawk		x
Calidris mauri	western sandpiper		x
Calidris minutilla	least sandpiper		x
Calypte anna	Anna's hummingbird		x
Capella gallinago	common snipe	x	x
Carduelis pinus	pine siskin	x	x
Carduelis tristis	American goldfinch	x	x
Carpodacus mexicanus	house finch	x	x
Carpodacus purpureus	purple finch	x	x
Cathartes aura	turkey vulture	x	x
Catharus ustulatus	Swainson's thrush	x	x
Certhia familiarus	brown creeper	x	x
Charadrius semipalmatus	semipalmated plover		x
Charadrius vociferus	killdeer	x	x
Chen caerulescens	snow goose		x
Chordeiles minor	common nighthawk	x	
Cistothorus palustris	long-billed marsh wren		x
Colaptes auratus	common flicker	x	x
Columba fasciata	band-tailed pigeon	x	x
Columba livia	rock dove		x
Corvus caurinus	northwestern crow		x
Corvus corax	common raven		x
Cygnus buccinator	trumpeter swan		x
Cygnus columbianus	tundra swan		x

Scientific Name	Common Name	Sterling 1965	Carson 1995
Dendroica coronata	yellow-rumped warbler	x	x
Dendroica petechia	yellow warbler	x	x
Dendroica townsendi	Townsend's warbler	x	
Dryocopus pileatus	pileated woodpecker	x	x
Empidonax difficilis	western flycatcher	x	x
Empidonax traillii	Traill's flycatcher	x	x
Falco columbarius	merlin		x
Falco peregrinus	peregrine falcon		x
Falco sparverius	American kestrel	x	
Fulica americana	American coot	x	
Geothlypis trichas	common yellowthroat		x
Haliaeetus leucocephalus	bald eagle	x	x
Hesperiphona vespertina	evening grosbeak	x	x
Hirundo rustica	barn swallow	x	x
Iridoprocne bicolor	tree swallow	x	
Ixoreus naevius	varied thrush	x	x
Junco hyemalis	dark-eyed junco	x	x
Lanius excubitor	northern shrike		x
Larus canus	mew gull	x	x
Larus glaucescens	glaucous-winged gull	x	x
Larus thayeri	Thayer's gull		x
Limnodromus griseus	dowitcher	x	x
Limnodromus scolopaceus	long-billed dowitcher		x
Lophortyx californicus	California quail	x	x
Loxia curvirostra	red crossbill	x	x
Melospiza lincolnii	Lincoln's sparrow		x
Melospiza melodia	song sparrow	x	x
Molothrus ater	brown-headed cowbird		x
Nuttallornis borealis	olive-sided flycatcher	x	
Oporornis tolmiei	MacGillivray's warbler		x
Otus kennicottii	western screech-owl	x	
Parus rufescens	chestnut-backed chickadee	x	x
Passer domesticus	house sparrow		x
Passerculus sandwichensis	savannah sparrow	x	x
Passerella iliaca	fox sparrow	x	x
Phasianus colchicus	ring-necked pheasant	x	x
Pheucticus melanocephalus	black-headed grosbeak		x
Picoides pubescens	downy woodpecker	x	x
Picoides villosus	hairy woodpecker	x	x
Pipilo erythrophthalmus	rufous-sided towhee	x	x
Piranga ludoviciana	western tanager	x	x
Porzana carolina	sora		x
Progne subis	purple martin	x	
Psaltriparus minimus	bushtit	x	x

Scientific Name	Common Name	Sterling 1965	Carson 1995
Rallus limicola	Virginia rail		x
Regulus calendula	ruby-crowned kinglet	x	x
Regulus satrapa	golden-crowned kinglet	x	x
Selasphorus rufus	rufous hummingbird	x	x
Sialia mexicana	western bluebird	x	
Sitta canadensis	red-breasted nuthatch	x	x
Spizella passerina	chipping sparrow	x	
Sturnella neglecta	western meadowlark	x	
Sturnus vulgaris	starling		x
Tachycineta thalassina	violet-green swallow	x	x
Thryomanes bewickii	Bewick's wren		x
Tringa flavipes	lesser yellowlegs	x	x
Tringa melanoleuca	greater yellowlegs	x	x
Tringa solitaria	solitary sandpiper		x
Troglodytes aedon	house wren		x
Turdus migratorius	American robin	x	x
Vermivora celata	orange-crowned warbler	x	x
Vireo gilvus	warbling vireo	x	x
Vireo solitarius	solitary vireo	x	x
Wilsonia pusilla	Wilson's warbler	x	x
Zenaida macroura	mourning dove	x	
Zonotrichia atricapilla	golden-crowned sparrow		x
Zonotrichia leucophrys	white-crowned sparrow	x	x

References

Carson, M. 1995. Birding observations around Rithet's Bog. *The Victoria Naturalist.* 51.3: 8-17.

Stirling, D. 1965. *Bird life of Rithet Peat Bog and ajacent areas, Royal Oak.* Unpublished list.

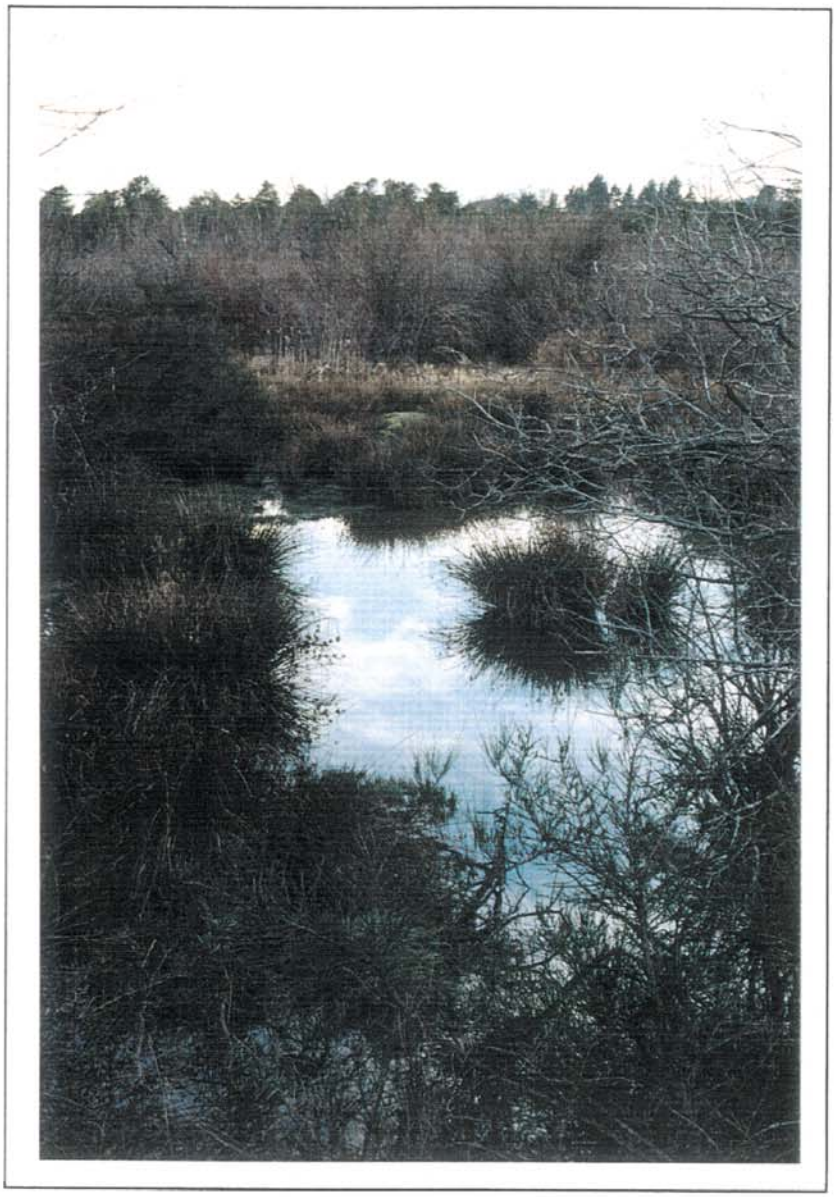
Stirling notes: "Bird life is varied and abundant on the Rithet Estate. Flooded areas around the lowland, Lodgepole Pine dominated peat bog are feeding grounds for several species of duck and a flock of Canada Geese. Wading Birds such as Yellow legs and Common Snipe are sometimes present in good numbers. Spotted Sandpipers and Mourning Doves, to name two rather scarce species (south Vancouver Island) nest here. Pheasants, Meadowlarks and Skylarks are resident in the open fields."

Appendix IV
Results of Rithet's Bog Butterfly Survey, May-Sept. 1995

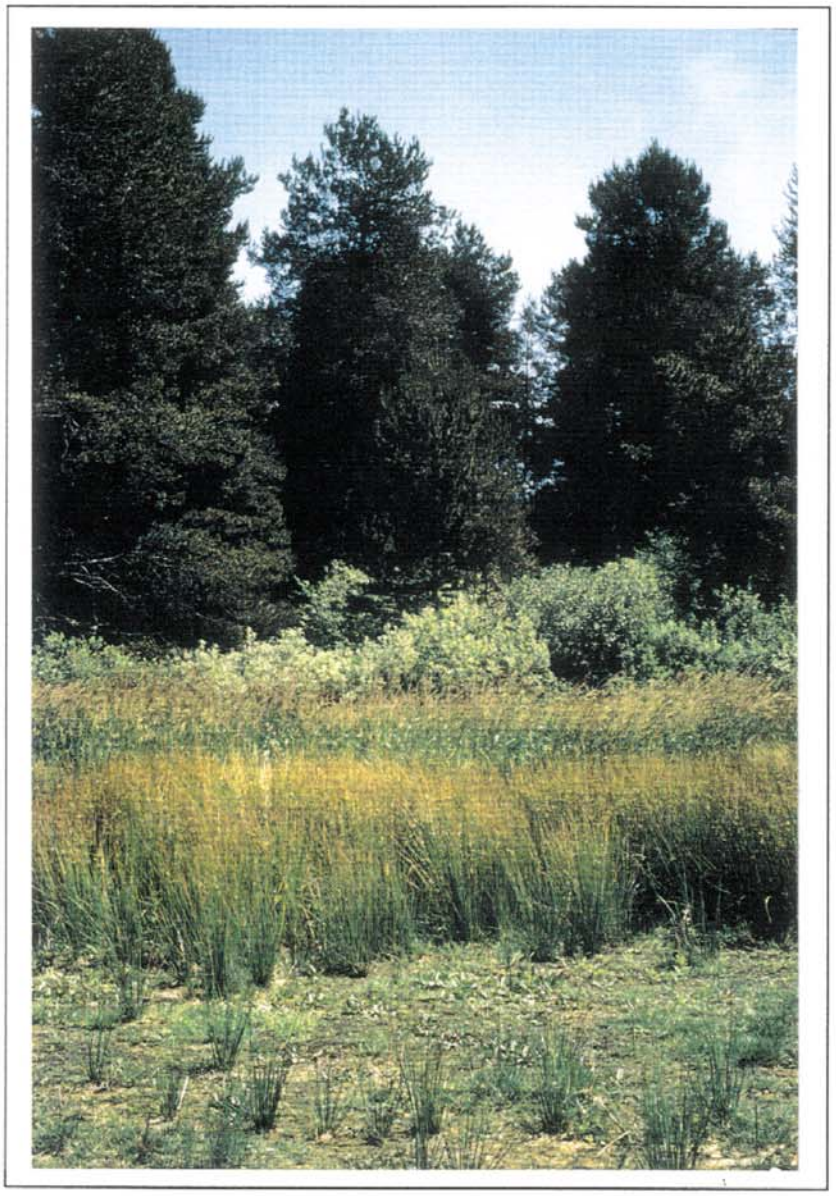
Scientific Name	Common Name
Anthocharis sara flora	Sara orange tip
Basilarchia lorquini burrisoni	Lorquin's admiral
Coenonympha tullia insulana	ringlet
Epidemia helloides	purplish copper
Epidemia mariposa charlottensis	Reakirt's copper
Thymelicus lineola	European skipperling
Neophasia menapia tau	pine white
Nymphalis antiopa antiopa	mourning cloak
Ochlodes sylvanoides sylvanoides	woodland skipper
Papilio eurymedon	pale swallowtail
Papilio rutulus rutulus	western tiger swallowtail
Papilio zelicaon zelicaon	anise swallowtail
Phyciodes mylitta mylitta	mylitta crescent
Phyciodes pratensis pratensis	field crescent
Pieris rapae	cabbage butterfly
Polygonia satyrus	satyr anglewing
Strymon melinus atrofasciatus	grey hairstreak
Vanessa atalanta rubria	red admiral
Vanessa cardui	painted lady

Note: Butterflies observed by Karen Golinski between May-September 1995.

Appendix V
Representative Site Photographs

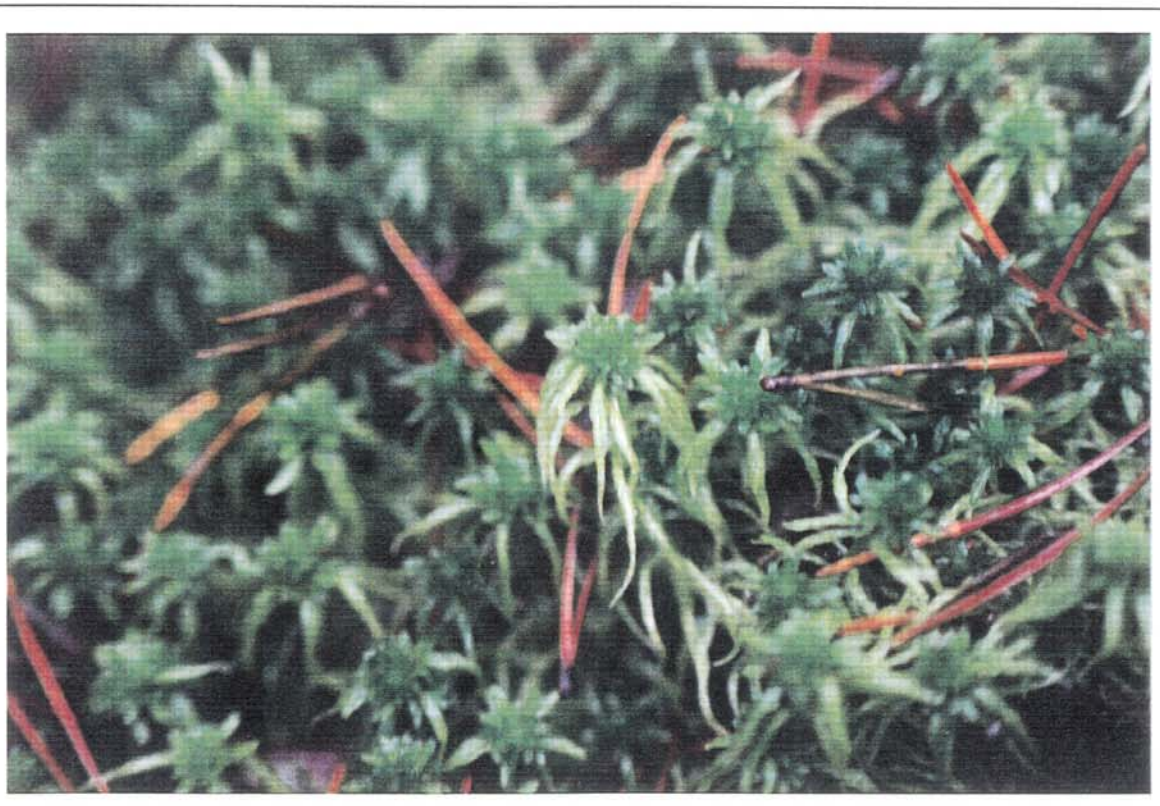


This small pond, located near Fir Tree Glen on the south east side of the park, provides habitat for birds such as sora (*Porzana carolina*), Virginia rail (*Rallus limicola*), and long-billed marsh wren (*Cistothorus auratus*).

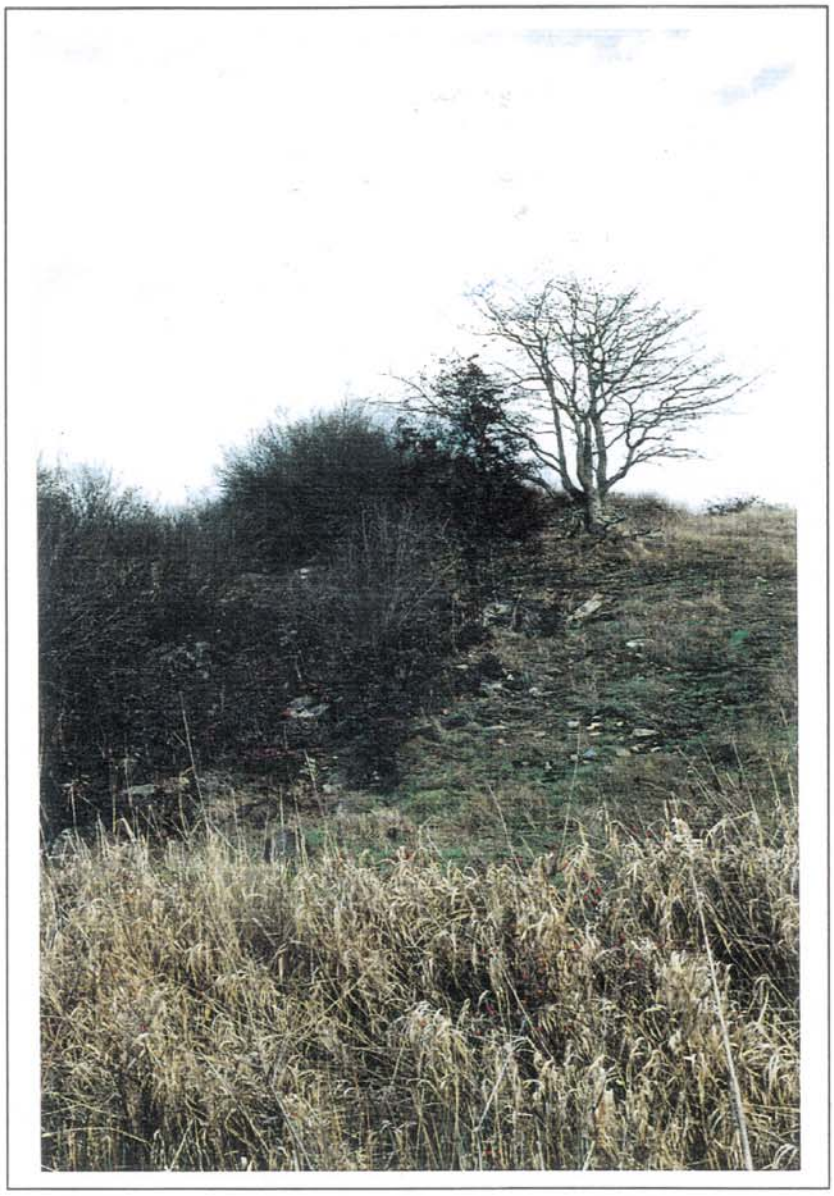


Marsh vegetation including rushes (*Juncus* spp.) and water smartweed (*Alisma plantago-aquatica*) is colonizing recently abandoned fields north west of the bog forest. Tall deciduous shrub thicket is found alongside old drainage ditches. Shore pine (*Pinus contorta* var. *contorta*) dominates the bog forest.

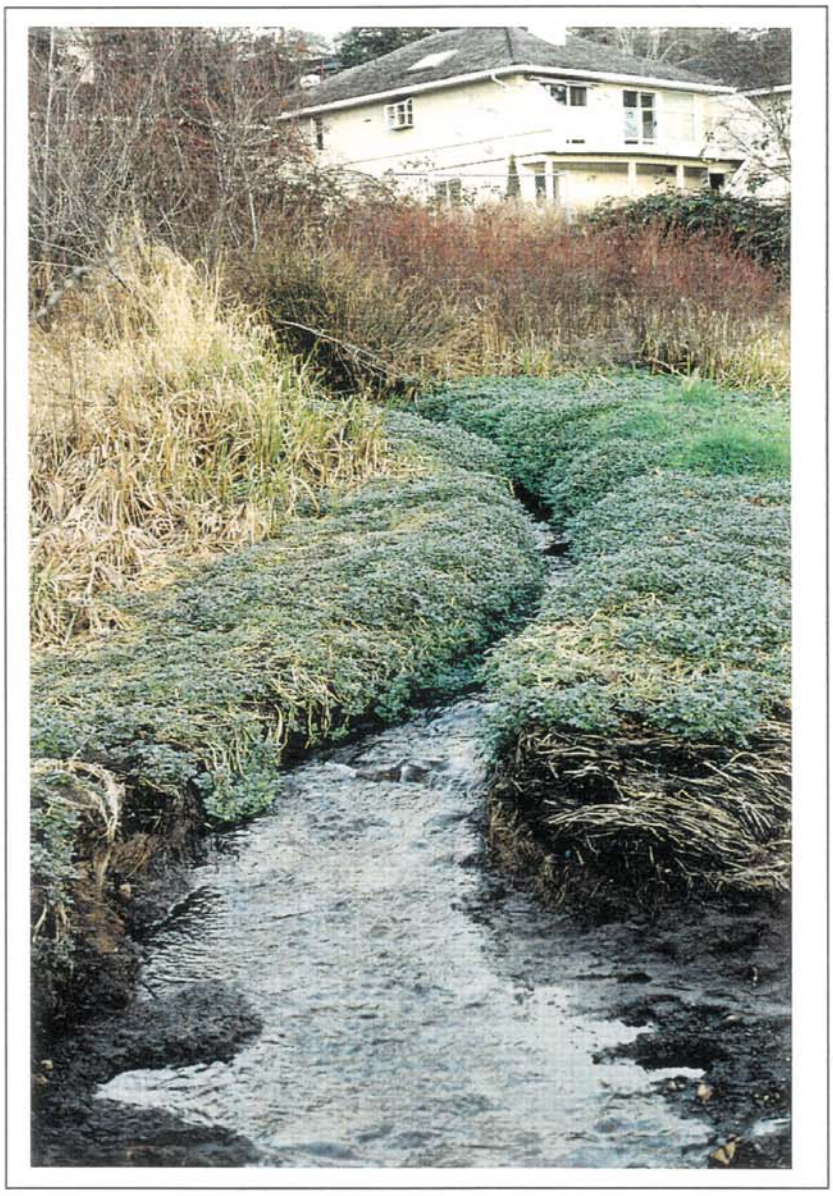
Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) stand.



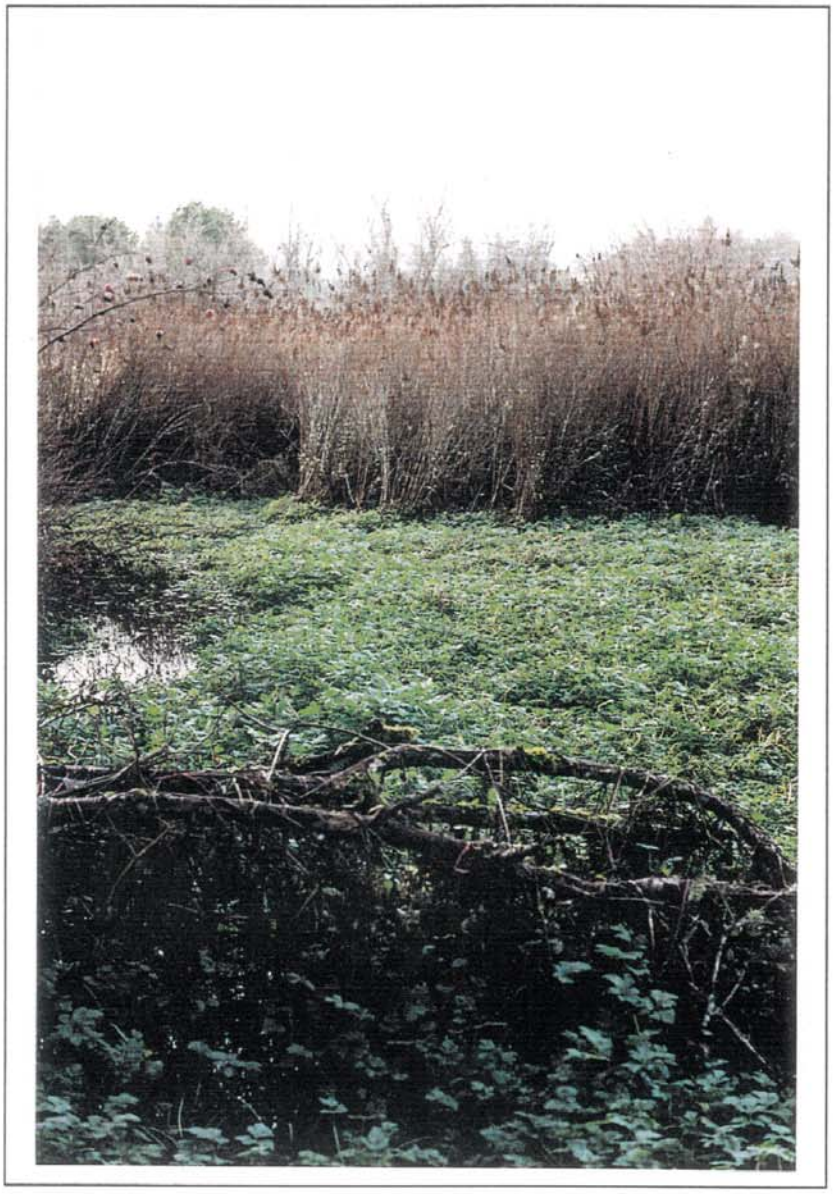
Small remnant patches of *Sphagnum* are found beneath openings in the bog forest canopy.



Garry oak (*Quercus garryana*) -rock-outcrop south of the perimeter trail. Shrubs in this plant community include snowberry (*Symphoricarpos albus*), dull Oregon grape (*Mahonia nervosa*), and Nootka rose (*Rosa nutkana*). Volunteers are working to eliminate Scotch broom (*Cytisus scoparius*) from the area.



Storm sewer runoff draining into the wetland surrounding Rithet's Bog deposits upland mineral soils. Watercress (*Nasturtium officinale*) and common rush (*Juncus effusus*) dominate this area.



Creek drains into permanently wet area near Fir Tree Glen. The vegetation community here is dominated by creeping buttercup (*Ranunculus repens*) and hardhack (*Spiraea douglasii*).