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Somenos Marsh Ecosystem Mapping and Ecosystem Management Plan

With special emphasis on the Garry Oak Protected Area

for:

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Environmental Stewardship, Vancouver Region

by:

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Somenos Marsh Ecosystem Management Plan

With special emphasis on the Garry Oak Protected Area

1.0 INTRODUCTION

Somenos Marsh, a wetland complex with associated uplands, including an important Garry oak stand, lies in the heart of the Cowichan Valley and is an area of exceptional wildlife, wetland, and fisheries values. A management study completed for the area in 2000 (P. Williams & G. Radcliffe 2000) identifies that the overriding vision for the area is to protect the ecological values of Somenos Marsh and sensitive uplands, while allowing human use that does not compromise these values.

The Garry Oak Protected Area and Somenos Marsh area falls within NTS Mapsheets 092B.082 and 092B.072. The elevation of the study area is from around 6m to 25m, and the Garry Oak Protected Area comprises about 10.5 ha.

The ecological values of the area are well described in the Management Plan and other reports (Chislett Lattey Manson Architecture and Engineering Inc. 1993; Edwards & Greig 1988; Fletcher 2000; Radcliffe 1991; Reid 2000; Somenos Marsh Wildlife Society 1995; Williams & Radcliffe 2000), and the reader is referred to these documents for further information. In summary however, some of the more significant natural values include overall high biodiversity, important plant, fish and wildlife populations, and exceptional waterfowl values. Five rare (red-listed) and two threatened (blue-listed) plants have been identified within the area, most within the Garry oak ecosystem (the Garry Oak Protected Area) on the southeast side.

The management plan identified a lack of good baseline information for most of the natural values of the area. It divided the area into five “management zones,” and within

each recommended a number of studies necessary to provide the basis for future ecologically sound management. The Management Zones identified were:

i. the lake
ii. marsh areas
iii. agricultural fields
iv. forests and woodlands
v. riparian areas.

It is zone four, comprising the forests and woodlands that is the focus of this study. Key management recommendations from the management plan included improved mapping and inventory of the study area vegetation communities. Site-specific restoration plans for the zone four area, including the Somenos Garry Oak Protected Area, were also recommended.

This project was subsequently commissioned by BC Parks (currently in charge of the Management Area) to redress the identified lack of baseline vegetation mapping and restoration planning. Objectives of this study are thus to:

- Classify and map Zone Four as per the Management plan, according to existing TEM standards, at 1:2,000.
- Classify and map the Somenos Garry Oak Protected Area following a recently developed GOE classification, at 1:2,000;
- Describe the natural ecosystems of the area (includes mapping out wildlife trees and trails in the park, and identifying wildlife values)
- Develop a restoration plan for Zone Four, with the main emphasis on the Garry Oak Protected Area. (This would address issues identified in the Management Plan such as invasive species and rare and threatened species management)
- Produce historical ecosystem maps of Somenos Lake and environs (extending beyond zone four);

The historic mapping component of this study is not confined to zone four, but rather covers all areas, and indeed extends beyond the management boundaries that confined the original Management Plan. It is intended to provide some historical context for current vegetation management, and to assist in setting longer-term management goals for the whole management area with respect to percentages/dispersion of different vegetation communities.

The resulting information is intended to provide a sound basis for future ecosystem and wildlife management.

2.0 BACKGROUND INFORMATION AND DATA SOURCES

2.1 Mapping Data Sources

Because of the large scale of the mapping and small size of the area involved, we determined the best photographic base to use for mapping was the existing ortho-photo imagery from 1999. There is little topographic variation across the study area, and the level of detail available was much better from this source, and from contour mapping from the District of North Cowichan. Therefore, the project does not fully conform to existing TEM standards. Nevertheless, the TEM approach and standard naming conventions have been applied.

The ecosystem polygons delineated for this project and used for both TEM and GOE classifications were delineated on an ortho-photograph provided by the District of North Cowichan. The digital data used to create ecosystem polygons consisted of the ortho-photos, local contours, field surveys, and field GPS data. ArcView 3.2 software was used in the creation of the maps. The contours provided by the District of North Cowichan were ortho-rectified by Eagle Mapping. Linework was hand-drawn in the field onto printed ortho-photos at 1:2,000. Due to the small size of the study area, 100% polygon visitation was completed, with visual inspections for each of the 41 polygons.

Contour data was supplied from the District of North Cowichan, in an ortho-rectified *.tif* format that was scanned from hardcopy contour maps from 1972. These lines were then digitized into a shapefile format for use in ArcView. These contours consisted of 2 metre intervals with sporadic 1 metre intervals falling within some of the study area. Ortho-photos used for the project were: 92B0723, 92B0724, 92B0821 and 92B0822.

GPS provided wildlife tree and large Garry Oak tree locations, various object (fence, gates, and sign) locations and trail sites. The GPS unit was a Garmin 12 (recreational grade), and most data collection was therefore recorded with an accuracy of approximately 5-7m.

2.2 Field Work

Field sampling was carried out in three, one-day field trips and consisted of two-person crews sampling between October 2002 and March 2003. One hundred percent of all polygons were visited (41 polygons) with visual inspections. Additional short visits were also made to collect supplementary ecological and wildlife information.

Notes were compiled for each polygon with information regarding invasive plants, dominant shrubs, likely locations of rare plants, snowberry cover, wildlife, and other pertinent information. The time of year (winter) limited the effectiveness of identifying rare plants, although it was still possible to accurately identify the ecosystems in the wintertime.

All Garry oaks with a diameter at breast height (dbh) over 30cm were marked with steel numbered tags, and a GPS reading was taken. The accuracy of the GPS unit was between 5.2 and 7.5m. The locations are plotted on the maps and an accompanying database was built. Trails, fences and additional features were also located on the maps.

2.3 Ecosystem classification and mapping

Two different classification schemes were applied to the polygons mapped in this project. Details of each are provided in sections 3 and 4. Classification and mapping closely followed the Terrestrial Ecosystem Mapping (TEM) methodology, and also incorporated the Garry Oak Ecosystems Recovery Team classification (GOERT) for Garry oak ecosystems.

A variety of classifications for Garry oak and associated ecosystems have been developed ranging from very simple, two class systems, through to highly detailed classifications. The **B**iogeoclimatic **E**cosystem **C**lassification system (BEC) recognizes two "site series" with a Garry oak component, while Erickson (1996) described 43 different oak communities. An intermediate physiognomic classification has been developed through the Garry Oak Ecosystems Recovery Team (GOERT) program, called a *Higher-Level Physiognomic Vegetation Categories for Garry Oak and Surrounding Ecosystems* (Meidinger *et al.* 2001). We have referred to this as the Garry Oak Ecosystem, or GOE, Classification.

BEC is an integrative classification combining site conditions (soil moisture, soil nutrient regime, climate) and the vegetation composition of mature or old-growth stands; whereas the GOE is primarily a physiognomic or "life-form" classification that integrates present day tree composition, tree density, and structural stage. The BEC system indicates what the climax plant community (site series) would be in the absence of disturbance. Typically, seral stages (younger successional stages) of the climax community can vary widely in plant composition and structure, although site conditions (the non-living component) remain unchanged. The GOE classification, on the other hand, describes the present nature of the stand. Thus several GOE units, representing

different seral stages, can be contained in one BEC site series. Further details are provided in Section 3.4.

As noted, the descriptions of the Garry oak ecosystems for the Somenos study area integrate both the BEC and GOE classifications. The project database lists the appropriate codes from each classification for each map polygon. Ecosystem maps have thus been produced that illustrate both the TEM codes and the GOE codes as the polygon labels (See Figures 1 and 2).

2.4 Digital Mapping and Database Production

Air photos were obtained from Landdata BC, which were then cascade controlled from TRIM photography with additional control points generated through aerial triangulation.

Contours were generated by digitizing scanned hardcopy maps made by the District of North Cowichan (1972), which were then geo-referenced and converted into an ArcView shapefile.

Polygons were digitized and numbered in an ArcView environment and corresponding ecosystem attributes were entered into Excel. An additional field was also added to the TEM database for the Garry oak ecosystem classification.

The historic maps were generated by delineating polygons on airphotos, which were then digitized by simply drawing them onto the ortho-image of 1999 to achieve some consistency of scale and location. This was done because each historic airphoto was at a different scale, quality and coverage for a given year.

Draft maps were plotted and reviewed for final edits before producing digital maps and attribute files for delivery.

3.0 TERRESTRIAL ECOSYSTEMS OF MANAGEMENT ZONE FOUR

Mapping nomenclature follows the *Standard for Terrestrial Ecosystem Mapping in British Columbia*, (RIC, 1998a). Each ecosystem unit (site series) was assigned a two-letter symbol, and identified using *The Field Guide for Site Identification and Interpretation for the Vancouver Forest Region* (Green and Klinka 1994). Anthropogenic units are also assigned two-letter symbols (RIC 1998a). Site modifiers codes were applied to shallow soils (< 1 m deep) and one gully. Structural stages describe the current vegetation stage using the standard seven-level system.

3.1 Surficial Materials and Soils of Management Zone Four

The dominant parent material in this area is morainal till, commonly referred to simply as morainal material. There are areas of thin soil (< 1 metre deep), especially in the areas dominated by Garry Oak and the large open wildflower meadow. The terrain symbol for this area is Mv (morainal veneer). Shale bedrock underlies these soils. The thin soil in the meadows gives way to deeper soils in the forested areas, both conifer and deciduous. The terrain symbol for these areas is Mb (morainal blanket, > 1metre deep). The smaller, slower-growing Garry oak are on shallow soils, whereas the larger faster-growing oak are on deeper soils. In areas close to the marsh, there is material that was historically deposited by the flowing waters of Somenos Creek. These are fluvial materials with the terrain symbol Fp (fluvial plain with slopes of 0 – 5%). Localized deposition on marine soils is also possible in the mapping area (Jungen 1985).

The soils in the Garry Oak Protected Area are well- to moderately-well drained, and are in the Brunisolic soil type.

Other areas in zone four are on the Somenos Lake floodplain and include polygons 1, 2, 39, 40, and 41. These polygons have organic soils overlaying mineral lacustrine (lake) materials. The organic soils have varying depths, ranging from shallow (Ov – organic veneer) away from the lake, to deeper near Somenos Lake (Ob – organic blanket). These soils are poorly to very poorly drained, and remain saturated for much of the year, as well as receiving annual flooding.

3.2 Biogeoclimatic Zones

There is one biogeoclimatic subzone within the Somenos study area, the Coastal Douglas-Fir Moist Maritime subzone (CDFmm). The CDFmm ranges between sea

level and 150 m on the east side of Vancouver Island and the Gulf Islands, an area where Douglas-fir is the climax tree species on mesic sites. The CDF occurs in the area commonly referred to as the "rainshadow" or the "Mediterranean-like climate" of the Strait of Georgia.

3.3 Ecosystems of the Mapping Area

3.3.1 Terrestrial Ecosystem Mapping

The Biogeoclimatic Ecosystem Classification system (BEC), along with the GOE classification, was used to classify and describe the different ecosystems in this mapping project. Using the BEC system for example, polygons dominated by Garry oak were mapped as Garry oak – Brome (CDFmm / QB 00), using standard TEM nomenclature. Upland conifer forests were generally the Douglas fir-Grand fir-Oregon grape unit (CDFmm / DG 04). These and other TEM units that were mapped are described below.

Tree species codes used in ecosystem descriptions are defined in Table 1. Table 2 provides a list and brief description of each of the TEM ecosystems identified and mapped. More detailed descriptions are provided in section 4.2. Figure 1 presents the TEM units mapped for the project.

Table 1. British Columbia Tree Species Codes (RIC, 1998a).

Common name	Species	Code
Garry oak	*Quercus garryana*	Qg
Douglas-fir	*Pseudotsuga menziesii*	Fd
Grand fir	*Abies grandis*	Bg
Bigleaf maple	*Acer macrophyllum*	Mb
Western redcedar	*Thuja plicata*	Cw
Sitka spruce	*Picea sitchensis*	Ss
Black cottonwood	*Populus balsamifera* ssp. *trichocarpa*	Act
Red alder	*Alnus rubra*	Dr

Table 2. BEC Ecosystems Types Mapped in Zone Four

Ecosystem Unit	TEM map code	BEC Site Series	Site Attributes	Moisture Regime	# of poly-gons	Structural Stages mapped	Modifiers mapped
Douglas-fir – Grand fir – Oregon grape	DG	04	gently sloping to nearly level sites, medium-textured soil, medium-rich nutrient regime	moderately dry	18	2, 3, 5, 6	g, s
Western redcedar – Grand fir - Foamflower	RF	06	lower slope, medium-textured rich soil, adjacent to riparian area	slightly dry – fresh	1	6	-
Cottonwood – Red-osier dogwood	CD	08	narrow floodplain along ephemeral creek	fresh - wet	1	3	g
Western redcedar – Skunk cabbage	RC	11	level areas on the Somenos floodplain, annual flooding, saturated soils	wet	3	2, 3, 4	-
Garry oak – Brome	QB	00	gentle S and SW slopes, richer nutrient regime,	Moderately dry – slightly dry	12	4, 5, 6	s
Fescue - Camas	FC	00	gentle slopes, shallow soils, forest openings, grass-dominated	dry - very dry	2	2b, 3	-
Willow – Spirea swamp	WS	00	level areas on Somenos floodplain, standing water for > 8 mos.	wet	1	3b	-
Rural *	RU	n/a			1	3	-

*Anthropogenic Unit

*Structural Stage and Modifier Codes are explained on the TEM map Legend (Figure 1).

Figure 1. Somenos Terrestrial Ecosystem Map.

3.3.2 Garry Oak Ecosystem Mapping

In addition to BEC units, each polygon was also classified according to the GOE classification. This physiognomic classification recognizes broad structural classes, including forest (greater than 50% cover by trees); woodland (10 to 50% cover by trees) and savannah (less than 10% cover of trees). Polygons classified according to the GOE system are presented in Table 3 and illustrated in Figure 2. The codes are those used for final map polygon labels. However, the GOE classes and codes used are more fully explained in Table 4.

Table 3. Garry oak and associated ecosystems mapped for Somenos Garry Oak Protected Area (GOE Classification).

Formation Subclass	Types, by Layer Dominants	Mapcode	# of polygons
Forest: >50% crown cover of trees; >10m trees			
Conifer Forest	Douglas-fir – Grand fir	CF-FdBg	3
Mixed Conifer / Broadleaf Forest	Garry oak - Douglas-fir	MC-Qg	7
Broadleaf Forest	Garry oak	BF-Qg	4
Woodland: <50%, at least 10% crown cover of trees; >10m trees			
Mixed Woodland	Garry oak - Douglas-fir	MW-QgFd	2
Broadleaf Woodland	Garry oak	BW-Qg	7
Savannah: <10% crown cover of trees; >10 m trees			
None mapped			
Low Woodland: single-stemmed species in dominant layer (3 – 10m)			
None mapped			
Shrubland: multi-stemmed species in dominant layer (usually <4m); >20% cover of shrubs; <10% of trees			
Evergreen shrub	Scotch broom dominated	ES-Br	2
Mixed shrubland	Ocean spray, Indian plum, others	MSh	5
Herbaceous Formations: >20% cover herbaceous, <20% shrubs			
Grass Communities		GC	5
Moss / Lichen Formations: >50% moss/lichen cover; <20% for each of herbaceous and shrub			
None mapped			

Figure 2. Garry Oak Ecosystem Map.

3.4 Correlation between the TEM and GOE units

As described in Section 2.3, there is not a direct, one-to-one relationship between the TEM and GOE classifications. Table 4 below provides a correlation between the TEM and GOE map units used. The important thing to note is that several GOE units can fit into one BEC unit. The GOE system seeks to classify the present day species variation in ecosystems containing Garry Oak, whereas the BEC system seeks to identify a more general, late successional, or climax plant community that will occur in the absence of disturbance. More detailed descriptions of both the TEM units and the GOE units are combined together into Table 5.

Table 4. Correlation between BEC and GOE Units for the Somenos Lake Mapping Project.

BEC ecosystem name	BEC code	GOE code *
FdBg – Oregon grape	DG	CF-FdBg, MC-Qg, MW-QgFd
Cw – Skunk cabbage	RC	n/a
Cw - Foamflower	RF	MC-Qg
Act – Red-osier dogwood	CD	GC
Fescue - Camas	FC	GC
Willow - Spirea	WS	n/a
Qg - Brome	QB	BF-Qg, BW-Qg, MW-QgFd

*refer to Table 3 for full names

Table 5: Detailed Ecosystem Descriptions

Name	TEM code & BEC site series no.	Brief Description	GOE unit GOE code	Structural Stages mapped	Vegetation	Poly-gons	Condition/Health Historic Comments
Douglas-fir – Grand fir – Oregon Grape **FdBg – Oregon grape**	DG/04	Gently sloping to nearly level sites; medium-textured soil; medium-rich nutrient regime; and moderately dry. The natural climax forest will be conifer dominated	Conifer Forest Douglas-fir – Grand fir **(CF-FdBg)** Forested subclass (>50% tree cover).	5,6	This unit is the mature Douglas-fir – Grand fir – Oregon Grape conifer forest on the north side of the GO park. These are productive, fast growing forests. The closed canopy lets little light through, so herb and shrub layers are poorly developed, however mosses are common including electrified cat-tail's moss and Oregon beaked moss. Grand fir is the leading regeneration species in the understory. Scattered mature deciduous trees are also present and include bigleaf maple, Garry oak, and dogwood. There are some deciduous snags present, having been overtopped by the conifers.	4, 32	-conifer forests are healthy, productive; -ample/medium recruitment of Bg, some Fd; -conifers are overtopping oaks and other deciduous trees; Historical photos indicate much less coverage of conifer trees 50 years ago
	DG/04	Gently sloping to nearly level sites; medium-textured soil; medium-rich nutrient regime; and moderately dry. The natural climax forest will be conifer dominated	Mixed Conifer / Broadleaf forest (MC-Qg) Forested subclass (>50% tree cover). Transitional forest/oak woodland	5,6	This unit is in the Douglas-fir – Grand fir – Oregon Grape site series, but contains scattered Garry oak and other deciduous trees. These polygons can be considered transitional between the pure oak stands and the pure conifer stands. Forest succession to conifers is very active in these polygons, however there is still a high diversity of shrubs. The herb layer is only well developed in gaps, but mosses are abundant. Shrubs include ocean spray, hawthorn, thimbleberry, bitter cherry, and dogwood, Indian plum, Pacific crabapple, and cascara.	12,13, 15,16, 26,31, 33,38	-forest health is good; -no oak regeneration; moderate conifer regeneration of Fd, Bg -conifer trees are currently overtopping oaks as well as other deciduous trees and shrubs; good example of such "transitional" areas is polygon 33.

Table 5 (cont'd). Detailed Ecosystem Descriptions

Name	TEM code & BEC site series no.	Brief Description	GOE unit GOE code	Structural Stages mapped	Vegetation	Poly-gons	Condition/Health Historic Comments
	DG/04	Gently sloping to nearly level sites; medium-textured soil; medium-rich nutrient regime; and moderately dry. The natural climax forest will be conifer dominated	**Mixed Woodland (MW-QgFd) (2)** Woodland subclass (<50% tree cover).	5,6	These two polygons are mixed woodlands comprising of Douglas-fir and Garry oak, situated adjacent to the central open area in park (polygon 37). Shrubs are abundant in the understory including snowberry, tall Oregon grape, and red elderberry. The mixed woodland is a transitional forest, found between the pure oak stands and the conifer dominated stands on cooler aspects.	18,20	-forest health is good; -moderate regeneration of Fd; low regeneration of Garry oak; -broom and hawthorn has been removed in adjacent polygons 19, 22. -climax forest is assumed to be conifer, with mixed deciduous including oak and maple.
	DG/04	Gently sloping to nearly level sites; medium-textured soil; medium-rich nutrient regime; and moderately dry. The natural climax forest will be conifer dominated	**Mixed shrubland – (MSh)**	3	These polygons have greater than 20% cover of shrubs and less than 10% tree cover. Common shrubs include snowberry, red elderberry, hawthorn, Indian plum, thimbleberry, dogwood, and scattered tree regeneration. Polygons 14, 19, and 22 are undergoing active succession. Eventually they will become mixed deciduous / conifer forests and then, in the absence of disturbance, they will be climax Douglas-fir – Grand fir forests. Shrubs in these polygons are diverse and include ocean spray, Indian plum, broom, Pacific crabapple, Sitka mountain ash, English holly, thimbleberry, cascara, common hawthorn, red elderberry, snowberry and Nootka rose. Young grand fir, Douglas-fir, maple, and dogwood is also present. Introduced plants include English holly, Scotch broom, and common hawthorn. The most common moss is electrified cat-tail's moss. Oak recruitment is scattered due to the thick shrubbery. Recent brush clearing may remedy this situation.	3,8, 14, 19, 22.	-forest health is good -moderate regeneration of Fd, Bg, maple; low regeneration (oak), -broom and hawthorn has been removed in polygons 19, 22; -others polygons under active succession to conifer

Table 5 (cont'd). Detailed Ecosystem Descriptions

Name	TEM code & BEC site series no.	Brief Description	GOE unit GOE code	Structural Stages mapped	Vegetation	Poly-gons	Condition/Health Historic Comments
Western redcedar – Grand fir – Foamflower **Cw – Foamflower**	RF/06	Lower slope, medium-textured rich soil; adjacent to riparian area; slightly dry – fresh	**Mixed Conifer / Broadleaf forest (MC-Qg)** Forested subclass (>50% tree cover). Transitional forest/oak woodland	6	This polygon is transitional between upland areas and the riparian area along Somenos Creek. The soil is deep and moist but above the level of annual flooding. Soil nutrient regime is medium to rich. The parent material is a silty fluvial deposit. At present, the fairly closed canopy cover discourages Garry oak regeneration. The leading tree species is Douglas-fir followed by Garry oak. Both species are rapid growing in this polygon due to the rich, moist soil, and ample light coming off Somenos Lake. Understory plants include snowberry, tall Oregon grape, yerba buena, foamflower, and trailing blackberry.	30	-healthy, vigorous forest; -moderate recruitment of Fd, Bg; -localized soil compaction along trail; -closed canopy discourages oak regeneration; -scattered large oak trees still present; -polygons were historically more open than at present, as per historic photos.
Cottonwood – Red osier dogwood **Act – Red-osier dogwood**	CD/08	Narrow floodplain along ephemeral creek fresh - wet	**Grass Community** **(GC)** Riparian grassland community	2, 3	Polygon 7 is the riparian zone along a small creek. Even though this creek is ephemeral, there is a narrow floodplain along parallel to it. Grasses such as orchardgrass dominate this polygon. However there are a few small cottonwood saplings growing as well as a few introduced shrubs such as Himalayan blackberry.	7	-Changes in stream hydrology may result fewer typical riparian trees and shrubs becoming established in polygon 7 -Scattered recruitment of cottonwood
Western redcedar – Skunk cabbage **Cw – Skunk cabbage**	RC/11	Level areas on the Somenos floodplain, annual flooding, saturated soils	N/a	2, 3, 4 .	These polygons are on the Somenos Lake floodplain, west of Somenos Creek. These are wet units that experience annual inundation. Soils are Gleysols, and are saturated for much of the year. However, due to water movement through the soil, the RC unit is quite rich and productive. Polygon 1 is in the herb stage (2). The dominant plant is reed canarygrass, with scattered sedges, and skunk cabbage. Scattered shrubs are present and include hardhack, red osier dogwood and red alder. Polygon 39 is shrub dominated including red alder, hardhack and red osier dogwood. Herbs include reed canarygrass, skunk cabbage, and sedges. Polygon 40 is dominated by tree saplings including red alder, cottonwood, scattered paper birch, and hardhack.	1, 39, 40	-Polygon 1 – tree species recruitment is low due to thick cover of reed canarygrass and other herbs -Polygon 39 medium recruitment has red-alder recruitment, no conifers (spruce or cedar) -Polygon 40 medium condition, cottonwood and red alder recruitment

Table 5 (cont'd). Detailed Ecosystem Descriptions

Name	TEM code & BEC site series no.	Brief Description	GOE unit GOE code	Structural Stages mapped	Vegetation	Poly-gons	Condition/Health Historic Comments
Garry oak – Brome **Qg – Brome**	QB/00	Gentle south and southwest slopes, richer nutrient regime, dry – slightly dry with soil depths ranging between 20 cm to approximately 1 m. Parent materials are morainal (Mv, Mvb). Forest floor litter layers are fairly thin (3- 8 cm), consisting of decaying oak leaves as well as grasses and other herbs.	QB occurs in the following GOERT units: **Broadleaf Forest; Garry Oak forest (BF-Qg)** Forested subclass (>50% tree cover) **Broadleaf Woodland (BW-Qg)** Woodland subclass (<50% tree cover) **Grass Community** **(GC)** Grass dominated	4, 5, 6	The Garry oak – Brome ecosystem unit is common throughout the mapping area. Garry oak – Brome is the climax plant association, given time and no disturbance. Three GOERT units cover the different seral stages and structure of this one more general BEC unit. The leading tree species is Garry Oak with scattered Douglas-fir. The most common shrub is snowberry with scattered tall Oregon grape, ocean spray, Douglas-fir, Indian plum, Scotch broom, and red-flowering currant. The high cover of snowberry often discourages the establishment of other plants including Garry oak. The grass and herb layer is very diverse. Grasses include orchard grass, sweet vernal grass, blue wildrye, soft brome, and Kentucky bluegrass. Common herbs include Pacific sanicle, yerba buena, Canada thistle, Hooker's onion, fairy slipper, early and great camas, field chickweed, white fawn lily, spring gold, miner's lettuce, western buttercup, and red columbine. Arboreal lichens and mosses are very diverse but not inventoried in this report. Terrestrial mosses are sporadic but include scattered electrified cat's tail moss. The diverse structure of oak forests provides important habitat for birds, animals and other species. **BF-Qg** This type has a canopy cover greater than 50%, with trees taller than 10 metres. However Garry oak, and deciduous trees in general, allow much more light to pass through the canopy than conifer trees so the herb and shrub layer has the potential to be well-developed. In fact, in most of these polygons, snowberry has become dominant and few other plants have been able to establish themselves. Scattered Douglas-fir is found in polygon 34. The tallest oak trees in the mapping area are in these polygons. Common herbs include yerba buena, Pacific sanicle, and trailing blackberry.	6, 9,10,11, 21, 23, 24, 25, 27,28, 34, 35	-low to no oak recruitment in all polygons; -forest health is considered low due to poor oak regeneration; -polygons 9,10, 11, and 28 have low snowberry cover (<10%); -polygons 18, 20,21,23,25 all have abundant snowberry (up to 90%); -polygon 24 is on shallow soils; -polygons 6 & 10 are ideal polygons for enhancement.

Table 5 (cont'd). Detailed Ecosystem Descriptions

Name	TEM code & BEC site series no.	Brief Description	GOE unit GOE code	Structural Stages mapped	Vegetation	Poly-gons	Condition/Health Historic Comments
Garry oak – Brome (cont'd) **Qg – Brome**					**Bw-Qg** This type has a canopy cover less than 50%, with trees taller than 10 metres. This is fairly open forest with a high diversity of shrubs, herbs, mosses and lichens. These sites are on gentle slopes, with soil depths ranging from 50 cm to a 1 metre. Parent materials are morainal (Mv, Mb) with pocket of Fluvial deposition (polygon 9). Soils have a moderately dry moisture regime, with medium to rich nutrient regimes. **GC** Polygon 6 is a grass-dominated slope containing shrubby weedy species including Himalayan blackberry, and broom. Introduced such as Queen Anne's lace is also present. Some roadside garbage is present as well as garden refuse. Historical oak forest.		
Fescue – Camas One mapped units, but small pockets also occurs locally in polygons dominated by Garry oak	FC/00	Gentle slopes, shallow soils, forest openings, grass-dominated; dry - very dry soil moisture	**GC** Herbaceous subclass (>20% herbaceous cover, < 20% shrubs).	2b	This polygon has shallow soils (10-25 cm) over gently rolling shale bedrock. Parent materials are thin morainal materials (Mv) with some *in situ* weathering of bedrock. Soils exhibit an organically enriched horizon ("Ah") that has formed from decaying roots of grasses and herbs. The result is a thin, but nutrient rich soil. FC has a dry moisture regime and a medium to rich nutrient regime. Run-off of rainwater is rapid on these sites, and dry conditions prevail for much of the growing season. However this polygon can be quite moist in the winter and early spring.	37	This polygon is dominated by grasses, with less that 20% shrub cover. Grasses include orchard grass, sweet vernal grass, and Kentucky bluegrass. The natural plant community is sensitive to trampling, and invasive plants have a negative impact on the wildflowers.

Table 5 (cont'd). Detailed Ecosystem Descriptions

Name	TEM code & BEC site series no.	Brief Description	GOE unit GOE code	Structural Stages mapped	Vegetation	Poly-gons	Condition/Health Historic Comments
Fescue – Camas **Qg – Brome**	FC/00 QB/00	Gentle south slope to level, medium rich nutrient regime, slightly dry to well-drained soils; depths ranging between 15 cm to approximately 1 m.	**EsBr** Grasses including orchard grass and sweet vernal grass.		These two polygons are dominated by Scotch broom. Machines and human traffic have disturbed both of these polygons. These polygons are crossed by trails that connect to residential areas, and act as vectors for invasive plants. Such plants include Himalayan blackberry, common St. John's wort, Queen Anne's lace, orchard grass, and sweet vernal grass. Polygon 36 has shallow soils that have been displaced in places. If left undisturbed, it could be restored to a Fescue – Camas site. Polygon 29 has deeper soils and is in a toe slope position. It has a high cover of broom that has spread from adjacent abandoned fields. With deeper soils, this polygon could support large, vigorous oak trees with lush wildflower meadows. Both these polygons have undergone some removal of broom. Removal of broom from the borders of the park would help to eliminate ingress. Herbs on undisturbed sites would typically include Hooker's onion, great camas, early camas, blue-eyed Mary, chocolate lily, dove-foot geranium, spring gold, common monkeyflower, yampah root, and clover spp.	29, 36	- oak regeneration is nil in both polygons - forest health low, due to machine activity and high recreational activity -polygon 29 has deeper soils, a good place to plant more oak after weed control; -polygon 36 has shallow disturbed soils, and was historically a wildflower meadow (fescue – camas), dominated by grasses and herbs that flower and go to seed in springtime months before summer drought.
Willow – Spirea	WS/00	Level areas on Somenos floodplain, standing water for >8 months.	n/a	3b	This polygon occurs on the Somenos Lake floodplain, and is inundated annually. Water remains on these sites well into the springtime, and soils remain wet or saturated during the summer months This is a permanent shrub unit dominated by the following species: hardhack, Sitka willow, Drummond's willow, Pacific willow and red-osier dogwood. Herbs include sedges, scattered skunk cabbage and reed canary grass.	41	-active regeneration of willows, hardhack and red-osier dogwood; -ecosystem health is good, except for pockets of reed canary grass which inhibit tree regeneration; -active succession of old fields to shrubs is occurring; -changes in hydrology could change the plant composition.

Table 5 (cont'd). Detailed Ecosystem Descriptions

Name	TEM code & BEC site series no.	Brief Description	GOE unit GOE code	Structural Stages mapped	Vegetation	Poly-gons	Condition/Health Historic Comments
Rural	RU	Polygon 2 is a former commercial development, abandoned in 1990 (approx.)	n/a	3	TEM mapping standards define rural as "any area in which residences and other human developments are scattered and intermingled with forest, pasture, farmland and native vegetation or cultivated crops". The area had been filled with gravel and paved, and the old asphalt is now undergoing rapid succession to shrubs. Due to the rapid drainage of the gravel, there are some plants growing here that only grow on dry sites e.g. roadside rock moss (*Rhacomitrium canescens*). At present, this spot is used for interpretation for the Somenos marsh, and several trails into the marsh commence from this polygon.	2	-moderate regeneration of cottonwood; -considering changes to the forest floor, hydrology and old asphalt, forest health would be considered as low; -abundant old asphalt and cement covers portions of the site, however succession to a cottonwood forest is relatively rapid.

4.0 HISTORIC VEGETATION MAPPING OF SOMENOS MARSH AREA

4.1 Approach to Historic Mapping

Somenos Lake, the floodplain, and adjacent upland areas were mapped. The total area covered by the historical mapping is approximately 500 ha. Boundaries for the historical mapping are listed in Table 6. The boundaries are somewhat arbitrary in that they were dictated by available historic air-photo coverage, rather than height of land or distance from Somenos Lake. Boundary distances from the lake vary from .5 to .75 km.

Table 6. Somenos Lake Historical Mapping Boundaries.

Side of lake	Boundary
West	Trans-Canada Highway #1
North	Norcross Road, N. Cowichan
East	A north-south line midway between Lakes Rd. and Somenos Lake
South	Beverly and Lewis streets, Duncan

4.2 Methods

Initially we gathered all the available historic aerial photography we could find. We then reviewed available imagery, and selected several discrete sets of photographs that would best support the historic mapping. Air photo interpretation was thus conducted on pre-selected photography; the aerial photographs used for the project are listed in Table 7. Ultimately, we completed mapping for five different points in time, from the earliest coverage, we could obtain (1936), through to 1999. Historic mapping for the first and the last of these in the sequence are illustrated in Figures 3 and 4.

Table 7. List of Air Photographs used for Historical Ecosystem Mapping.

Year	Photo numbers
1936	BC 6 17-20
1950	BC 1053 46-48
1975	BC 7760 125-127
1980	BC 80075 172-173
1999	Orthophotos 92BO723; 0724; 0821; 0822

Figure 3. Study Area Vegetation in 1936

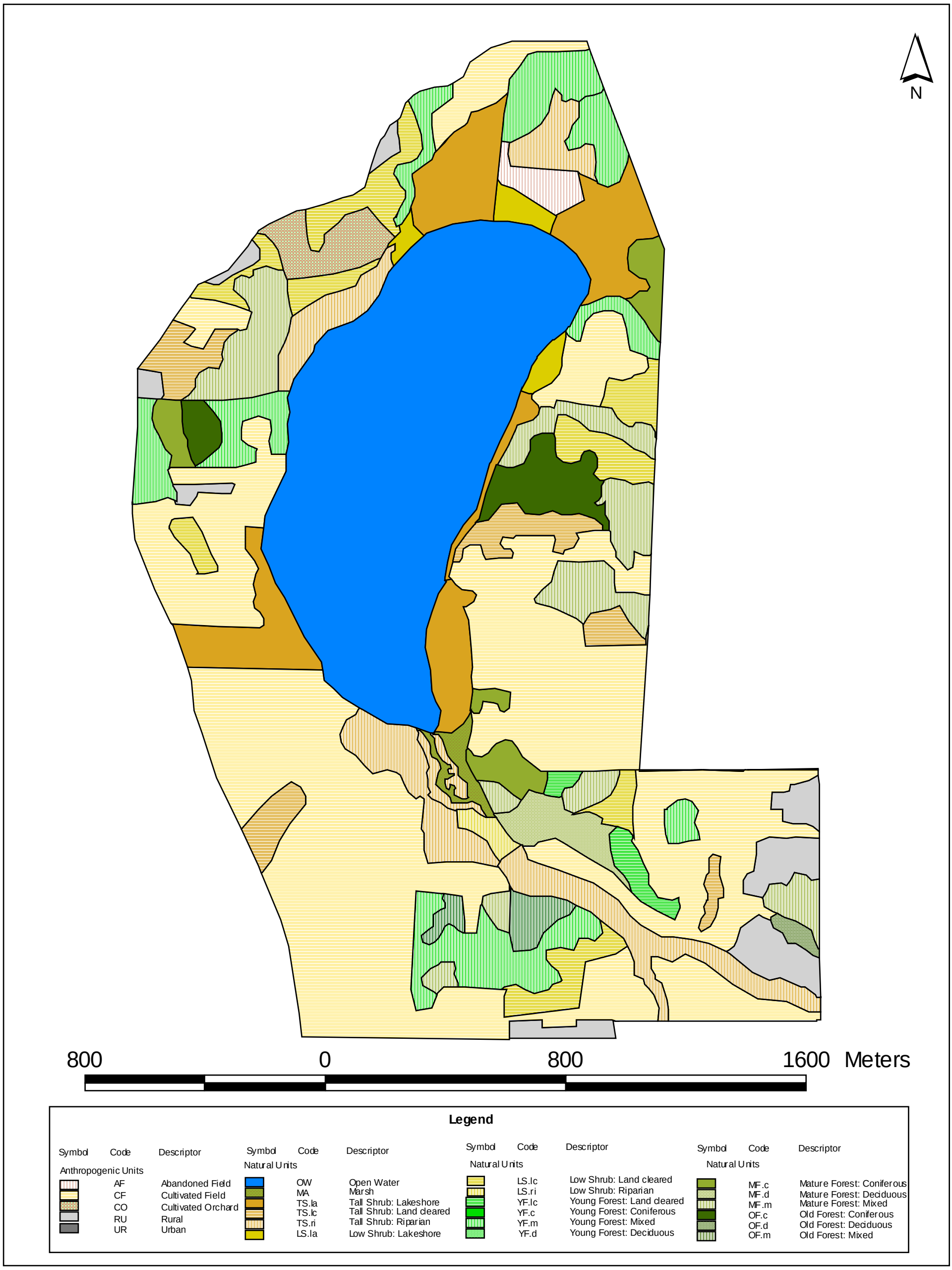
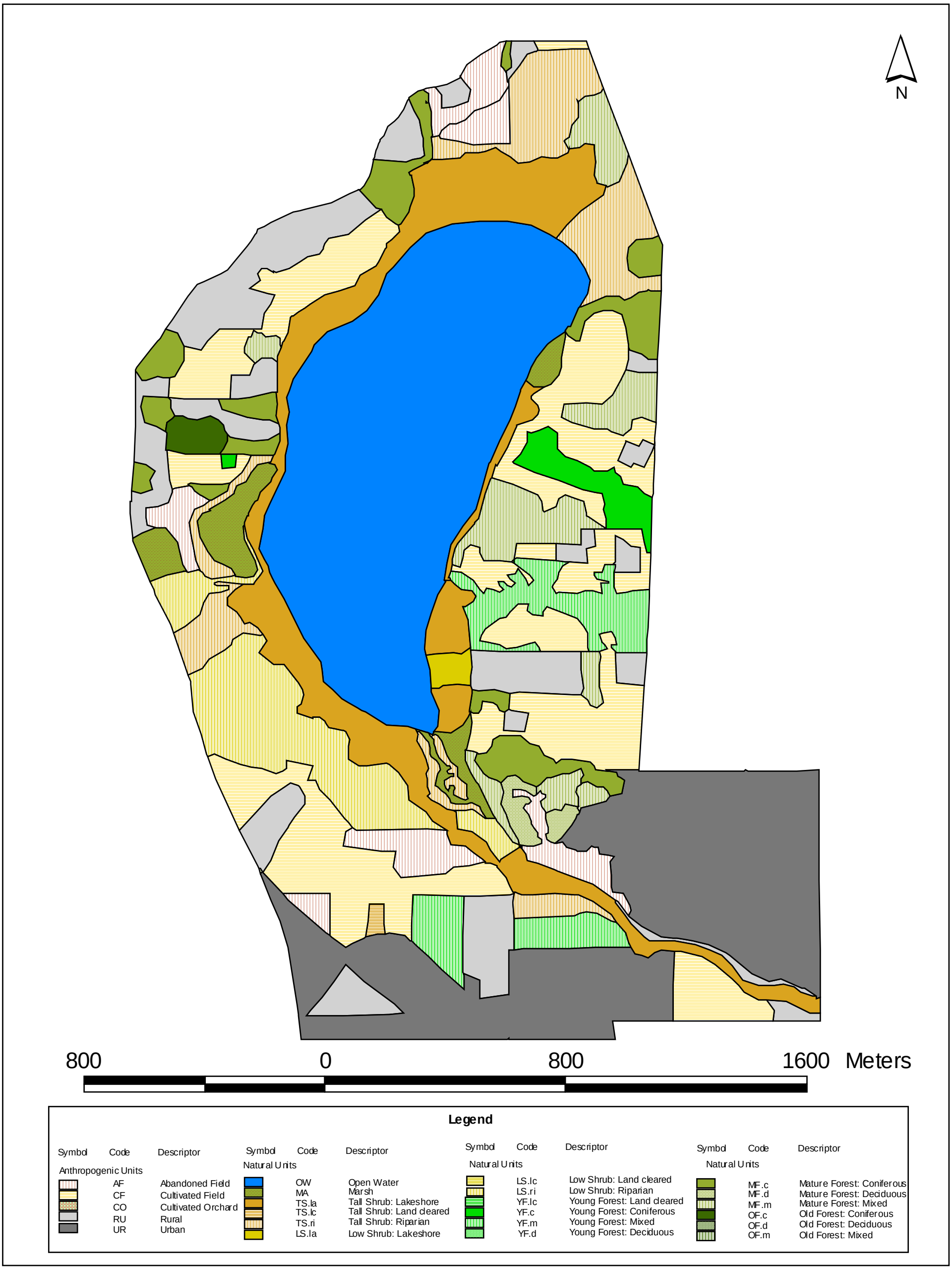


Figure 4: Study Area Vegetation in 1999



Initial delineation of units was done by pen while looking at air-photos through a stereoscope. There were considerable differences between the photo lines, which made interpretation easier on some photos than others. These were differences in:

- Scale (ranging from approx. 1:10,000 to 1:40,000);
- Coverage (some photo lines only covered portions of study area);
- Resolution (harder to differentiate certain units on some photos i.e. tall vs. low shrub, old vs. mature forest).

Line transfer was completed using ArcView software and a base map of the area from 1999 ortho-photos. This methodology was chosen because of the three points mentioned above. Linework was digitized into an ArcView shapefile format, then attached to an ecosystem database and appropriately labeled.

4.3 Vegetation Units used in Historical mapping

A project specific physiognomic classification was used in this mapping, with anthropogenic and ecosystem codes coming from Terrestrial Ecosystem Mapping (TEM) standards – see Table 8. No fieldwork was conducted specifically for this portion of the work, so equivalent BEC units are likely, but not certain.

Table 8. Mapping Units used in Historical Ecosystem Mapping of Somenos Lake.

Units	Sub-type	Map code	TEM or BEC [Φ]	Full name
Young Forest (structural stage 4-5)	Conifer	YF.c	DG	FdBg-Oregon grape
	Deciduous	YF.d	DG	FdBg-Oregon grape
	Mixed	YF.m	DG	FdBg-Oregon grape
Mature Forest (st. stage 6)	Conifer	MF.c	DG	FdBg-Oregon grape
	Deciduous (oak)	MF.d	DG	FdBg-Oregon grape
	Mixed (Fd & oak, others)	MF.m	DG	FdBg-Oregon grape
Old Forest (st. stage 7)	Conifer*	OF.c	DG	FdBg-Oregon grape
	Deciduous (oak)	OF.d	DG	FdBg-Oregon grape
	Mixed (Fd & oak, others)	OF.m	DG	FdBg-Oregon grape
Fields -abandoned fields eventually become low, then tall shrub	Actively cultivated	CF	CF	Cultivated field
	Abandoned field	AF	none	
Tall Shrub (2-8m)	Riparian - along Somenos Cr.	TS.ri	WS	Willow-*Spirea* swamp
	Lakeshore	TS.la	WS	Willow-*Spirea* swamp
	Upland (land clearing)	TS.cl	DG	FdBg-Oregon grape
Low Shrub (< 2m)	Riparian - along Somenos Cr.	LS.ri	WS	Willow-*Spirea* swamp
	Lakeshore	LS.la	WS	Willow-*Spirea* swamp
	Upland (land clearing)	LS.lc	DG	FdBg-Oregon grape
Marsh (patches of open water)		MA	CT	Cattail marsh (*Typha latifolia*)
Urban (continuous development)		UR	UR	
Rural (scattered development)		RU	RU	
Cultivated orchard		CO	CO	

*All upland old and mature conifer forests are Douglas-fir dominated. On the Somenos Lake floodplain the only conifer trees were in several small polygons opposite the Garry oak park where a mixed Sitka spruce, cedar and cottonwood stand existed.

[Φ] Likely TEM or BEC equivalent code.

4.4 1859 Mapping of the Somenos District

Mapping for agriculture potential was conducted in the "Somenos District" of the Vancouver Island Colony in 1859 by Colonel O. James R.E., F.R.N., M.R.I.A., and lithographed at the Topographical Depot of the War Office under the direction of Major A. Cooke R.E. The abbreviation R.E. refers to the Royal Engineers, who were responsible for the engineering and construction of road and bridges when the province was still a British Colony. The map scale is "20 chains to one Inch", which appears to be the equivalent of about **1:40,000**. **A**s is to be expected, the map is very general, with descriptions such as "Good Land, Thickly Wooded with Cedar, Pine, Maple and Alder". The upland areas around Somenos Lake are referred to as "Oak and Pine" (Pine likely referring to Douglas-fir); the Somenos floodplain is referred to as "Low and Marshy"; and the north end of Somenos Lake where Somenos Creek enters is referred to as "Low and Marshy with Alder and Sea Meadow Grass". The interesting thing is the reference to "Oak and Pine" in upland areas surrounding the lake, suggesting that it is possible, and even likely, that Garry Oak was historically more common in the area than it is today.

4.5 Analysis of Historical mapping results

Figures 3 and 4, as well as the overview in the map pocket, illustrate the results of the historic mapping. The mapping was then analyzed, with the units listed in Table 8 used in the initial analysis of vegetation trends of Somenos Lake area. Somenos Lake itself, being of a relatively constant coverage, was not mapped. The following units (see Table 8 for units and codes) were grouped together to yield more meaningful results:

- young forest,
- mature forest
- old forests
- tall shrub (lakeshore and riparian)
- low shrub (lakeshore and riparian);

In addition, fields (cultivated and abandoned), marsh, urban, rural and cultivated orchard units were analyzed. The changes in coverage for these different units over the last 65 years are summarized in the following Table 9, and are illustrated in chart 1.

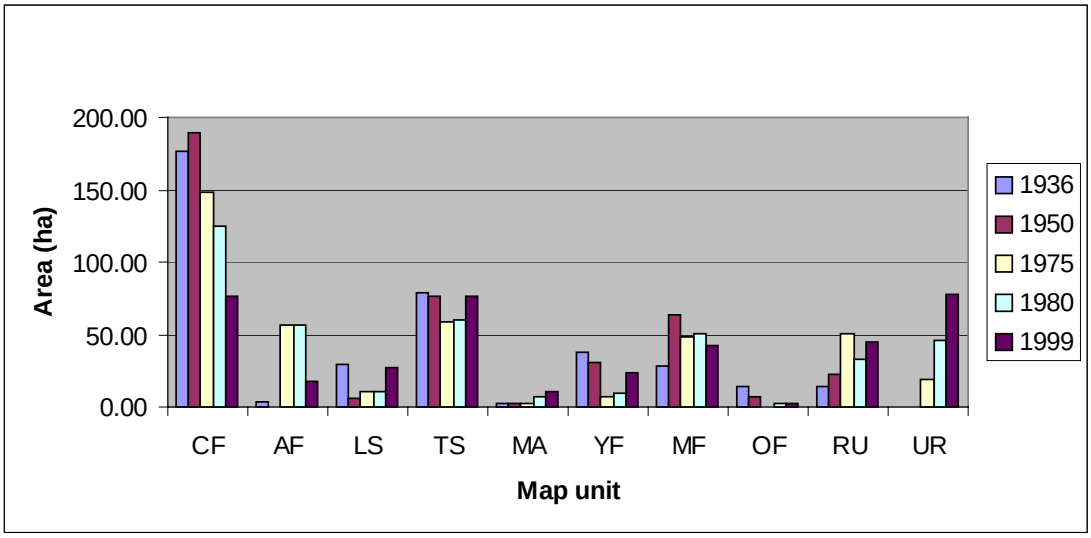


Chart 1. Somenos Marsh Ecosystem Unit by Area (ha) over time.

Each unit is discussed in greater detail in following sections. Due to data limitations (such as air-photo scale and quality), the total hectares of coverage for each unit has a likely error of 5%.

Table 9. Summary of Historical Changes for each Unit in the Somenos Lake area.

Map unit	Code	Summary of changes
Cultivated field	CF	Dramatic reduction of over 50%, from 190 ha in 1950 to 75 ha in 1999.
Abandoned field	AF	Dramatic increase between 1950 and 1975, correlated with decline in CF.
Low shrub	LS	1950 saw little LS due to widespread cultivation, but increases as AF becomes overgrown.
Tall shrub	TS	Stable amount of coverage over the years, average of 75 ha.
Marsh	MA	Increase from 2.5 ha to over 10 ha in 1999, due to marsh creation by Ducks Unlimited.
Young forest	YF	The highest amount of young forest is in 1936, much of this related to land clearing.
Mature forest	MF	From a high of65 ha in 1950, coverage has stabilized between 40 – 50 ha.
Old forest	OF	Decline from 14 ha in 1926 to less than 3 ha in 1999. OF will increase over time as MF ages.
Rural	RU	Stable since 1975 at approx 45 ha, however, some RU has become UR, with new RU being created .
Urban	UR	Dramatic increase from 0 ha in 1950 to 78 ha in 1999

4.5.1 Cultivated field (CF)

Cultivated fields have decreased from a high of 190 ha in 1950 to 76 ha in 1999, a reduction of well over 50%. This decrease is a reflection of the declining emphasis on agriculture in the Cowichan Valley over the last 50 years. Early air photos (1936, 1950) show the remarkable amount of farms and cultivated areas in the Somenos watershed. The areas of decline surround the lake, but are most noticeable on the Somenos Lake floodplain, where extensive agriculture took place right up to 1975, after which it started to decline rapidly, along with increasing urbanization.

4.5.2 Abandoned field (AF)

There was a dramatic increase in abandoned fields between 1950 and 1975 as cultivated fields were left fallow. This number decreased in later years as abandoned fields became low-shrub and then tall-shrub communities.

4.5.3 Low shrub (LS)

Low shrub communities have increased in recent years in the Somenos Marsh as abandoned fields become overgrown with shrubs such as willows, red-osier dogwood, and hardhack.

4.5.4 Tall shrub (TS)

The riparian and lakeshore tall shrub communities have remained stable at about 75 ha over the last 70 years.

4.5.5 Marsh (MA)

A marsh is defined here as "a wetland composed of permanent shallow open water with scattered emergent vegetation, found in association with lakes and streams" (RIC 1998a). Marshes in the mapping area have increased slightly in recent years due to several installations made by Ducks Unlimited on the Somenos flats. However, total area is small (under 10 hectares).

4.5.6 Young Forest (YF)

There was close to 40 ha of Young Forest in 1936, but much of this was brush, and saplings left over after land clearing. Young Forest declined in the 1960's to 1980's as fields and rural areas expanded. A slight increase in Young Forest is seen in recent years as some rural areas and fields have become reforested.

4.5.7 Mature Forest (MF)

Once the majority of the land clearing occurred in the first half of the last century, the total amount of Mature Forests has remained fairly stable at around 50 ha. In recent years, MF has declined slightly as a result of urbanization. However, in many cases, the trees still remain scattered throughout the urban areas, although they are no longer intact forest stands. Significant stands of mature forest are found on the eastern side of Somenos Lake, including stands in the Garry Oak Protected Area.

4.5.8 Old Forest (OF)

The total coverage of Old Forest has declined from about 15 ha in 1936 to less than 5 ha by 1999. Most of this loss has been to Rural and Urban and, in the case of the Sitka spruce – cottonwood forest on the floodplain, to agriculture (CF). However if existing mature forests continue to grow, the total amount of Old Forest will increase over the next 50 years. A significant old-growth stand exists at the BC Forest Discovery Center.

4.5.9 Rural (RU)

Rural areas saw a steady increase in area from 15 ha in 1936 to about 45 ha as of 1975. Since then, total area has been relatively stable. However some rural areas have become urban, with new rural areas being created in turn. This was particularly noticeable following 1975 when many rural areas became urban (Chart 1).

4.5.10 Urban (UR)

No Urban areas existed in the study area prior to 1960, but a dramatic increase in Urban has occurred between 1975 and 1999. The present total cover of Urban is close to 80 ha.

4.5.11 Cultivated orchard (CO)

A large cultivated orchard is readily seen in the Norcross Road area on the 1936 and 1950 air photos, but by 1975 it had become a cultivated field. It was likely an apple orchard.

After conducting the initial analysis, the following groupings were made of the above units:

- Old, mature, and young forest (total forest)
- Tall and Low shrub (riparian and lakeside shrubs only) and Abandoned fields
- Rural and Urban

4.5.12 Old, mature, and young forest - Total forest

The total coverage of all forest types peaked in 1950 at 100ha. A dramatic decrease to about 50 ha took place between 1950 and 1975. However, in the last 25 years the total coverage has gradually increased to about 70 ha. If existing forests are retained, Old Forest should increase in coverage as young and mature forest become older. Historical photos indicate a mixed conifer – black cottonwood forest growing on the south side of Somenos Creek near the park. At present, however, no mature or old forests of any kind occur on the Somenos Floodplain. The largest forest groves occur on the east side of Somenos Lake, where forests of all age classes are found. The largest grove of old forest on the west side of the lake is found at the BC Forest Discovery Centre.

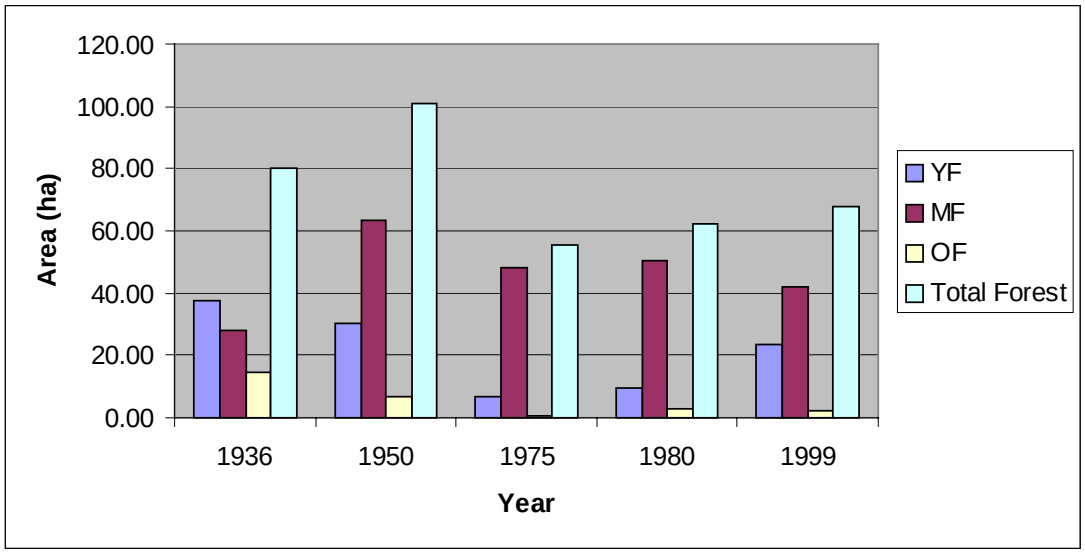


Chart 2. Young, mature and old Forest over time surrounding Somenos Marsh.

4.5.13 Total shrub cover and abandoned fields on Somenos floodplain

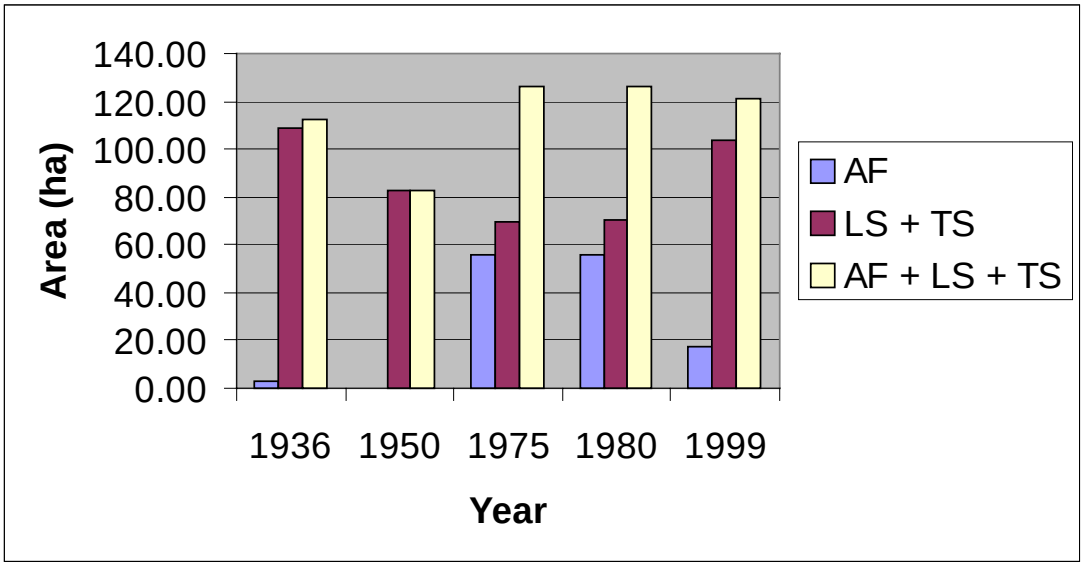


Chart 3. Tall, Low shrub and abandoned field over time

Abandoned cultivated fields on Somenos floodplain develop into low, then tall shrub communities within 10 years or so due to the constant moisture and rich soils. The most dramatic conversion of abandoned fields to shrub communities occurs between 1980 and 1999 (see chart above). The total of all shrub and abandoned fields (120 ha) represents the total amount of shrub cover likely in the near future, if present trends continue.

4.5.14 Rural and Urban

Rural and Urban areas fragment the natural landscape and decrease biological connectivity so it was logical to summarize these two units together. As of 1999, total coverage of these two units was about 120 ha. However there are differences between these two units from a biological point of view. For example, many rural areas retain important habitat including pastures, hedgerows, and small forest groves including, in some places, large and mature oak trees.

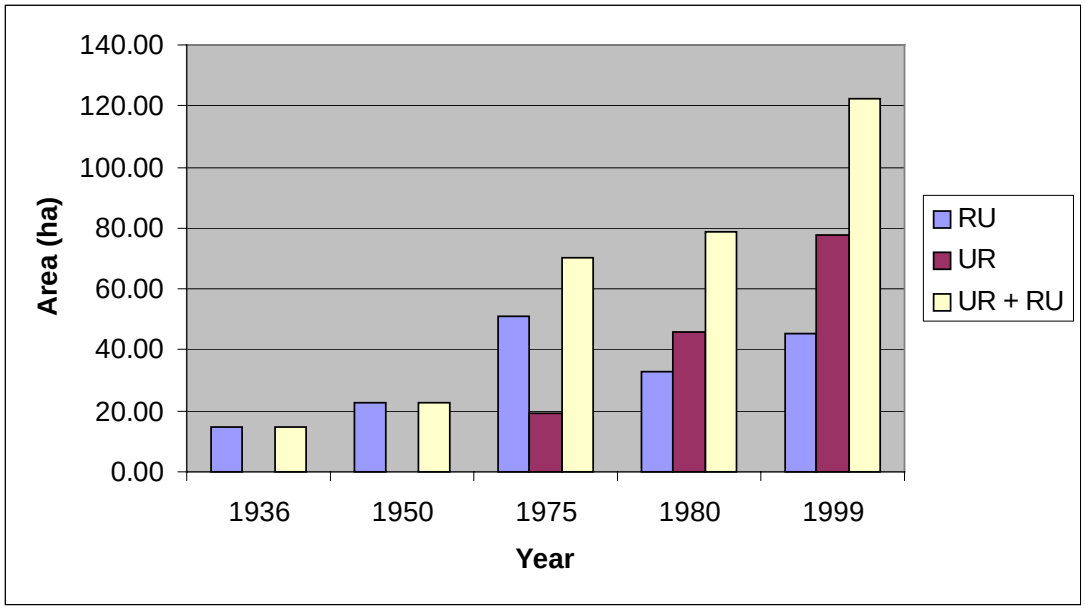


Chart 4. Urban and rural developments over time

These habitat types tend to favor small mammals and birds rather than larger mammals. Urban landscapes more dramatically reduce "connectivity", have fewer biological legacies, disrupt natural drainage patterns, and are sources of pollution. These conditions can be ameliorated to some degree by the planting of trees, hedgerows, and plants that are attractive to bees, butterflies and birds and thus provide buffers.

4.6 Summary of Changes, and Management Implications

The key points to note from the analysis are:

- Loss of old forests (cleared prior to historic mapping, for agriculture)
- Subsequent loss of agricultural areas (from almost 200ha in 1936, to 75 ha in 1999)
- Increasing urbanization and fragmentation

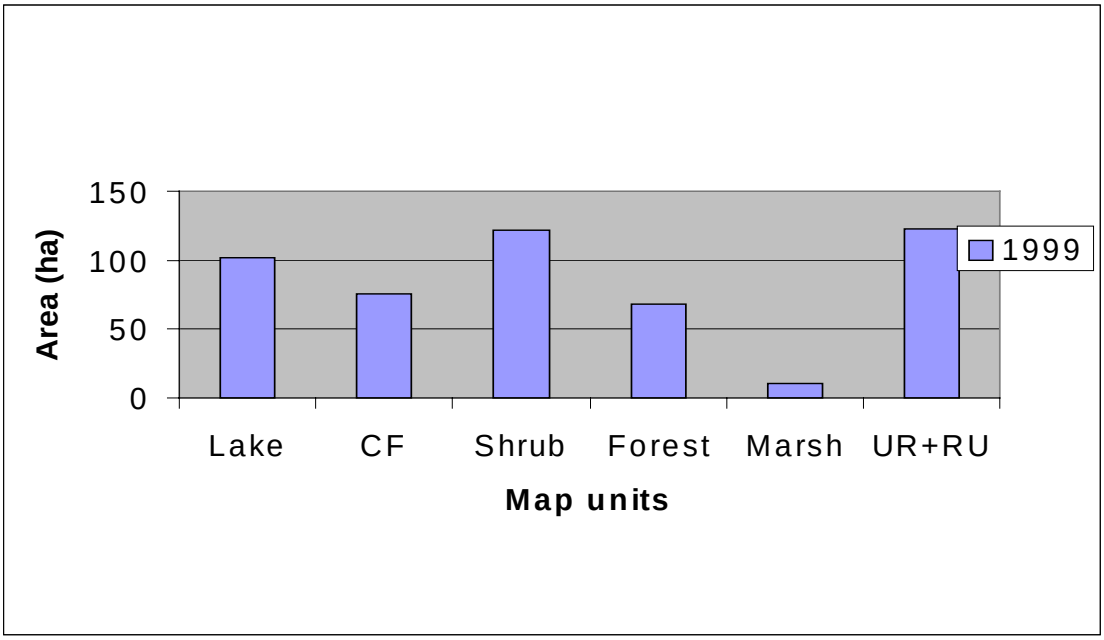


Chart 5. Current cover of combined units

The cover of Urban at present is 78 ha, and RU is at 45 ha; together the total is about 122 ha, the largest coverage of all mapping units. Urban growth has increased in the Somenos Lake area by about 20 ha / decade and indications are that this trend will continue.

The shrub unit has approximately the same coverage as UR/RU with 121 hectares. This figure includes newly abandoned fields because of their rapid conversion to shrublands. The historic cover of shrubs in the mapping area was approximately 140-150 ha.

The unit with the third highest coverage is Somenos Lake itself at 102 ha. The lake appears to have remained much the same size over the years. However, because the air-photos are simply a "snapshot" in time, and were taken in the summer months, no

evidence is offered regarding the extent and duration of the annual flooding of Somenos Lake and Somenos Creek.

The decrease in cultivated fields in the mapping area is linked to the decline of agriculture in the Cowichan Valley (and elsewhere on Vancouver Island). Increases in the duration of annual flooding on the Somenos flats have also discouraged farming in this area. The current coverage of cultivated fields is about 75 ha. Many of these fields are on upland areas surrounding the marsh such as along Norcross Road or on the east side of Somenos Lake. Trends indicate that the amount of cultivated fields and pasture will continue to decline.

Total amount of forest in the mapping area at present is approximately 68 ha. From a low of 55 ha in 1975, the total amount of forest is slowly increasing but has not attained the coverage of 1950 - 100 ha. With the amount of rural and urban landscapes increasing, existing forests may prove to be the victims of this growth.

The loss of older forests in particular will mainly have occurred prior to the first aerial photographs of the area, when the land was originally cleared for agriculture. As noted in 3.8 when the area was mapped in 1859, upland areas around the lake were generally mapped as oak and pine (likely Douglas-fir), so Douglas-fir and oak forests were likely much more widespread then. However, on 1936 air photos, much of that forested area was under cultivation (in particular all the area between Norcross Rd. and the lake). Since original land clearing, the decline of old forests has continued, so only about 3 ha remains in the area at the present day. The importance of these older forests around the marsh therefore needs to be underscored, and efforts should be made to protect every last fragment that remains.

Opportunities also exist for establishing new forests, in particular along Somenos Creek in suitable locations on the Somenos floodplain. Encouraging private landowners in rural and urban to plant trees and preserve existing forests will provide for future forests.

The marsh unit has the lowest coverage at about 10 ha. However there is not always a clear distinction between Marsh and Lake. For example, the shallow water interface around the lake between the open water and the shrub community could also be classified as marsh, but was not mapped as such due to its narrowness. The total amount of open water (lake plus marsh) in the mapping area is about 110 ha.

The results of the historic mapping lead to a number of recommendations for future vegetation management in the area. These include:

- Increase active farming and encourage agricultural uses such as haying, so long as they are compatible with wildlife management objectives (see Williams and Radcliffe 2000)

- Establish vegetation targets for within the area, incorporating current and historic values

- Protect every remaining pocket of forest and woodland habitat around the marsh; enlarge where possible by peripheral plantings

- Restore floodplain forests where opportunities exist, including areas within management Zone Four

- Actively encourage tree planting and woodland restoration on private lands around the lake.

5.0 ECOLOGICAL VALUES

5.1 Rare and Threatened Plants and Habitats

The Garry oak and associated ecosystems provide habitat for a large number of rare species. These ecosystems contain 93 species that have been designated as being "at risk" in British Columbia while 24 of these are threatened or endangered worldwide (GOERT, 2001).

A number of known red and blue listed plants have been specifically documented around Somenos. These are briefly summarized in Table 10.

Table 10. Rare Plant Habitats

Latin name	Common name	Habitat	GOERT code	Comments
Viola praemosa var. praemorsa	Yellow montane violet	Dry grassy slopes and oak woodlands	BW-Qg GC	Occurs in open oak stands and adjacent meadows
Triteleia howellii (Brodiaea howellii)	Howell's triteleia	Dry to mesic grassy meadows	BW-Qg GC	Occurs in open oak stands and adjacent meadows
Psilocarphus elatior	Tall woolly-heads	Moist vernal meadows and muddy pathsides	GC	Likely occurs adjacent to Somenos Creek, outside the park
Navarretia intertexta	Needle-leaved navarretia; pin cushion plant	Moist meadows and vernal pools	n/a	Likely occurs along Somenos Creek, outside park boundaries
Cyperus erythrorhizos	Red-rooted cyperus	Moist to wet, often sandy sites	n/a	This wetland plant occurs just outside of the official park boundaries along Somenos Creek.
Polygonum hydropeperoides	Water pepper	Wet swampy sites, and shallow water	n/a	This wetland plant occurs along Somenos creek outside the official park boundaries.
Bidens amplisima	Vancouver Island beggarticks	Moist to wet ditches, streambanks and pond edges, open habitat	n/a	This plant occurs just outside the official park boundaries along Somenos Creek.

Photo 1. Yellow Montane Violet (*Viola Premorsa)*

5.2 Rare and Threatened Wildlife and Habitats

Wildlife Values of the Somenos Marsh Area in general are discussed in the Somenos Management Plan. However, the Garry Oak protected area supports some specific species/values, and these are the focus of this section. GOERT identified vertebrate and invertebrate Species at Risk (SAR's) associated with the Garry oak complex (Fuchs 2001). While many of the species identified in that document do not presently occur in the study area, a few do, while several that are known or believed to have been present in the past are now gone. Important examples include the Large Marble butterfly (undescribed Island subspecies, possibly extinct), the Western Bluebird (extirpated from Vancouver Island), and Lewis' Woodpecker (extirpated from Vancouver Island).

The shift away from vegetation adapted to frequent fires has been accompanied by a shift in the vertebrate and invertebrate population towards species adapted to forested ecosystems. Loss of invertebrate populations such as butterflies are particularly noticeable (Guppy, 2001). Many species of butterfly rely on the open Garry oak meadows for all or part of their life cycle. As Garry oak trees are a key to these values, we decided to tag and number all Garry oak trees on site that were greater than 30cm dbh. An excel database was constructed containing the information on each tree and is

intended to be used in future studies. Table 11 identifies those mapped polygons which contain the majority of the oak trees on site.

Table 11. Polygons with High Number of Garry Oak Wildlife Trees.

Polygon number	Species	Comments	GOERT label
34	Garry oak	This polygon has the largest oak trees in it	BF-Qg
10	Garry oak	Pure oak stand but trees are smaller than in 34	BW-Qg
35	Garry oak	Large oak trees	BF-Qg
28	Garry oak	Medium sized trees	BF-Qg
11	Garry oak	Medium sized trees	BW-Qg

5.2.1 Invertebrates

A list of butterflies recorded in the general area is provided in Appendix A. Most are relatively common species. However, the Common Ringlet, recorded at Somenos, is red-listed by the CDC as it is considered endangered. In addition, at least two blue-listed butterfly species occur and have been recorded; the Propertius Duskywing and the Common Wood-Nymph. It should be noted that the observations of butterflies are from a number of visits over the year by Derrick Marven. However, no systematic inventory has been attempted. The timing and scope of this project did not permit field assessments for butterflies; D. Marven and G. Radcliffe made one brief field visit to look at and discuss potential butterfly habitats. It remains quite possible that additional relatively rare butterflies that are generally associated with GOE's could also occur at this site. The following brief notes summarize knowledge for those species that once occurred, or that are currently known for the site. The information is summarized from: Guppy & Shepard 2001; Fuchs 2002; BC MELP Wildlife at Risk series 1999.

Butterflies

Loss of habitat, loss of native plant food sources, and habitat reduction are the key issues with respect to butterflies. Many of these species have extremely small spatial ranges, and may live out their lives in a matter of meters (Guppy & Shepard 2001). The alienation of natural habitat by development, introduction of weedy plants, and changes in natural process like the exclusion of fires, has allowed meadows to be developed or grow into mature forests (Guppy, 2001). Examples of this process are apparent in some of the DG polygons at Somenos, and in the encroachment of snowberry, as well as broom, for example into polygons 22 and 23.

The following three species of butterfly have been recorded at Somenos in the past and should be considered in any management and restoration plans.

Common Ringlet *insulana* subspecies *(Coenonympha california insulana)*

***recorded at Somenos**

The red-listed Common Ringlet was abundant on V.I. in the mid 50s, 60s, but is now dwindling. It relies on meadows, open grassy areas, and GOE's, but only where they are damp enough to maintain green grass through summer, but that do not flood excessively in winter. Roadsides, woodland edges and clearings, prairies, and bogs are also utilized. The Common Ringlet flies from May to October (two broods which barely overlap). They lay eggs on green grass and possibly sedges that are required for larval food. Urbanization, brush incursion, (especially Scotch broom) are threats for this species.

Propertius Duskywing (*Erynnis properties*)

***recorded at Somenos**

The blue-listed Propertius Duskywing is strongly associated with GOE's, specifically hillsides, woodland clearings, and open meadows, and is always near oaks. They are more common to the south in Washington and Oregon. Specimens have been collected primarily on the southeast tip of Vancouver Island and the adjacent Gulf islands, where Garry oak occurs. Propertius Duskywings rely on Garry oak as the host plant. They are known to use meadow plants for nectar. Nectar sources include camas, vetch, and Hooker's onion. Propertius Duskywings pupate in the leaf litter below Garry oaks; leaving leaf litter at the base of trees will help to protect hibernating larvae. They fly from late April to early July (one record in late July).

Photo 2. Propertius Duskywing (*Erynnis properties*) (photo: Derrick Marven)

Common Woodnymph *incana* subspecies *(Cercyonis pegala incana)*

***recorded at Somenos**

The Common Woodnymph is found in grassy forest openings, clearcuts, roadsides, meadows, and stream banks. The larval foodplants in BC are probably grasses. Elsewhere, *Tridens flavus, Avena fatua, Stipa* sp., *Andropogon* sp., and *Carex* sp. have been recorded as foodplants. The Common Woodnymph flies from July to September. Adults feed on flowers and on willow and poplar sap

Dragonflies

The marsh area in general supports a high diversity of dragonfly species, and a list of species recorded to date is provided as Appendix C. Some of these are especially abundant in the vicinity of the Garry Oak Protected Area, although the list is not confined to the Garry Oak area. As with butterflies, this list has been compiled over time (by D. Marven), and we are unaware of any systematic inventory efforts within the area targeting this group. Again, the list is of species that are generally relatively common. However, three of the recorded species are on the provincial blue list. These are the **Western Pondhawk (** *Erythemis collocata)*; **Blue Dasher (***Pachidiplax longipennis)* and the **Yellow-legged Meadowhawk (***Sympetrum vicinum)*. Very little published

information on these species is available; the best summary source is probably Cannings (2002).

Other Invertebrates

A number of other rare invertebrates are also known to be generally associated with GOE's. These are identified in Fuchs (2001) and are not repeated here. However, no direct inventory has been conducted and it is unknown if many of these (or any) occur at Somenos.

5.2.2 Vertebrates

Reptiles and Amphibians

No red- or blue-listed species are known for the Garry oak area. Within the marsh, the blue-listed Painted turtle is reputedly present. Although native to BC its origin at Somenos is uncertain, and it may be introduced to the area. For terrestrial reptiles in general, the past disturbance of the area, combined with lack of talus and limited CWD, combined with the small area of the site and lack of contiguity with other natural terrestrial areas, make this an unlikely site for most of the reptiles considered at risk.

Birds

The bird diversity of the area is relatively high, and the Garry oak woodlands and the adjacent meadows and forest receive high use by a wide diversity of native birds. The juxtaposition of the oak stands with coniferous forest and marsh no doubt contributes substantially to the high values of this site. Many of the species typically found are common everywhere. Again, no inventory was conducted for this project. However, some noteworthy species have been recorded in the past by local naturalists and others. The following identifies some of the known bird values of the site, and some of the species that historically would have likely nested here.

Great Blue Heron (*Ardea herodias*)

Just over 1% (25 pairs) of the Canadian population of the nationally vulnerable *fannini* subspecies of the Great Blue Heron breed and winter in the immediate vicinity of the study area. Although the Somenos Management Area is not used for breeding, the lake and wetlands provide the herons with a very high quality winter feeding resource. It is partly in recognition of this value that Somenos was designated in October 2000 as an Important Bird Area (IBA), giving it increased international status and recognition. Long-term maintenance of good quality feeding habitat for the herons is considered an important issue. Reduction of shallow feeding areas

through the encroachment of shrubs into the agricultural fields will eventually reduce feeding habitat quality.

A number of Great Blue Heron routinely perch and likely roost in the larger conifers right along the edge of the marsh. They appear quite sensitive to people walking along the trail here, and often flush as walkers approach (G.Radcliffe *pers. obs.*). The shallows immediately adjacent to this area (west of polygon 31) seem to provide an exceptionally rich feeding ground for herons and other birds, and should be well protected with visual buffers.

Peregrine Falcon, *anatum* subspecies (*Falco peregrinus anatum)*

The Peregrine Falcon, *anatum* subspecies, is a red-listed species, which sometimes perches in the taller conifers on site. Although the birds do not nest here, Somenos is an extremely productive feeding area and is likely of high value to pairs of peregrines resident in the general area, and to younger dispersing birds. Pairs have nested at Tzouhalem, Prevost, and in the Mt. Maxwell area; Somenos would be well within foraging distance for all of these.

Western Bluebird (*Sialia mexicana*) Georgia Depression population

The Western Bluebird prefers habitat areas with interspersed trees and openings including woodlands, sparsely forested slopes, hill summits, and burned or logged forest pastures (Fraser *et al.* 1999 Fuchs 2002, Godfrey 1966). The study area provides some good potential habitat for Western Bluebird, although habitat is very limited in area.

At one time it is likely that Western Bluebird nested at this site. Unfortunately, it is now extirpated from the island. Due to the small representation of the site, it is unlikely to be worthwhile attempting to provide nesting habitats for bluebirds at Somenos, in isolation from other sites. In conjunction with other, larger areas however, this site might help support them. However, at the present time the abundance of gray squirrels and also of starlings and house sparrows make prospects unlikely. Any attempt to bring these birds back to the island would need to be accompanied by an intensive management effort to reduce/eliminate the gray squirrel, and also to prevent nestbox occupation by starlings, sparrows or other invasive species.

In addition to the above birds, other species of interest include the Western Wood Peewee (*Contopus sordidulus*), Great Horned Owl (*Bubo virginianus*), and Band-tailed

Pigeon (*Columba faasciata*). Western Wood Peewee has been recorded in the Garry oak area at Somenos in the past. Although not a listed species, it seems to be quite localized in distribution and is seldom recorded in this general area, so this may be of local significance. A Great Horned Owl is often present in the denser coniferous area near the northern boundary. The study area also provides oak groves where Band-tailed Pigeons will roost and feed. Band-tailed Pigeons prefer open woodland and edges for habitat.

Mammals

There are no known or historic records of red or blue listed mammal species currently present in the area. The blue-listed ermine may theoretically have occurred at one time, but there are no records of it for the Somenos area. Large mammals that would have been present but are now essentially absent are the black bear and cougar.

6.0 ECOLOGICAL CONDITIONS

6.1 Invasive Species

After habitat loss, invasive species pose the second greatest threat to natural ecosystems, and particularly GOEs (GOERT 2003). Major classes of invasive species that threaten the Somenos GOEs are:

- Alien invasive woody species
- Alien invasive herbaceous and graminoid species
- Native invasive species
- Invasive animals

Table 12 lists the ten worst alien invasive plant species in GOEs (Murray and Pinkham, 2002).

Table 12. Ranking of 10 worst Alien Invasive Plant Species in Garry Oak Ecosystems

Common Name	Scientific Name
Orchard grass	*Dactylis glomerata* L.
Scotch broom	*Cytisus scoparius* (L.) Link
Gorse	*Ulex europaeus* L.
English ivy	*Hedera helix* L.
Velvet-grass	*Holcus lanatus* L.
Spurge-laurel	*Daphne laureola* L.
English hawthorn	*Crataegus monogyna* Jacq.
Sweet vernalgrass	*Anthoxanthum odoratum* L.
Himalayan blackberry	*Rubus discolor* Weihe & Nees
Hedgehog dogtail grass	*Cynosurus echinatus* L.

Many invasive introduced invertebrate and vertebrate wildlife species, from slugs to starlings, have also benefited from the overall landscape fragmentation and from agricultural land practices that have occurred in the area. They impact on the GOE's in a variety of ways. Invasive introduced animals often predate on or out-compete the native fauna and can significantly impact upon them, or may even eliminate them. Species such as house sparrows and European starlings often increase along boundaries and can detrimentally impact upon the fauna within the GOE, and Somenos is no exception. They can also impact upon the native vegetation; for example, squirrels feed

on Garry oak shoots as well as utilizing acorns, which may have implications for the health and regeneration of Garry oaks.

6.1.1 Alien invasive woody species

Alien invasive woody species, notably Scotch broom, Himalayan blackberry, English hawthorn, daphne, English ivy and holly can create major structural changes in GOEs. Scotch broom and English hawthorn are the two major alien invasive woody species that occur in the Somenos GOEs. However, many of the alien invasive woody species that were present in the Somenos GOEs were removed over the past two years.

Photo 3. European hawthorn piled along roadside

Photo 4. Cut broom piled in open meadow

The Habitat Stewardship Program of the federal government provided funding for the Restoration and Management Recovery Action Group of GOERT to conduct extensive alien invasive woody species removal in the GOEs of the Cowichan Valley (Somenos, Tzuhalem and Cowichan Garry Oak Preserve).

6.1.2 Alien invasive herbaceous and graminoid species

Alien invasive herbaceous and graminoid species such as orchardgrass (*Dactylis glomerata L.)* can impact GOEs by competing with native grasses and forbs. Orchardgrass, velvet-grass *(Holcus lanatus L.)*, sweet vernal grass (*Anthoxanthum odoratum* L.) and hedgehog dogtail grass (*Cynosurus echinatus L.*) are believed to be the most damaging alien invasive grasses in the Somenos GOEs. Orchardgrass is by far the most aggressive of these. In areas to the south and west parts of the study area, extensive infestation with reed canarygrass (*Phalaris arundinacea* L.) occurs. This species forms a dense thatch that prevents establishment of other species, a situation termed successional stagnation by Kimmins (1987). Although there are numerous alien invasive herbaceous species that occur in the Somenos GOEs, the impact of these species is not as great as the impact of the grasses.

6.1.3 Native invasive species

The elimination of fire in the Somenos GOEs and grazing by livestock has allowed native invasive species such as Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and common snowberry (*Symphoricarpos albus* (L.) Blake) to encroach and impact on the Somenos GOEs, especially where soils are deep and there is ample moisture.

Photo 5. Snowberry encroaching in garry oak stank

6.1.4 Introduced Invertebrates

A number of exotic introduced species occur at Somenos that have become, or may become, a management problem and may impact detrimentally upon species at risk. The Cabbage White butterfly (*Pieris rap*ae) was introduced in the mid 1800's and is believed to have eliminated larval foodplants of some native butterflies. European skipper (*Thymelicus lineola*) has also arrived on the island, although to date it has only been found associated with hay fields. Other introduced invertebrates likely to occur at Somenos include many species of earthworms, slugs and snails. A number of the introduced invertebrates impact directly and visibly upon the Garry oak trees. For example, the winter moth infested oaks in the early 1980's, and more recently the tiny jumping gall wasp (*Neuroterus saltatorius*) and a tiny aphid-like phylloxeran (*Phylloxera nr. glabra*) have affected the oaks. Management of these invertebrates is not specifically considered in this restoration plan, but may well become important in future restoration efforts, as more is learned about their effects and management.

6.1.5 Introduced Vertebrates

A wide array of introduced, often invasive, vertebrates occurs at Somenos. In many cases, adequate control, once a species has gained a foothold, is likely to be difficult and expensive; or effectively impossible, as incursions from outside the Restoration Plan area are inevitable. This includes, for example, grey (black variety) squirrel and eastern cottontail in the uplands; American bullfrog and Green Frog in the wetlands, birds such as the European Starling and House Sparrow, and many others.

List of Introduced Amphibians and Reptiles:

- Painted Turtle (origin in the area is uncertain)
- American Bullfrog
- Green Frog

The American Bullfrog is a voracious predator of great concern, and is believed to have a major impact on native amphibians. The Green Frog, abundant at Somenos, may also impact native amphibians although it is of lower concern than the bullfrog.

List of Introduced Birds:

- Barred Owl
- European Starling
- House Sparrow

- House Finch
- Brown-headed Cowbird
- Ring-necked pheasant
- California Quail
- Rock Dove
- Skylark

The highly urban and agricultural nature of the area has resulted in a relatively hostile landscape for many native birds, even where habitat is suitable. Several non-native bird pest species (have successfully established themselves and have almost certainly negatively impacted upon native bird species in the area. Some of the worst offenders are birds such as the European starling (*Sturnus vulgaris*) and house sparrow (*Passer domesticus*). These species will occupy cavities, including nest boxes, and often out-compete many native cavity-nesting species. The starling is a major pest in agricultural areas and thrives in open habitats. The house sparrow thrives in suburban and urban environments, and is thought to be a significant competitor with native birds for food and nest sites at low elevations. The house finch also favors backyards and bird feeders, and prefers to nest in ornamental trees.

No quantification of impacts of invasive species, such as house sparrows, on native birds is readily available. The house sparrow, for example, is often cited as a key cause of the decline of western bluebirds (and also of the purple martin), but data is difficult to locate.

Some of the native species that may benefit from the urbanization of the general area, and that may in turn impact on other native birds, include gulls, crows, and possibly pigeons. There may also be relatively high numbers of seed-eaters such as white-crowned sparrows and dark-eyed juncos.

Additionally, agricultural lands in the vicinity have provided suitable habitat for an introduced brood parasite, the Brown-headed Cowbird (*Molothrus ater)*. It lays its eggs in other birds nests, displacing the natural young so the parent raises the cowbird's chicks. This species will also use nest boxes readily. Introduced cowbirds are present at Somenos, and presumably impact on the native fauna through brood parasitism. Starlings also thrive around the site, and will aggressively take over natural and man-made cavities and prevent many native cavity-nesters from breeding.

List of Introduced Mammals:

- Eastern Grey Squirrel (including black variety)
- Eastern Cottontail
- Norway Rat
- Black Rat
- House Mouse

Noteworthy invasive and introduced mammals at Somenos include the Eastern Cottontail and the Eastern Gray Squirrel. Eastern Cottontail moved into B.C. around 1950 and to Vancouver Island in 1964 or 1965. It has spread throughout the southern part of the island, thriving in suburban areas with lawns. It is already very common on site and can be expected to continue to be so in the absence of targeted control programs. It provides an excellent food source for many raptors (eagles, hawks, owls).

Although European Rabbits (*Oryctolagus cunicululs*) or domestic rabbits are often released and establish feral populations (e.g., in vicinity of Victoria Hospital and Malaspina College in Nanaimo), they do not appear to be in residence in the Somenos area at this time. They can threaten native vegetation. Burrowing can also be a problem. They are included on the CWS database list as one of the "Worlds 100 Worst" invasive species (Keddy 1999, cited in Polster Environmental Service 2002).

The Grey Squirrel is thought to have arrived on Vancouver Island in 1966. Larger than the native red squirrel, it thrives in disturbed, inhabited areas on the southern island and prefers hardwoods that produce seeds (such as Garry oaks, or many planted ornamentals). It will breed in tree cavities, but also in nest boxes erected for larger birds such as owls or ducks. Grey squirrels are thought to have a serious impact on the native Red Squirrel, as well as impacting on many bird species through egg and nestling predation. They are also on the "Worlds 100 Worst" list of invasive species. Unfortunately, Grey Squirrels already commonly occur in our Garry oak areas, and will likely increase further. They are abundant at Somenos, and in addition to impacting on wildlife populations, they may impact on Garry oak regeneration, as well as possibly on the health of the trees. On sunny days, numerous Grey Squirrels can be observed within the Garry oak areas in particular. They appear to use the adjacent conifers for cover, as well as occasional logs and stumps among dense patches of snowberry (G. Radcliffe *pers. obs.*).

6.1.6 Native Invasive Wildlife Species

In addition to introduced animals, many native species have likely benefited from development of the area, and these may have expanded/benefited at the expense of some of the more sensitive faunal species. While not necessarily "invasive", species like raccoons and mink are good examples of highly adaptable local species. Mink are relatively common in the area and have been observed adjacent to the marsh and in the near vicinity on a number of occasions. Any increase in their numbers could result in increased predation pressures on small songbirds within the GOE. However, it is unknown what their baseline populations are like as there has been no direct inventory. No raccoon sign was observed on site but they are likely present.

Some native raptors may also have benefited from adjacent developments. For example, Coopers' hawks often predate small birds attracted to bird feeders in suburban habitats. Barred owl may also have increased in the general area. This species predates smaller owls and could thus lead to declines in other species, such as the blue-listed subspecies of western screech owl, as well as northern pygmy owl or northern saw-whet owl, all of which might occur in the general vicinity. No specific surveys have been completed.

6.2 Existing Habitat Conditions and Issues

The Somenos Marsh Management plan identifies the key management issues for wildlife relate to possible declines in biodiversity due to increased human related impacts, and to maintenance of the high waterfowl values, especially for Trumpeter Swans and Great Blue Herons. Management for these latter species hinges more on other zones (i.e. less on the focus of this project, zone 4).

Somenos Lake, the fields, and the forests around it provide valuable habitat for many species of birds. In particular, they provide valuable feeding and roosting sites for wintering waterfowl. As areas around become more developed and habitat availability and diversity is reduced, the significance of the marsh area for a variety of species further increases. Some key issues (in addition to invasive species) affecting wildlife diversity at Somenos are discussed below in more detail.

6.2.1 Loss of Wildlife Tree and Coarse Woody Debris

Due to continued urban expansion, there will be a potential decline in bird populations in the Cowichan Valley due to loss of nesting, perching and roosting habitats.

The upland forest adjacent to the lake is also critical for providing nesting, perching and roosting for many bird species including a number of birds of prey that feed over the lake and wetlands, and likely roosting habitat for a number of bat species. Large wildlife trees and coarse woody debris (CWD) in particular are extremely important components of the forest and woodland ecosystems. Any reduction in large wildlife trees, snags, and coarse woody debris within and adjacent to GOE's (e.g. through clearing, windthrow, and gradual reductions without future replacement) can potentially result in declines in species that depend upon these elements of the environment. This includes many species, but particularly cavity nesting birds, both primary cavity nesters and secondary cavity nesters common in the area, as well as bats and a large number of invertebrates.

Photo 6. Course woody debris is a key habitat element

Impacts on these species can occur both through loss of potential nesting sites and through reduced food availability (e.g. snags and CWD provide abundant invertebrate foods for species such as the pileated woodpecker). In addition, large birds that depend upon the larger structure wildlife trees, such as eagles, large owls, hawks, or herons could loose perching, roosting, and/or nesting sites, and use of the area by these species could therefore theoretically be reduced. A number of mammals and many invertebrates also

utilize snags and CWD, and these species can be similarly affected by any reduction in these habitat elements.

6.2.2 Edge Effects

Edge effects within such a small site probably pervade through most of the site. There is no data to indicate the levels, for example of competition or predation from native and non-native species favored by edges (e.g. cowbirds) with or upon many small nesting birds in the Somenos area. For example, crows, seagulls, and eagles are opportunists that may access nests better along an exposed perimeter, and nesting success near edges is thus often greatly reduced for many small songbirds. Trails only extend these edge effects further into the remaining natural stands.

Increased light levels inside the forest, along the perimeter of GOE's surrounded by urban environments, may have locally altered microclimates and habitats. This may affect animal behavior, e.g., by attracting many night-flying insects and in turn predators, such as bats, to the area. The extent of these effects is unknown, but lighting within the property is unlikely to be substantial as it is buffered from the adjacent housing developments to some degree by coniferous forest. The Garry oak area to the south of zone 4 (outside management plan area) is probably more affected.

Pesticides, herbicides and even biological control agents can drastically reduce populations of non-target species; special care must therefore be used in their application. Recent research on the effects of *Bacillus thuriengiensis* (Bt) has indicated that there may be drastic effects, especially of *Btk*, on the larval populations of butterflies and moths with implications for many years (Guppy, 2001). Avoiding the use of chemicals altogether is likely the safest practice. However, it is recognized that at times some very careful use (e.g. of herbicides to control an invasive exotic weed) may result in benefits to other Species at Risk. In this case, professional advice and a very careful weighing of the pros and cons of the different options is needed.

6.2.3 Disturbance of Wildlife

Animals are directly disturbed by human presence. Generally, this is unintentional, although deliberate harassment can occur. Repeated disturbance of many species can for example exclude them from important feeding or resting sites, can cause them to relocate, may result in reduced reproductive success, and can even directly lead to death of individuals. Trampling can also destroy butterfly eggs and larvae, and nests and eggs of ground nesting birds in particular. In addition, it can result in death or in reduced

vigor of many plants, and can alter successional patterns. This in turn further affects the habitats available to ground nesting or low shrub nesting birds, to butterflies, and other wildlife.

Increased residential development adjacent to the marsh, as well as a general human population increase in the area, has resulted in greatly increased use of portions of the site in recent years. Recreational activities such as mountain biking, dirt biking, hiking (and possibly boating) appear to have increased.

Photo 7. Dirt bike jumps inside fenced area

6.2.4 Domestic animals

Disturbance is not only by people of course, but by their pets. Disturbance by domestic grazing animals is unlikely at this site, thanks to the fencing. However, domestic cats and dogs do utilize the study area, and the impacts of these domestic pets on wildlife in the area may be serious. They are likely to be highly significant in such a small area, located as it is within range of numerous residential dwellings where cats and dogs are kept. Dogs will chase and harass wildlife straying outside of the natural area boundaries, and may well pursue and kill wildlife within their natural habitats. While many people do keep their dogs leashed within the area, some do not, and free-running dogs were observed roaming all over the area on a number of occasions during fieldwork

Cats can have a significant impact on small bird and small mammal populations. Domestic cats have been implicated in the extinction of a number of species elsewhere and their presence is especially serious where SAR are present. There is also the possibility of the establishment of feral cat populations.

7.0 RESTORATION PLAN BACKGROUND

7.1 Introduction

The ecological values associated with the Somenos Garry Oak ecosystem (GOE) and the associated ecosystems have been significantly compromised due to urban encroachment and introduced species, and will be lost altogether if active management is not undertaken to restore the ecosystem and to maintain the restored communities. Restoration is viewed as one of the most effective means protecting the remaining species at risk and providing habitat for the re-establishment of those that have been extirpated. However, the small size of the area and the presence of many invasive species renders intensive, ongoing management essential if there is to be any hope of maintaining the natural ecosystems in the long-term.

7.1.1 Restoration Goals

Restoration goals are aimed at re-establishing the pre-contact ecosystems that existed on this site. Of course detailed information about the pre-contact ecosystems is lacking and reliance must be placed on a theoretical reconstruction of these ecosystems from the TEM mapping of this site and from assessments of other sites. In this regard, a number of reference ecosystems (see 7.1.2 below) have been reviewed to provide further information. In addition to the goal of re-establishing the pre-contact ecosystems, this restoration plan seeks to identify and plan for the re-integration of ecosystem elements that served to maintain the pre-contact ecosystems. Fire and the harvest of camas bulbs are believed to have been the two major disturbance elements associated with these ecosystems. Re-establishment of these elements will be critical to the success of the restoration program.

The goal of maintaining a high natural diversity of wildlife species that use the Garry oak and associated ecosystems within the highly fragmented landscape within which they exist, brings a whole suite of additional problems beyond those for vegetation. Wildlife is in general highly mobile. Except for some of the smaller invertebrates, few species live out their entire lives within the confines of a given ecosystem unit or patch such as Somenos. Some animals may depend upon the Garry oak areas at Somenos for feeding, for nesting, for resting, for courting, or for a secure refuge, but they also use many other habitats at certain times and/or for certain activities. For example, peregrine falcons have

often been observed perching in the forest stands, but predate birds mainly over the open marsh, and the nearby sewage lagoons, and nest on cliffs at Mt. Tzuhalem, Mt. Prevost and similar sites. Restoration of the vegetation therefore, does not guarantee recovery or persistence of natural wildlife populations, and additional management measures may need to be considered. However, because of the very small size of the area, many of the factors influencing the wildlife populations are beyond the direct control of the managing agency. Many of the issues need to be dealt with at the landscape, regional, national and even international levels. (e.g. declines in migratory songbirds due to impacts on wintering areas).

Reference Ecosystems

Other naturally occurring Garry oak ecosystems can help provide insights into vegetation pathways and species composition. Thus reference ecosystems such as occur at Eagle Heights, Mount Tzouhalem and on the Cowichan Garry Oak Preserve can be used to assist in determining the pathway that the Somenos GOEs might follow in returning to a pre-contact state.

Reference ecosystems are used to define parameters for the ecosystems being restored where those features have been damaged, degraded or destroyed. There are no pristine Garry oak ecosystems like the Somenos Garry oak stand currently in existence. Therefore, reference ecosystems must be derived from similar ecosystems that remain, either in whole or in part. Appendix C includes descriptions of three local ecosystems that provide information that can be applied to the restoration of the Somenos GOEs.

Plan Organization

This restoration plan is organized to provide a description of the restoration strategy and framework for the Somenos GOEs. The following sections provide detailed prescriptions and recommendations for dealing with the three major impediments to proper ecosystem function and the pathway to recovery. Invasive species, both alien and native, pose the second largest threat to GOEs after land alienation (urban and agricultural encroachment). The cessation of aboriginal burning and camas harvest has had a profound effect on the Somenos GOEs as well as other GOEs on the east coast of Vancouver Island. The loss of some significant species, notably key grass species has altered the characteristics of the Somenos GOEs in terms of the ability of these ecosystems to be brought back to the natural ecological pathway (trajectory) that they were on in pre-contact times. Restoration of the vegetation in the study area does not

therefore guarantee the recovery or persistence of the natural wildlife populations, and additional management measures also need to be considered.

For wildlife, a number of key issues need to be addressed in the restoration plan:

a) Simplification of habitats through reduction of spatial and structural diversity
b) Impacts by invasive, introduced species (through predation, competition). Declines in migratory songbird populations due to influences elsewhere. This is an International issue, beyond the scope of this plan.
c) Displacement and other disturbance effects from human and pet activities.

The key restoration elements are discussed under the following main subject areas;

- invasive species management;
- re-integration of disturbance regimes;
- re-establishment of a suitable species complement;
- wildlife management and habitat enhancements

The plans rely on the TEM mapping and description of the historical as well as the current ecosystems existing on the site to provide the foundation for the restoration plans. In all cases, the management treatments must be sensitive to the presence and maintenance of species at risk. The plans will therefore present suggestions for ecosystem maintenance and a recommended program of monitoring to determine if the ecosystems are responding as expected and if the results that are being achieved.

8.0 RESTORATION PLAN

Strategies for dealing with invasive species are the first step in restoration of the Somenos GOEs and are presented in the following sections.

8.1 Invasive Plant Species Treatments

The most effective means of dealing with invasive species in GOEs are outlined in the GOERT (2003) manual and will not be repeated here. This manual may be obtained from GOERT and the detailed annotated bibliographies that were produced in association with the manual are available on line at www.goert.ca in the References section.

Major alien invasive woody species removal work has been undertaken at the Somenos GOEs over the past few years. See photo 4 of cut and piled broom. However, continued treatments designed to control invasive species will be required in almost all polygons. In particular, outliers of invasive species such as holly and daphne that appear in undisturbed forests should be dealt with promptly.

In the more open Garry oak and mixed Douglas-fir / Garry oak communities, invasive species management will need to include treatments such as cutting and biomass removal for alien invasives and culling for small Douglas-fir that threaten to establish. Douglas-fir trees over 50 cm dbh can be retained to grow into old growth character trees as long as these do not form a closed canopy. Where Douglas-fir has developed a closed canopy, enough of the trees should be removed to return the polygon to an open Garry oak dominated community.

Snowberry (*Symphoricarpos albus* (L.) Blake) in growth will need to be managed through mowing and fire following an adaptive management approach as discussed above. Treatments in polygons 21, 23, 24, 25, 27 and 28 could be used to define the most appropriate management techniques for return of this area to a pre-contact condition. Maintaining a control area that is left untreated could be compared to areas that were mown and burned in various combinations. Three treatments are suggested; mowing; mowing and burning once (early July) in 2003; and mowing and burning twice in 2003 (early July and mid September). MacDougall (2002b) suggests that destabilization of alien invasive grass swards coupled with re-introduction of native species could be an effective means of treating impacted GOEs. Burning treatments are discussed in greater detail in sections 8.3 and 8.4.1. Mowing will be used to reduce the

height of the snowberry so that it does not act as a ladder fuel during subsequent burning.

8.1.1 Alien Invasive Woody Species

The most effective strategy for dealing with alien invasive woody species, or any invasive species for that matter is to work from the areas of least concentration towards centres of greatest concentration, taking care to avoid leaving uncontained patches (Murray and Jones, 2002). Monitoring is required to ensure these do not re-establish.

8.1.2 Alien Invasive Herbaceous / Graminoid Species

Strategies that can be used to control the invasive grasses such as restoring burning to these ecosystems (A. MacDougall *pers. comm*. 2002a) may be effective in the management of invasive forbs. Monitoring following operational treatments will serve to identify those treatments that are effective in the management of alien invasive herbaceous and graminoid species.

8.1.3 Native Invasive Species

Restoring fire as a disturbance regime is thought to be the most effective means of preventing further encroachment while removal can be used to address sites where these species have already established. Girdling some of the Douglas-fir and allowing the standing snags to remain on the site may help encourage the return of woodpeckers and cavity nesting birds. Treatment of encroaching common snowberry may entail cutting and subsequent burning although the response of this species to these treatments is not entirely known. Re-sprouting from underground plant parts may be a problem with this species. Table 13 indicates polygons where snowberry management is a priority; all of these polygons are candidates for snowberry removal.

Table 13. Polygons with high cover (> 25 %) of snowberry (*Symphoricarpos albus*).

Polygon number	GOERT Label	Comment
12	MC-Qg	
18	MW-QgFd	Open nature of polygon encourages snowberry
20	MW-QgFd	Open nature of polygon encourages snowberry
21	BW-Qg	Almost total cover of snowberry (90%)
23	BW-Qg	Almost total cover of snowberry (90%)
27	BF-Qg	
33	MC-Qg	
34	BF-Qg	
35	BF-Qg	

8.2 Invasive Wildlife Species Management

Invasion by non-native wildlife species must be minimized. The maintenance of healthy populations of indigenous fauna is both a goal and a key, discouraging invasive species from establishing. Active population management for introduced invasive wildlife species should be implemented. This could include for example shooting to remove gray squirrels, efforts to exterminate American bullfrogs, and egg addling for Canada geese.

Possible management options include physical exclusion of pest species, direct removal by various means (trapping, shooting etc.), and indirect controls such as reducing breeding success of pest species (e.g. egg addling). Every effort should be made to eliminate the most damaging species, such as American bullfrog. Some species, such as European starling, are likely to be almost impossible to adequately control. However, their impacts upon native birds can be reduced to some degree through e.g. provision of nest cavities that favor native species but eliminate starling use. Habitat enhancements that may favor the non-native species over native species should be avoided (e.g. ensure nestboxes for swallows and small passerines are unsuitable for starlings).

Gray squirrels should be a high priority for management. Invasive non-native wildlife species are however often very difficult to control due to public perceptions and the mobility of the animals. Trapping and removal is apparently being tried at Cowichan Garry Oak

Preserve, and could be implemented at Somenos. It would also be worth considering bird control of Grey Squirrels at Somenos, using raptors to control the squirrels (in fall or winter). This may or may not be more effective than trapping, or may be worth an effort in conjunction with trapping. Trials to establish the most efficient and cost effective approaches should be conducted. Immigration from the surrounding areas is however likely to be an ongoing problem.

A resident population of Canada Geese, introduced to the Cowichan Valley, is considered a pest species causing considerable damage to agricultural crops. A resident Canada Goose management plan has been proposed (Williams and Radcliffe 2000) but is beyond the scope of this restoration plan. The Canadian Wildlife Service manages populations in the area through an egg addling program. However, future action may be required to limit impacts of this species on lakeshore vegetation and on other waterfowl.

Beavers can hamper restoration projects, e.g. by cutting down planted trees and shrubs (e.g in Bings Creek). In the past, relatively regular trapping of beavers has occurred at Somenos. Beaver damage will be a maintenance issue that needs to be continually monitored. However, the species is an extremely important, integral part of the functional ecosystems.

In the past, muskrats have also been trapped in the area to control their numbers. However, they do not appear to be abundant in the study area. Mink that occur around the marsh however may have a significant impact on nesting birds. They are however, a part of the natural fauna, and their impact is likely a lesser issue that the impact of domestic cats and dogs on local songbird and waterfowl populations.

Public education is critical in ensuring the success of any restoration efforts. The public needs to be aware of the dangers and problems of invasive wildlife. This will help reduce future introductions or releases (e.g. tadpoles, turtles), and will help to garner support for any necessary invasive wildlife control programs. Research on the impacts of invasive species should also be encouraged, and baseline information – e.g. quantification of indigenous fauna (seasonally) and invasive fauna would be helpful in establishing management goals.

8.3 Re-integration of Disturbance Regimes

Fire was an important ingredient in the formation of the pre-contact Somenos GOE's. Fire was used by First Nations people in the cultivation of camas, a staple food (Boyd

1999). Burning was probably undertaken in the summer after the spring harvest of the camas (Beckwith 2002). In addition to burning, "cultivation" caused by harvesting the camas was probably instrumental in shaping the pre-contact GOEs. Once camas stands have been re-established to the point where they can sustain some level of harvest, providing camas harvesting as part of the restoration work will be considered. As the restoration of the Somenos GOEs proceeds the involvement of the Cowichan Tribes would be a desirable part of the ongoing management of the Somenos GOEs.

Pre-contact burning did not have to contend with the extensive alien invasive flora that now exists in most GOEs. Therefore, re-establishment of fire in the Somenos GOEs will need to be conducted carefully to determine the effects of burning on exotic and native species. Treatments suggested for the Somenos GOEs (polygons 21, 23, 24, 25, 27 and 28) will include a mown plot that is burned once and a mown plot that is burned twice. Traditionally burning was conducted after the camas harvest, in early July. At this time most young birds have fledged and left their nests, so this timing minimizes potential impacts in this respect. The first burning should thus be conducted in early July, depending on the weather conditions at the time of burning. The second burning will need to be delayed until there is sufficient biomass to sustain a fire. Mid to late September is believed to be the period when the second burning can be most effective.

The use of fire in ecological restoration raises concerns with those living near by. A program of information dissemination will be needed to advise residents of plans for burning in the Somenos GOEs. In addition, the cooperation of local fire departments (North Cowichan and Duncan) will be needed to conduct any ecosystem burning in a safe and effective manner. The assistance of the Ministry of Forests initial attack base at Cobble Hill has been sought and obtained for any burning that might be undertaken. The initial attack group has all of the equipment needed to make any ecosystem burning a safe and controlled event.

8.4 Repatriation of Key Native Species

8.4.1 Garry Oak Ecosystems

Many of the key native species, particularly grasses, which once occupied the Somenos GOEs, have been lost due to grazing livestock; the exclusion of fire, and the invasion by alien species. Re-introduction of some of the more important of these is thought to be a useful addition to the restoration of the Somenos GOEs. California brome, California oatgrass, blue wildrye and Roemer's fescue are recommended as the key grasses that should be used for restoration of the Somenos GOEs. In addition, planting yellow

montane violet (*Viola praemorsa* Dougl. *ex* Lindl. ssp. *praemorsa*), a rare species that has a major population centre at Somenos, will provide an opportunity to explore techniques for re-establishment of Species at Risk (SAR).

MacDougall (2002b) suggests that repatriation of native species can help to reduce the effects of the heavy exotic species cover. Treatments where burning is being applied should be further divided so that half of each treatment can be planted with plugs of native grasses (California brome (*Bromus carcinatus* Hook. & Arn.), California oatgrass (*Danthonia californica* Boland), blue wildrye (*Elymus glaucous* Buckl.) and Roemer's fescue (*Festuca idahoensis* Elmer ssp. *roemeri* (Pavl.) Aiken) and the yellow montane violet. Seeds of these species should be collected as early in the year as possible so that viable plugs can be grown. About 4 months will be needed to grow suitable plugs for planting. An estimated 30,000 plugs will be needed to plant the treatment areas at a density that will assist in resisting the exotic grasses. These plugs will be grown from seed collected at Somenos if possible otherwise from seed collected at other local GOEs. Planting work will need to be conducted in the fall once the fall rains start and the soils are moist.

8.4.2 Sitka Spruce Forest

Restoration work in polygons 1, 39 and 40 should be aimed at re-establishing the Sitka spruce (*Picea sitchensis* (Bong,Carr.) forest that appears to have once occupied the site. The most effective means of setting these polygons on the pathway that will eventually lead to a Sitka spruce forest is to provide a pioneering cover of cottonwood (*Populus balsamifera* L. subsp. *trichocarpa* (Torrey & Gray) Brayshaw) and red-osier dogwood (Cornus stolonifera Michx.). The cover of cottonwood and red-osier dogwood will provide shade that will kill the reed canarygrass. Once the reed canary grass is gone, Sitka spruce seedlings can be planted under the cottonwood.

Although it may take several centuries until the Sitka spruce forest matures, the successional pathway will be set with the planting of the cottonwood and red-osier dogwood. Both of these species can be established from cuttings. Large (10 to 20 cm in diameter and 3 to 4 m long) cottonwood cuttings are recommended to provide a competitive advantage for the cottonwood. These should be inserted into the substrate at least 1 m so that a good system of roots can develop. These trees will need to be wind firm as they will be the first objects struck by winds from the north across Somenos Lake. A post-hole auger can be used to dig the holes for the cottonwood posts. These should be spaced 2 m to 3 m apart. Once the cottonwood has been established for about

10 years, red-osier dogwood cuttings can be planted underneath. These should at least 2 cm in diameter at the tip and 1 m long and should be inserted at least 75 cm into the moist soil.

8.4.3 Repatriation of Wildlife Species

Maintaining healthy wildlife populations hinges heavily upon managing for healthy, natural vegetation communities. Thus implementation of the vegetation management program will go a long way to also managing for wildlife. For wildlife, even for species already extirpated, the emphasis should be on re-creating and maintaining structural niches – such as the open grasslands for species such as Vesper sparrow and Western meadowlark, together with concurrent control for invasive species. Unfortunately, there is little that can be done to manage for a number of animal species with large home ranges, especially the larger carnivores. Indeed, although bear and cougar would have once formed a part of the local ecology and landscape, they are unlikely to visit the GOE area today, as the landscape level habitat contiguity has been largely lost. And at this site, human safety considerations must outweigh purist restoration goals.

Re-introduction of already extirpated species, such as the Western Bluebird, or possibly some of the butterflies, is however a future possibility. Success would be contingent upon many factors, including many that are outside of the immediate area. Detailed, species by species programs would need to be developed. The possibility of re-establishing Western Bluebird populations is briefly discussed in section 8.6.4. However, wildlife management initially should focus upon the implementation of the general management measures described below (section 8.5) together with a few species-specific actions in section 8.6.

8.5 General Wildlife Management Measures

8.5.1 Control Invasive Species

This is discussed in section 8.2. It is also important to avoid land management practices that will further encourage invasive species to the site, or enhance their populations.

8.5.2 Minimize Disturbance

This involves control of domestic pets and recreational activities to avoid disturbance, especially during the breeding season. Disturbance impacts along trails can often be minimized by ensuring that sensitive sites are avoided, by leaving

vegetative buffers around any potentially important wildlife use areas, and by ensuring dogs are leashed at all times, or by excluding them altogether. In this small area, the options for buffering however are extremely limited. No new trails should be established here – there are already a lot for this small area. Adequate visual buffering of sensitive areas (especially winter-feeding, roosting areas, and summer breeding areas), and establishing some areas as off-limits for human use at certain times, are appropriate management measures.

8.5.3

8.5.4 Maintain or Enhance Structure for cavity nesters, raptors, bats, and invertebrates

This includes provision of sufficient large wildlife trees, snags and CWD. Maintain large conifer and deciduous trees; many large old oaks have large, dead limbs that provide ideal nesting. For raptors and many cavity nesters, provision of more perching, nesting and roosting structures are suggested, through improved upland forest and woodland habitat, together with a nestbox program in the interim.

A nest box program can be considered to provide nesting sites for many small native birds, and is especially beneficial where the availability of natural cavities is already limited. However, considerable care is required in the design and siting of nestboxes to ensure they do not simply boost the populations of invasive exotics like the starling and house sparrow. It is suggested that a trial program be developed in which boxes are located in the area, but are carefully monitored. If a nest box program is implemented, then concurrent management of the grey squirrel population is imperative.

Plant trees and plan to provide for some future wildlife trees and snags to replace losses over time, for adequate perching, roosting and nesting sites; identify future candidate wildlife trees, including adequate large conifers.

8.5.5 Protect all riparian areas; implement riparian plantings where applicable

Riparian habitats are a cornerstone in managing for biodiversity. Riparian areas at Somenos should be fully protected, and tree and shrub planting to improve riparian conditions should be considered where applicable. Buffering riparian

areas from any future developments and disturbances, including walking trails, should be a priority.

8.5.6 Maintain Spatial Diversity of habitat types

This includes managing for sufficient proportions, or patches, of open grasslands, meadows and oak woodlands across the site, as well as shrub dominated areas, and coniferous forests. Prevent succession of grasslands to brush, including broom (see vegetation management).

8.5.7 Maintain food and nectar supplies for butterflies and other invertebrates

Again, implementation of appropriate vegetation management, which will restore the wildflower meadows, should go a long way to restoring larval habitats and adult nectar supplies at this site. However, in addition, the provision of specific nectar sources and larval foodplants for butterflies in the residential areas nearby should be encouraged (see next section). Replacement of traditional garden areas, or restoration of difficult to manage, degraded sites with butterfly gardens targeting use of native plants for native butterflies, would be an appropriate use of adjacent land that could also help to attract and support species that also use the Garry oak ecosystems. Maintenance of natural leaf litter layers, even in groomed garden areas at the base of oak trees on lawns, can help to provide for overwintering larvae and pupae

8.5.8 Educate the pubic and liaise with neighboring landowners

Educate visitors and neighbors about GOE's, the need to respect the boundaries and the special values on this land, and the reasons for maintaining as much of a buffer as possible. Encourage local residents and site neighbours to practice environmentally friendly gardening techniques, to plant native tree buffers within their properties, and to garden for native wildlife species. Also, inform residents about the need for control of pets, about the impacts of invasive species, and the need for control programs.

Species at Risk Management Measures

Rare and Threatened Butterflies and Dragonflies

Manage the area to maintain larval foodplant populations and nectar sources for butterflies, and plant or enhance larval food species and nectar sources (including

e.g. camas) where appropriate. This may even include managing to maintain non-native plants (for example, ribwort plantain is a key food source for Edith's checkerspot), although provision of sufficient native foodplants is preferable. Avoid use of chemicals, including pesticides such as Bt. Manage to minimize populations of competitors, e.g. cabbage white, in nearby areas such as surrounding residential areas. Minimize trampling by people and pets. Establish population targets and species specific plans for the red and blue listed species, i.e. red-listed Common Ringlet, and blue-listed Propertius Duskywings. At a later stage, the possibilities of re-introducing extirpated species should also be reviewed.

8.5.9 Great Blue Heron

Protect Great Blue Heron feeding and roosting areas along the east side of the lake, by maintaining a good vegetated visual barrier between trails and the shallows where they feed, and by maintaining all the larger conifers along the east side. Also need to ensure a future supply of perching/roosting trees here. Minimize human disturbance by keeping trails well back from the lakeshore.

8.5.10 Peregrine Falcon

Manage wetlands/marsh areas for production of ducks, as these are the dietary mainstay (along with other birds). Protecting duck nesting areas from disturbance will contribute. It is also essential to maintain large coniferous perching trees around the lake and marsh margins.

8.5.11 Western Bluebird

While it may be desirable to encourage re-introduction of western bluebird to the area, the limited areal extent of the GOE here would make this unlikely to succeed in isolation. This needs to be addressed at a broader level (e.g as a supporting site in context of planning for Mt. Maxwell, Mt. Tuam, Mt. Tzuhalem, Cowichan Garry Oak Preserve)

Conduct some baseline inventory studies on the wildlife, with specific attention to species at risk and invasive species. Quantify seasonal populations of native fauna and invasive species. Thus for example breeding bird surveys and amphibian surveys should be conducted to establish baselines for future monitoring. Set population targets for species of specific management interest, including maximum acceptable

populations/densities for invasive species, and minimum population targets for species at risk.

Restoration Plans for 2003 And Beyond

Restoration work in the Somenos GOEs will focus on two major treatments; removal of invasive species; and re-establishment of pre-contact disturbance regimes. The detailed plans for these during the 2003 season are presented in the following sections. Plans for all of the TEM units within the Somenos GOEs are summarized in Table 14. The use of the term camas in this table implies the myriad of herbaceous species that inhabit GOEs. The plans entail three major treatments as discussed below.

Table 14. Summary of Short Term Restoration Plans

Polygon Number	TEM Unit	Ecosystem Unit	Restoration Plans
1	RC	Western redcedar – Skunk Cabbage	Control reed canarygrass by establishment of cottonwood / red-osier dogwood community.
2	RU	Disturbed (former Boatland parking lot)	Encourage establishment of cottonwood / red-osier dogwood community.
3	DG	Shrub dominated	Control invasives (English hawthorn), allow natural succession to proceed.
4	DG	Conifer forest Douglas-fir & grand fir	Control invasives (daphne & holly) allow natural successional change.
5	DG	Open grass community	Control invasives (broom), re-establish fire, encourage camas growth & harvest.
6	DG	Open grass community	Control invasives (broom), re-establish fire, encourage camas growth & harvest.

Table 14 (cont'd). Summary of Short Term Restoration Plans

Polygon Number	TEM Unit	Ecosystem Unit	Restoration Plans
7	DG	Open grass community with ephemeral stream	Control invasives (English hawthorn, broom & orchardgrass), re-establish fire, encourage riparian shrubs.
8	DG	Mixed shrubland	Control invasives (English hawthorn, daphne, blackberry) allow natural successional progress.
9	GB	Garry oak woodland	Control invasives (broom, snowberry, Douglas-fir, orchardgrass, etc.), re-establish fire, encourage camas growth and eventual harvest.
10	GB	Garry oak woodland	Control invasives (broom, snowberry, Douglas-fir, orchardgrass, etc.), re-establish fire, encourage camas growth and eventual harvest.
11	GB	Garry oak woodland	Control invasives (broom, snowberry, Douglas-fir, orchardgrass, etc.), re-establish fire, encourage camas growth and eventual harvest.
12	DG	Mixed Douglas-fir / Garry oak forest	Cull Douglas-fir under 50 cm dbh, control invasives, re-establish low intensity ground fires, encourage camas growth and harvest.
13	DG	Mixed Douglas-fir / Garry oak forest	Cull Douglas-fir under 50 cm dbh, control invasives, re-establish low intensity ground fires, encourage camas growth and harvest.
14	DG	Mixed shrubland	Control invasives (English hawthorn, daphne, blackberry) allow natural successional progress.
15	DG	Mixed Douglas-fir / Garry oak forest	Cull Douglas-fir under 50 cm dbh, control invasives, re-establish low intensity ground fires, encourage camas growth and harvest.
16	DG	Mixed Douglas-fir / Garry oak forest	Cull Douglas-fir under 50 cm dbh, control invasives, re-establish low intensity ground fires, encourage camas growth and harvest.
17	GC	Open grass community	Control invasives (broom), re-establish fire, encourage camas growth & harvest.
18	DG	Mixed woodland of Douglas-fir / Garry oak	Cull Douglas-fir under 50 cm dbh, control invasives, re-establish low intensity ground fires, encourage camas growth and harvest.

Table 14 (cont'd). Summary of Short Term Restoration Plans

Polygon Number	TEM Unit	Ecosystem Unit	Restoration Plans
19	DG	Mixed shrubland	Control invasives, re-establish fire, encourage camas and eventual harvest.
20	DG	Mixed woodland of Douglas-fir / Garry oak	Cull Douglas-fir under 50 cm dbh, control invasives, re-establish low intensity ground fires, encourage camas growth and harvest.
21	GB	Garry oak woodland	Control invasives (broom, snowberry, Douglas-fir, orchardgrass, etc.), re-establish fire, encourage camas growth and eventual harvest.
22	GB	Mixed shrubland	Control invasives, including snowberry, re-establish fire, encourage camas and eventual harvest.
23	GB	Garry oak woodland	Control invasives (broom, snowberry, Douglas-fir, orchardgrass, etc.), re-establish fire, encourage camas growth and eventual harvest.
24	GB	Garry oak woodland	Control invasives (broom, snowberry, Douglas-fir, orchardgrass, etc.), re-establish fire, encourage camas growth and eventual harvest.
25	GB	Garry oak woodland	Control invasives (broom, snowberry, Douglas-fir, orchardgrass, etc.), re-establish fire, encourage camas growth and eventual harvest.
26	DG	Mixed woodland of Douglas-fir / Garry oak	Cull Douglas-fir under 50 cm dbh, control invasives, re-establish low intensity ground fires, encourage camas growth and harvest.
27	GB	Garry oak woodland	Control invasives (broom, snowberry, Douglas-fir, orchardgrass, etc.), re-establish fire, encourage camas growth and eventual harvest.
28	GB	Garry oak woodland	Control invasives, re-establish fire, encourage camas growth and eventual harvest.
29	DG	Broom shrubland	Remove broom and other invasives, re-establish fire, encourage camas and eventual harvest.
30	RF	Riparian forest	Control invasives (English hawthorn, broom, daphne), re-establish low intensity ground fires, take care of species at risk in this polygon.

Table 14 (cont'd). Summary of Short Term Restoration Plans

Polygon Number	TEM Unit	Ecosystem Unit	Restoration Plans
31	DG	Mixed woodland of Douglas-fir / Garry oak	Cull Douglas-fir under 50 cm dbh, control invasives, re-establish low intensity ground fires, encourage camas growth and harvest.
32	DG	Conifer forest Douglas-fir & grand fir	Control invasives (daphne & holly) allow natural successional change.
33	DG	Mixed woodland of Douglas-fir / Garry oak	Cull Douglas-fir under 50 cm dbh, removed Douglas-fir around remnant Garry oak, control invasives, re-establish low intensity ground fires, encourage camas growth and harvest.
34	GB	Garry oak woodland	Control invasives (broom, snowberry, Douglas-fir, orchardgrass, etc.), re-establish fire, encourage camas growth and eventual harvest.
35	GB	Garry oak woodland	Control invasives (broom, snowberry, Douglas-fir, orchardgrass, etc.), re-establish fire, encourage camas growth and eventual harvest.
36	FC	Festuca / Camas grassland	Control invasives (broom, orchardgrass, etc.), re-establish fire, encourage camas and eventual harvest.
37	FC	Festuca / Camas grassland	Control invasives (broom, orchardgrass, etc.), re-establish fire, encourage camas and eventual harvest.
38	DG	Mixed woodland of Douglas-fir / Garry oak	Cull Douglas-fir under 50 cm dbh, removed Douglas-fir around remnant Garry oak, control invasives, re-establish low intensity ground fires, encourage camas growth and harvest.
39	RC	Western redcedar – Skunk Cabbage	Control reed canarygrass by encouraging cottonwood / red-osier dogwood community, allow eventual succession to Sitka spruce.
40	RC	Western redcedar – Skunk Cabbage	Control reed canarygrass by establishment of cottonwood / red-osier dogwood community.
41	WS	Wetland shrubs	Consider blackberry control and replacement with hardhack.

Ecosystem Maintenance

Garry oak ecosystems will not perpetuate themselves in the absence of some form of maintenance. The proliferation of invasive species, both alien and native, will out-compete the GOEs and will eventually result in the loss of these ecosystems on the landscape. In pre-contact times, landscape burning and camas harvest served to maintain the beautiful open savannahs that greeted Douglas when he first came to southern Vancouver Island (Boyd 1999). The aim of the restoration work that is proposed here is to reach an ecological state where burning and camas harvest once again maintains these ecosystems in the desired state. Some measure of invasive species management will be needed to ensure that alien and/or native species do not again occupy the Somenos GOEs. It is expected that invasive species management for plants and animals will be an ongoing occupation in the Somenos GOEs.

Monitoring

A program of site monitoring will be needed to ensure success. There are three basic forms of monitoring that will be applied to the restoration work on the Somenos GOEs; implementation monitoring; effectiveness monitoring and validation monitoring (Gaboury and Wong 1999). Implementation monitoring will be used to ensure the restoration work is carried out as planned. Effectiveness monitoring will be used to determine whether the treatments have been effective in reducing the cover of invasive species and increasing the cover of the desired native species. Validation monitoring will be used to address the question of whether the assumptions presented in the restoration plan are correct.

A minimum of 10 permanent plots will be established in each of the trial areas. In each plot, detailed floristics and cover values will be determined. Repeated sampling at floristically appropriate intervals will provide information on species compositional changes and changes in percent cover of the various species. In addition to the plot samples, photo points will be established to document visual changes in the treated ecosystems. Photographic documentation of ecosystem changes can provide a dramatic record of the restoration work that has been done.

Information gained from monitoring the performance of the various treatments will be used to develop any treatment changes that are needed to achieve the desired results. This information will help to address the lack of understanding of the effects of the proposed treatments.

Monitoring of wildlife populations, including exotic wildlife species, should also be conducted. For example, an inventory every three years of key species and species groups is recommended. This should include breeding bird surveys, butterfly and dragonfly inventory, and species-specific inventories. The introduced gray squirrel populations should be enumerated and monitored, and any Species at Risk should also be the focus of more intensive monitoring. This would permit us to better understand the distribution and abundance of these species on site, their influences on other species, and the effects of implementing vegetation and wildlife management. The feedback from this monitoring is essential if an adaptive management strategy is to be implemented effectively.

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APPENDIX A: THE BUTTERFLIES OF SOMENOS MARSH

Compiled by Derek Marven

Anise Swallowtail	***Papilio zelicaon***
Western Tiger Swallowtail	***Papilio rutulus***
Pale Swallowtail	***Papilio eurymedon***
Cabbage White	***Pireris Rapae***
Pine White	***Neophasia menapia***
Sara Orangetip	***Anthocharis sara***
Purplish Copper	***Lycaena helloides***
Brown Elfin	***Callophrys augustinus***
Gray Hairstreak	***Strymon melinus***
Spring Azure	***Celastrina ladon***
Silvery Blue	***Glaucopsyche lygdamus***
Mylitta Crescent	***Phyciodes mylitta***
Satyr Comma	***Polygonia satyrus***
Mourning Cloak	***Nymphalis antiopa***
Red Admiral	***Vanessa atalanta***
West Coast Lady	***Vanessa anabella***
Painted Lady	***Vanessa cardui***
Lorquin's Admiral	***Limenitis lorquini***
Common Wood-Nymph	***Cercyonis pegala***
Common Ringlet	***Coenonympha tullia***
Propertius Duskywing	***Erynnis propertius***
Woodland Skipper	***Ochlodes sylvanoides***

APPENDIX B: THE DRAGONFLIES OF SOMENOS MARSH

Compiled by Derek Marvin

Common Spreadwing	***Lestes disjunctus***
Western Red Damsel	***Amphiagrion abbreviatum***
Boreal Bluet	***Enallagma boreale***
Tule Bluet	***Enallagma carunculatum***
Northern Bluet	***Enallagma cyathigerum***
Pacific Forktail	***Ischnura cervula***
Western Forktail	***Ischnura perparva***
California Darner	***Aeshna californica***
Blue-eyed Darner	***Aeshna multicolor***
Paddle-tailed Darner	***Aeshna palmata***
Shadow Darner	***Aeshna umbrosa***
Common Green Darner	***Anax junius***
American Emerald	***Cordulia shurtleffi***
Spiny Baskettail	***Epitheca spinigera***
Western Pondhawk	***Erythemis collocata***
Dot-tailed Whiteface	***Leucorrhinia intacta***
Eight-spotted Skimmer	***Libellula forensis***
Common Whitetail	***Libellula lydia***
Four-spotted Skimmer	***Libellula quadrimaculata***
Blue Dasher	***Pachydiplax longipennis***
Variegated Meadowhawk	***Sympetrum corruptum***
Black Meadowhawk	***Sympetrum danae***
Cardinal Meadowhawk	***Sympetrum illotum***
Red-veined Meadowhawk	***Sympetrum madidum***
Striped Meadowhawk	***Sympetrum pallipes***
Yellow-legged Meadowhawk	***Sympetrum vicinum***

APPENDIX C: REFERENCE ECOSYSTEMS

Eagle Heights

Eagle Heights is a GOE located west of Shawnigan Lake on a south facing ridge above the Koksilah River. Although these GOEs are on a relatively shallow soiled site and therefore not totally analogous to the Somenos GOEs, the Eagle Heights ecosystems have not been massively invaded by Scotch broom and invasive grasses and therefore have a species composition that is thought to be analogous to what the Somenos GOEs may have contained in pre-contact times. Good representations of California brome (*Bromus carcinatus* Hook. & Arn.), California oatgrass (*Danthonia californica* Boland), blue wildrye (*Elymus glaucous* Buckl.) and Roemer's fescue (*Festuca idahoensis* Elmer ssp. *roemeri* (Pavl.) Aiken) are found on the Eagle Heights pocket grasslands. Appendix D-1 presents a partial list of vascular plants that occur on the Eagle Heights grasslands. Anthropogenic ecosystem manipulation has not been a major factor in the genesis or maintenance of the Eagle Heights grasslands.

Mt. Tzuhalem

The Mt. Tzuhalem GOEs occur as a result of shallow soils over a conglomerate / sandstone bedrock and the steep, southwest facing slopes. In addition, selective logging has removed some of the large, old Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) trees that once grew on this slope. Although representatives of the important GOE grass species can be found on Mt. Tzuhalem. The extensive coverage by Scotch broom until relatively recently and the subsequent modification of ecological conditions that have promoted the growth of agronomic grasses, results in an ecosystem that is not the same ecologically as it was in pre-contact times. The abundance of forbs, including some of the rarer GOE species, is an important characteristic of the Mt. Tzuhalem GOEs that can be used in the design of the restoration work at the Somenos GOEs. Appendix D-2 also presents a list of vascular plants found in the Ecological Reserve on Mt. Tzuhalem. Aboriginal use of the Mt. Tzuhalem GOEs is not believed to have been a major contributor to the pre-contact ecological condition of the area.

Cowichan Garry Oak Preserve

The Cowichan Garry Oak Preserve is a property that was recently purchased from the original owner by the Nature Conservancy of Canada. It is located on the gently sloping lands on the northwest side of Quamichan Lake and is the only other significant deep-soiled GOEs in the area. Like the Somenos GOEs, the Cowichan Garry Oak Preserve has been assaulted by invasive species, livestock grazing and the control of fire. However, this area most closely resembles the Somenos GOEs ecologically. Work on restoration of the

Cowichan Garry Oak Preserve GOEs has progressed more rapidly than has work on the Somenos GOEs. Results from this work, primarily invasive species removal, including conifer removal, can be applied to the Somenos GOEs with a reasonable congruence. Experiments on the use of fire as a management tool have been conducted at the Cowichan Garry Oak Preserve for the past several years and the results can help guide the operational restoration work planned for the Somenos GOEs.

APPENDIX D-1: PARTIAL LIST OF VASCULAR PLANTS FOR EAGLE HEIGHTS

Eagle Heights "Pocket Grasslands"
Partial List of Vascular Plant Species

Compiled by H. Roemer, BC Parks, April 1999, updated September 2002

(**B** = blue-listed; **R** = red-listed; **rare** = rare, unlisted)

Native graminoids of open sites

Note: Eagle Heights has the richest and best preserved grassland communities on Vancouver Island. It holds the most complete assemblage of grass species (20+ species) and grassland community types (4 - 7, depending on classification) native to the coastal areas of BC.

Agrostis pallens	dune bentgrass **B**	Koeleria macrantha	junegrass
Agrostis microphylla	small-leaved bentgrass **rare**	Luzula multiflora	field woodrush
Bromus carinatus	California brome	Melica harfordii	Harford's melic **rare**
Bromus marginatus	mountain brome **rare on V.I.**	Melica subulata	Alaska onion-grass
Carex inops	long-stoloned sedge	Dichanthelium acuminatum	western witchgrass
Danthonia californica	California oatgrass	Poa canbyi (P. secunda group)	Canby's bluegrass
Danthonia intermedia	timber oatgrass	Stipa lemmonnii	Lemmon's needlegrass
Elymus glaucus	western wild-rye	Stipa nelsonii var.dorei	Columbian needlegrass
Festuca idahoensis ssp. roemeri	Roemer's fescue	Vulpia microstachys	small fescue (annual)

Some other native plants of interest:

		Campanula scouleri	Scouler's harebell
		Clarkia amoena	farewell-to-spring
Agoseris grandiflora	large-flowered agoseris	Collomia heterophylla	varied-leaf collomia
Allium acuminatum	Hooker's onion	Daucus pusillus	American wild carrot
Arbutus menziesii	madrone	Delphinium menziesii	Menzies' larkspur
Arctostaphylos columbiana	manzanita	Dodecatheon hendersonii	Henderson's shooting-star
Aspidotis densa	Indian dream fern	Dodecatheon pulchellum	pretty shooting-star
Athysanus pusillus	sandweed	Epilobium foliosum	foliose willow-herb **rare**
Brodiaea coronaria	harvest brodiaea	Eriophyllum lanatum	woolly sunflower
Camassia quamash	early camas	Fritillaria affinis	chocolate lily

Githopsis specularioides	common bluecap **R**
Heteropcodon rariflorum	heterocodon **B**
Legousia perfoliata	Venus looking-glass **rare**
Linanthus bicolor	bi-coloured linanthus
Linaria texana	Texan blue toadflax **rare**
Lomatium nudicaule	Indian consumption plant
Lomatium utriculatum	spring gold
Lotus micranthus	small-flowered deer-vetch
Madia gracilis	slender tarweed
Microsteris gracilis	pink microsteris
Mimulus alsinoides	chickweed monkeyflower
Mimulus guttatus	common monkeyflower
Montia fontana	blinks
Montia linearis	narrow-leaved montia
Montia parvifolia	small-leaved montia
Notochelone nemorosa	woodland penstemon **B**
Orobanche pinorum	pine broom-rape **R**
Pentagramma triangularis	goldenback fern
Perideridia gairdneri	yampah root
Piperia candida	white lip rein orchid **R**
Piperia elongata	tall rein orchid
Piperia transversa	royal rein orchid
Prunella vulgaris	self-heal
Quercus garryana	Garry oak
Saxifraga integrifolia	entire-leaf saxifrage
Saxifraga rufidula	red-wool saxifrage
Trifolium microcephalum	woolly clover
Trifolium microdon	thimble clover
Trifolium oliganthum	few-flowered clover
Trifolium variegatum	white-tip clover
Trifolium willdenowii	tomcat clover
Triphysaria pusilla	tiny owl-clover
Triteleia hyacinthina	fool's onion
Zygadenus venenosus	death camas

APPENDIX D-2: VASCULAR PLANT CHECKLIST FOR MT. TZUHALEM

ECOLOGICAL RESERVE #112 MT. TZUHALEM: VASCULAR PLANT CHECKLIST

Compiled by H. Roemer

(Rare-listed plants: **R** = red list; **B** = blue list as of 1999)

Abies grandis	grand fir
Acer macrophyllum	big-leaf maple
Achillea millefolium	yarrow
Agoseris grandiflora	large-flowered agoseris
Aira caryophyllea	silver hairgrass
Aira praecox	little hairgrass
Allium acuminatum	Hooker's onion
Allium cernuum	nodding onion
Amelanchier alnifolia	saskatoon
Antennaria neglecta	field pussytoes
Anthoxanthum odoratum	sweet vernalgrass
Arbutus menziesii	madrone
Arctostaphylos uva-ursi	kinnickinnick
Aster curtus	white-top aster **R**
Athysanus pusillus	sandweed
Balsamorhiza deltoidea	deltoid balsamroot **R**
Brodiaea coronaria	harvest brodiaea
Bromus carinatus	California brome
Bromus hordeaceus	soft brome
Bromus tectorum	cheat grass
Calandrinia ciliata	red maids
Camassia leichtlinii	tall camas
Camassia quamash	early camas
Cardamine oligosperma	little western bittercress
Cardamine pulcherrima var. tenella	slender toothwort
Carex inops	long-stoloned sedge
Castilleja hispida	harsh paintbrush
Cerastium arvense	field chickweed
Clarkia amoena	farewell-to-spring
Clarkia purpurea ssp. viminea	twiggy godetia **R**
Collinsia parviflora	blue-eyed Mary
Collomia linearis	narrow-leaf collomia

Cornus nuttallii	Pacific dogwood
Crocidium multicaule	crocidium
Cystopteris fragilis	brittle bladderfern
Cytisus scoparius	Scotch broom
Dactylis glomerata	orchardgrass
Danthonia californica	California oatgrass
Delphinium menziesii	Menzies' larkspur
Dodecatheon hendersonii	Henderson's shooting star
Dodecatheon pauciflorum	few-flowered shooting star
Elymus glaucus	western wildrye
Eriophyllum lanatum	woolly sunflower
Erodium cicutarium	stork's bill
Erythronium oreganum	white fawnlily
Festuca idahoensis ssp. Roemeri	Roemer's fescue
Fragaria vesca	wood strawberry
Fragaria virginiana	wild strawberry
Fritillaria affinis	chocolate lily
Galium aparine	cleavers
Geranium molle	dovefoot geranium
Heuchera micrantha	small-flowered alumroot
Holcus lanatus	common velvetgrass
Holodiscus discolor	ocean spray
Isoetes nuttallii	Nuttall's quillwort
Koeleria macrantha	junegrass
Lathyrus nevadensis	Sierran peavine
Lathyrus sphaericus	grass peavine
Lilium columbianum	Columbia lily
Linanthus bicolor	bulbiferous fringecup
Lithophragma parviflora	woodland star
Lomatium nudicaule	bare-stem desert parsley
Lomatium utriculatum	spring gold
Lonicera ciliosa	trumpet honeysuckle
Lonicera hispidula	hairy honeysuckle
Lotus micranthus	two-colour lupine
Luzula multiflora	field woodrush
Madia sativa	coast tarweed
Mahonia aquifolium	tall Oregon grape
Mahonia nervosa	dull Oregon grape
Meconella oregana	Oregon poppy **R** [note 1]

Melica subulata	Alaska onion grass
Microsteris gracilis	pink microsteris
Mimulus alsinoides	chickweed monkeyflower
Mimulus guttatus	yellow monkeyflower
Moehringia macrophylla	sandwort
Montia fontana	blinks
Montia linearis	narrow-leaved montia
Montia parvifolia	small-leaved montia
Montia perfoliata	miner's lettuce
Myosotis discolor	yellow and blue forgetmenot
Nemophila parviflora	small-flowered nemophila
Orobanche uniflora	one-flowered broomrape
Orthocarpus pusillus	dwarf owl-clover
Osmorhiza chilensis	sweet cicely
Pachystima myrsinites	false-box
Pentagramma triangularis	golden-back fern
Perideridia gairdneri	yampah root
Philadelphus lewisii	mock orange
Physocarpus capitatus	ninebark
Piperia elegans	elegant rein orchid
Piperia unalascensis	laska rein orchid
Plectritis brachystemon	white-flowered plectritis
Plectritis congesta	seablush
Poa canbyi (now P.secunda)	Canby's bluegrass
Poa glauca	glaucous bluegrass
Poa pratensis	Kentucky bluegrass
Polypodium glycyrrhiza	licorice fern
Polystichum imbricans	imbricate swordfern
Polystichum munitum	swordfern
Potentilla glandulosa	sticky cinquefoil
Prunella vulgaris	self-heal
Prunus emarginata	fire cherry
Pseudotsuga menziesii	Douglas-fir
Psoralea physodes	California tea **B**
Quercus garryana	Garry oak
Ranunculus occidentalis	western buttercup
Rosa gymnocarpa	bald-hip rose
Rosa nutkana	Nootka rose
Rubus parviflorus	thimbleberry

Rubus ursinus	trailing blackberry
Rumex acetosella	sheep sorrel
Salix sitchensis	Sitka willow
Sanicula bipinnatifida	double-pinnate sanicle **R**
Sanicula crassicaulis	Pacific sanicle
Sanicula graveolens	Sierra sanicle
Satureja douglasii	yerba buena
Saxifraga caespitosa	tufted saxifrage
Saxifraga integrifolia	grassland saxifrage
Saxifraga rufidula	red-wool saxifrage
Sedum spathulifolium	broad-leaved stonecrop
Selaginella wallacei	Wallace's selaginella
Silene gallica	small-flowered catchfly
Silene scouleri	Scouler's catchfly **R**
Sisyrinchium douglasii	satin flower
Smilacina stellata	star-flowered Solomon's seal
Stellaria media	chickweed
Stellaria nitens	shining chickweed
Stipa lemmonnii	Lemmon's needle-and-thread
Symphoricarpos albus	common snowberry
Symphoricarpos mollis	creeping snowberry
Teesdalia nudicaulis	shepherd's cress
Trientalis latifolia	western starflower
Trifolium microcephalum	woolly clover
Trifolium microdon	thimble clover
Trifolium oliganthum	few-flowered clover
Trifolium tridentatum	tomcat clover
Triteleia hyacinthina	fool's onion
Veronica arvensis	common speedwell
Vicia americana	American vetch
Vicia hirsuta	airy vetch
Vicia sativa	common vetch
Viola praemorsa	yellow montane violet
Vulpia bromoides	rat-tail fescue
Woodsia scopulina	Rocky Mountain woodsia
Zygadenus venenosus	death camas

Note 1: Not observed in recent years (extirpated?)