FORESTED SWAMPS OF CENTRAL- AND NORTH-COAST BRITISH COLUMBIA

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Introduction

Forested swamps are one of several landscape elements to receive special management under the ecosystem-based management (EBM) approach that has been agreed to by several members of the forest industry, by First Nations and by the Province of British Columbia for the Central and North Coast land use planning areas. Background documents that guide forest practices include the Ecosystem-based Management Handbook and key elements of the Hydroriparian Planning Guide (HPG).

This document is intended to provide operational guidance to foresters, engineers and others in identifying forested swamps on the ground. Included are relevant definitions, and clarification of terms and criteria for distinguishing forested swamps and for locating forested swamp boundaries on the ground.

Concepts and Definitions

Wetlands of British Columbia – A guide to identification (MacKenzie and Moran, 2004) defines wetlands as:

> ***"areas where soils are water-saturated for a sufficient length of time such that excess water and resulting low oxygen levels are principal determinants of vegetation and soil development. Wetlands will have a relative abundance of hydrophytes in the vegetation community and/or soils featuring 'hydric' characters."***

Wetland ecosystems occur on azonal sites (i.e. atypical sites in relation to the prevailing climate) determined by excessively wet, soil water regimes. An essential feature of most wetlands is their marked contrast with surrounding better drained uplands – contrast in overall appearance, contrast in species, contrast in community structure and contrast in soils. Contrast between wetlands and uplands increases as climate becomes increasingly dry, and the contrast is greatest in areas of pronounced dry summers – e.g. in the CWHxm and IDFww. In climatically very wet, hypermaritime subzones – i.e. in the CWHvh – where upland zonal soils are also poorly drained, the contrast between wetland and upland is less marked.

Mackenzie and Moran (2004) define five classes of wetlands – bogs, fens, marshes, swamps and shallow waters. They define swamp as:

"a nutrient-rich wetland ecosystem where significant groundwater inflow, periodic surface aeration, and/or elevated microsites allows growth of large trees or tall shrubs under subhydric conditions."

This concept of swamp is consistent with earlier wetland classifications, including the Canadian Wetland Classification System, which is available at http://www.portofentry.com/Wetlands.pdf.

Hence the key elements of swamps are:

- they are nutrient-rich, that is relatively rich in nutrients. This implies a so-called minerotrophic regime (soil water chemistry) that is strongly influence by groundwater. This serves to distinguish swamps from bogs that are relatively nutrient-poor and have vegetation largely unaffected by groundwater chemistry.
- they have a near-surface watertable, which fluctuates seasonally and in response to weather and/or flow in adjacent rivers or streams.
- they include soils that are sufficiently aerated to support trees and/or tall shrubs. Sufficient aeration may result from either water table fluctuations or the presence of elevated microsites
- they support trees and/or tall shrubs; and consequently can be forested, treed or tall-shrub-dominated.
- they have either mineral or organic substrates. Organic substrates tend to be relatively thin (i.e. <40 cm thick), and often include mineral materials (silt) either disseminated throughout the organic materials or as distinct, thin layers representing past inundation events.

Pursuant to EBM, it is not all swamps but specifically forested swamps that are to receive special management. The definition of a forested swamp recently developed for the legal objectives is:

> ***"a forested mineral wetland or a forested peatland with standing or gently flowing nutrient rich water in pools or channels and the water table is usually at or near the surface of the wetland or peatland."***

This raises the question of just what constitutes "forested" (forest)?

The IUCN (formerly the International Union for the Conservation of Nature; now the World Conservation Union) defines forest as:

> ***"a minimum area of land of 0.05-1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10-30 per cent with trees with the potential to reach a minimum height of 2-5 metres at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground, or open forest. Young natural stands and all plantations which have yet to reach a crown density of 10-30 per cent or tree height of 2-5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest."***

The above definition is somewhat ambiguous with respect to both crown cover (… more than 10-30 per cent…) and what constitutes a tree (…height of 2-5 metres…). This renders the definition unsuitable for regulatory purposes. In B.C., trees are defined as tree species with a height exceeding 10 metres (Walmsley et al ,1980) at maturity. Tree species of 10 metres or less are considered as tall shrubs (2-10 m height) or low shrubs (<2m height) (Walmsley et al,

1980). This definition has been widely and consistently applied in British Columbia since 1980. The U.S. National Vegetation Classification system provides a useful distinction between wooded (woodland) and forested (forest) based on crown cover. Forests consists of trees with overlapping crowns forming >60% crown cover; whereas woodlands are more open, with only 25% to 60% crown cover.

Based on the above considerations, I suggest that in relation to EBM, a forested swamp should have a crown cover in excess of 60% comprised of trees (or capable of growing trees) greater than 10 metres tall.

Swamps that do not meet the definition of a forested swamp include wooded swamps (also called treed swamps) and tall shrub swamps. These belong to a group of wetlands that also includes bogs, fens, marshes and shallow waters.

Swamps of Coastal British Columbia

On the central and north coast of British Columbia, forested swamps and wooded swamps are not uncommon but probably comprise less than one percent of the landscape.

Forested swamps are associated with richer sites in a fluvial setting, as for example the Sitka spruce – Skunk cabbage site association described on page 145 of *Wetlands of British Columbia*). Wooded swamps are associated with poorer sites and usually supported by organic substrates; they comprise part of the Ws54 site association of *Wetlands of British Columbia* (page 143). In the richer forested swamps, canopy closure is relatively high and forest productivity is medium to good; nutrient availability apparently offsets the excessive wetness of these sites to a considerable extent.

In coastal British Columbia, forested swamps are most extensive within the wetter biogeoclimatic subzones – the CWHvh and CWHvm subzones. The following table summarizes the main features of forested and wooded swamps of the central and north coast.

Characteristic	Forested Swamps	Wooded Swamps
Microsite	In both, raised microsites occupy <50% of the overall site area; and there commonly are substantial areas/patches of exposed, black mucky soil	
Canopy	>60%, typically ranging from 55-80%	<60%, typically 10-35%
Setting	Fluvial (active floodplain); hydroriparian; back channels and flood channels are common	Depressional, toeslope or hydroriparian
Inundation	Frequent inundation, usually accompanied by sediment deposition (silt or very fine sand); slow moving waters during overbank flooding	Inundation uncommon to rare, and without sediment deposition (floodwaters are dark with dissolved organics but carry little sediment)
Substrate	Mineral; perennially high water table	Organic; perennially high water table
Soil Type	Rego Gleysol	Organic soil (Mesisol or Humisol) or Peaty phase of a Gleysol

Characteristic	Forested Swamps	Wooded Swamps
Typical tree species	Sitka spruce, red alder	Redcedar, yellow cypress, shore pine
Skunk cabbage	Vigorous skunk cabbage with large, darker green leaves; cover >15%, typically 25-40%	Rather poor skunk cabbage with smaller, yellow green leaves; cover >15%
Distinguishing species	devil's club, salmonberry, lady fern, foamflowers, *Conocephalum conicum*,	*Vaccinium* spp., false azalea, salal, deer fern
Other wetland species	Sedges and loose mats of Sphagnum mosses. At the species level, there are differences between the two types (e.g. *Sphagnum squarrosum* [richer] vs. *Sphagnum papillosum* [poorer]), but this requires a good understanding of the difficult taxonomy of these two genera.	
Absent species	Species associated with bogs are absent; including shore pine, Labrador tea, crowberry, bog-laurel, bog cranberry, cottongrasses, sticky false asphodel, sundews, king and swamp gentians, butterwort, reindeer mosses and compact, hummock-forming Sphagnum mosses	Bog species are absent except perhaps for minor amounts of species such as crowberry and Labrador tea on localized, more acidic, raised microsites
Associated ecosystems	CWhvm1/09 and CWHvh/08 (both red-listed) on better drained portions of fluvial terraces, invariably closer to main river channels	In CWHvh, often grades into bog forest (CWHvh/11) which in turn often borders on blanket bogs (CWHvh/32)
Associated values	Concentrated feeding by bears (especially grizzly - skunk cabbage and salmonids); off-channel and back-channel fisheries habitat; sediment storage	Light to moderate feeding by bears (skunk cabbage)
Silviculture	Medium to high productivity sites but difficult to regenerate following logging	Low productivity sites, often in a mosaic with even poorer sites

Images 1-3. These images illustrate 3 features of forested swamps:

1. Large, vigorous skunk cabbage of richer forested swamps.
2. Areas of exposed black mucky soil.
3. Indications of regular inundation during overbank flooding.

In the CWHxm and CWHdm, swamps are generally associated with sites that experience strongly fluctuating water tables. These sites are very wet and frequently inundated during the winter and remain very moist during the summer. They occur on areas of subdued topography of raised marine terraces that were inundated by the ocean in the early post-glacial period. These swamps correlate well with the CWHxm/15 and CWHdm/15 site series (Green and Klinka, 1994). Characteristic species include red alder, black cottonwood, trembling aspen (coastal variety), Sitka spruce, Pacific crab apple, red-osier dogwood, black twinberry, salmonberry and slough sedge. Canopy cover tends to be relatively low, hence wooded swamps are more common than forested swamps. Although individual trees may be productive with good height, overall stand productivity is low because of the poor stocking. Both site series are distinctive with easily identifiable species, and they contrast strongly with surrounding ecosystems. In second-growth, young seral forest following logging; these sites tend to remain as poorly stocked openings for a considerable time because of severe limitations to tree regeneration and re-establishment.

Images 4 & 5 show the distinctive species combination that identifies forested swamps of the CWHxm and CWHdm – Sitka spruce, cottonwood and/or aspen, and slough sedge.

Defining the Boundary of Forested Swamps

In the drier and submaritime CWH subzones and variants, the boundary between swamps (wooded or forested) and uplands is generally sharp (i.e. transition is less than +/-5 metres) and demarcated by a rapid change in vegetation and soils. Gradational boundaries are uncommon. This situation makes definition of the boundary and application of the appropriate buffer relatively straightforward.

In wetter maritime and hypermaritime subzones (CWHvm and CWHvh), the boundary between forested swamps and adjacent upland may be sharp or gradational. Where a forested swamp is situated on a more or less flat fluvial terrace (bench), the boundary to upland is likely to be sharp. In this case, the upland can be a higher fluvial terrace, in which case there will be an abrupt step of one or a few metres up to the higher terrace level; or the upland can be a valley wall or sideslope underlain by till, colluvium or bedrock. Where forested swamps are situated on fluvial terraces, the forested swamp is commonly separated from the mainstem stream by a red-listed high bench ecosystem (i.e. site series CWHvm/09 or vh/08).

Wetter subzone gradational boundaries typically occur at the toe of fluvial fans or where fluvial fans merge onto more or less flat fluvial terraces. In the transition, there is a change from wetland soils and vegetation to upland soils and vegetation; and, in some cases this change may be gradational. In wetter subzones, the adjacent upland may well be poorly drained; in the hypermaritime, the adjacent upland is most likely poorly drained since even zonal sites are poorly drained. What then, defines the boundary between a forested swamp wetland an a wet, poorly drained upland?

Diagnosis of poorly drained sites of all types is best undertaken with due consideration for microsite variation. Raised, freely drained microsites need to be distinguished from the wet, flat to depressional areas. At the wettest end of the range, the flat to depressional sites are by far in the majority; and raised microsites are small, are not particularly raised and are not extensive. At the driest end of the range, there may be a predominance of freely drained microsites with many zonal or circum-mesic species (e.g. western hemlock, *Vaccinium* spp., and feathermosses [*Hylocomium splendens, Rhytidiadelphus loreus*]), and the depressional microsites may merely be scattered or only very uncommon, small holes within which wetland plants survive but do not grow very well (e.g. skunk cabbage). In the mid-range, raised microsites appear as distinct islands within a flat to depressional matrix. Separately listing species respecting the microsite differences usually results in one list of typical wetland species (hydrophytes) and another list of zonal (circum-mesic) species on the raised microsites. The wetland soils (Mesisols, Humisols, Gleysols) occupy the flat to depressional areas and the raised microsites are functionally Folisols, even though they may not meet the strict definition of a Folisol (i.e. combined LFH horizon thickness >40 cm). Perspective often shifts the focus of interest. For example, a forest engineer interested in locating a road would focus on the wet, flat to depressional sites and the soil, surficial materials and water table beneath; whereas a silviculture forester would focus on the extent and nature of raised microsites that are needed to regenerate and re-establish a stand of trees if the forest is to be logged.

Canopy closure afforded by tree layers is strongly correlated with the extent of freely draining, raised microsites since most trees, especially the larger trees, grow on the elevated sites. Such raised microsites are characterized by various accumulations of rotten wood and Folisol soils (or folisolic materials, if their thickness is insufficient to be classified as a Folisol). In the early development of these raised microsites, the organic material might be imported, as for example drift logs on a floodplain, or contributed by fallen trees from adjacent better drained sites. Later in the succession, the proportion of in-situ accumulated organic (folisolic) material steadily

builds up as the expanding forest increasingly modifies the site and moves it from a wetland condition towards an upland condition.

Perusal of available plot data does not reveal any particular logical break between the extent of tree canopy or proportion of microsites at the forested swamp to upland boundary. Mackenzie and Moran's (2004) description of the Ws54 site association apparently encompasses a wide range of microsite variation, as indicated by the wide range of included plant communities. For example, the canopy closure (tree layer) of Ws54 communities ranges from 0-100% with a mean of 51% (see page 143; note the other layers also have a wide range of covers).

Although some of this range in plant community and site can truly be considered to belong to the Wetland realm; I suggest that part of this range would better be considered to be a part of the Transition realm. In the absence of any logical break, I recommend that the boundary between forested swamps and poorly drained upland forest be placed on the transition where 50% of the microsites have freely drained substrate and 50% of the microsites have saturated surface soils on flat to depressional situations. Forested swamps of the Wetland realm would therefore include only those sites with more than 50% of saturated surface soils; and, poorly drained upland sites with more than 50% of freely-drained, folisolic soil (substrate) would be considered to be of the Transitional realm (i.e. not wetland). Such transitional upland sites fit the central concept of the two forest sites classified by Green and Klinka (1994) as CWHvm1/14 and CWHvh/13 quite well. It is not, however, in accord with Appendix 4 of MacKenzie and Moran (2004), which equates various skunk cabbage site series (e.g. CWHvm1/14, CWHvh1/13 and CWHvh2/13) with the Ws54 wetland site association.

Forested swamps do not include poorly drained areas transitional to uplands in which folisolic growing substrate (i.e. folic material derived from the litter of trees and lesser vegetation of upland sites) occupies at least 50% of the site and hydromorphic organic matter (organic materials accumulated under saturated conditions) and wetland species (hydrophytes) occupy a minority of the site area

Image 6 (left) shows the extent of saturated, flat to depressional site (clearly >50%) in a forested swamp. **Image 7** (right) shows the boundary between upland (foreground) and forested swamp (mid to background).

Management of Forested Swamps of Different Sizes

For management purposes, it is necessary to decide on strategies appropriate to differing sizes of forested swamps. This should consider the relative rarity of forested swamps in the landscape as well as their ecological importance, and balance these considerations against operational constraints.

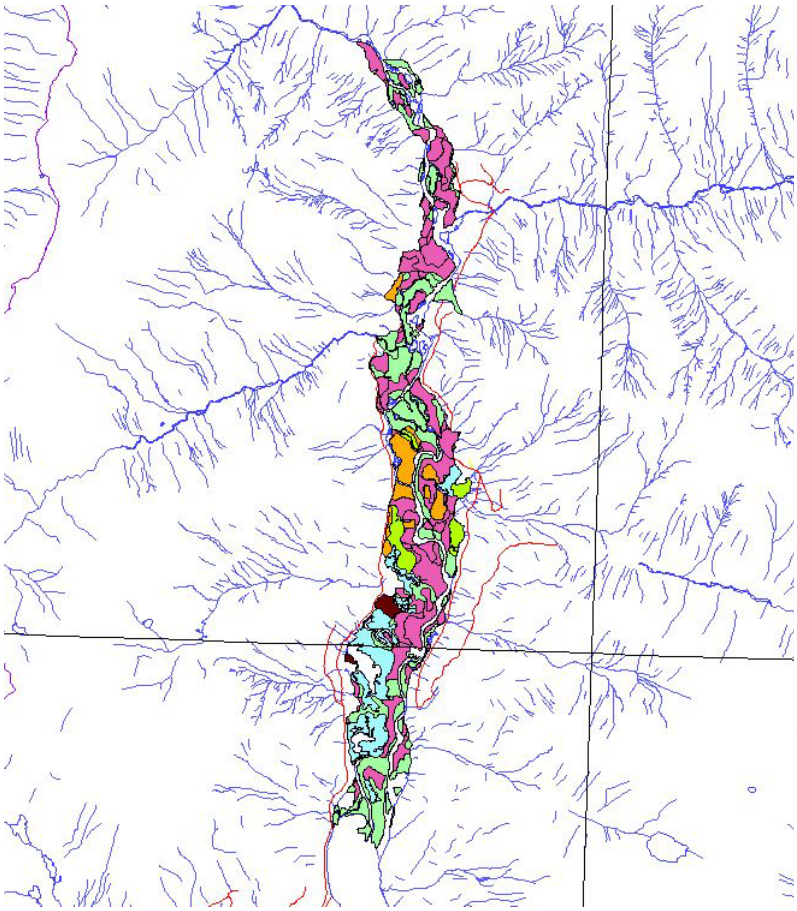
In the drier and submaritime variants of CWH, wetlands of all kinds are uncommon to rare; and thereby are relatively more important components of biodiversity with respect to the vegetation they support and the organisms supported by these ecosystems (amphibians etc.). In the wetter CWH (vm and vh), wetlands are far more extensive in the landscape, and in much of the Hecate Lowland Ecosection, wetlands may even predominate in the landscape. However, not all wetlands are equally represented. In the Hecate Lowland, the acidic, nutrient-poor bogs are extensive; but relatively nutrient-rich shallow waters, marshes, fens and swamps have a relatively restricted distribution and extent.

Towards the drier southern part of the central – north coast area, in large river valleys penetrating the Coast Mountains, ecosystem mapping within the Apple and Stafford watersheds reveals that forested swamps occupy about 0.1% of the total watershed area. In the north, this extent likely increase by a factor of 3-5, but still is unlikely to approach 1% of total area.

In many cases, forested swamps will be situated on one side of planned cutblocks, on a wet, low-lying terrace (bench) paralleling a river (there may or may not be a strip of red-listed, high bench plant community between the forested swamp and the mainstem channel). In this situation, units of several hectares can be expected. Designing a buffer in this situation is relatively straightforward and minimum size of the forested swamp is unlikely to be an issue. Furthermore, the buffer is unlikely to be greater in area[1] than the feature of interest/concern (the forested swamp).

Where small units of forested swamp occur in association with smaller streams or groundwater discharge areas, they may be internal to a planned cutblock. Setting a minimum size of forested swamp to manage will always be arbitrary and difficult to support with a scientific rationale. However, in current variable retention practice, 'larger' patches (aggregates) are commonly 0.4 ha or larger in size. In consideration of the dynamic nature of forested swamps (i.e. inundation, sediment deposition), I suggest that the integrity of forested swamps of less than 1.0 hectares extent can be maintained through stand level retention, which incorporates any buffer considered necessary to avoid excessive windfall. Only forested swamps exceeding 1.0 hectares would require a specially designed buffer. Such a buffer should be applied flexibly to suit the situation at hand, with a width in the order of 0.5 to 1.5 times the height of the neighboring forested polygon.

[1] Note that a 50 m buffer around a 0.25 ha feature (i.e. a 50 by 50 m square) encompasses 2.0 ha or 8 times the area of the feature of interest/concern.
A 50 m buffer around a 0.5 ha feature (i.e. approx. 70 by 70 m square) encompasses 2.4 ha or almost 5 times the area of the feature.
A 50 m buffer around a 1.0 ha feature (i.e. a 100 by 100 m square) encompasses 3.0 ha or 3 times the area of the feature.



The image to the left shows the distribution of special EBM elements in the Stafford River valley above Stafford Lake.

Forested swamps (3) are yellow green.

Fens are light blue.

Bogs (2) are dark brown.

Red-listed plant communities (CWHvm/09) are orange and pink. Light green areas are early seral fluvial ecosystems (CWHvm/10).

Active fluvial areas include the yellow green forested swamps, the light blue fens, and the yellow green, light green and pink fluvial ecosystems/terrain.

Note the integrated and at times overlapping nature of these elements of special concern, and their association with alluvial channels of a large river.