Restoration Plan
for
Dionisio Point Provincial Park
Galiano Island

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TABLE OF CONTENTS

LIST OF MAPS

I. Context

Up until 150 years ago, over 75% of the forest landscape of East Vancouver Island and the adjacent Gulf Islands was dominated by trees greater than 100 years of age. Today only 2.6% or 10,605 hectares of the same landscape is characterized by older forest (McPhee et al., 2000). Regenerating forests, agricultural lands, roads and urban development have replaced and fragmented old forest ecosystems within the Coastal Douglas-fir Biogeoclimatic Zone (CDF) making them some of the most endangered in British Columbia. All old-growth forest types that are either dominated or co-dominated by Douglas-fir within the CDF are currently on the province's list of rare and endangered ecosystems (Flynn, 1999).

Fragmentation of the forested landscape due to human land-use has resulted in:

- extensive loss of original habitat
- reduced habitat patch size
- increased edge and decreased interior habitats
- increased isolation of habitat patches
- modification of natural disturbance regimes and successional patterns
- spread of exotic vegetation (including plantation stock from off-island)

Addressing these existing impacts requires that conservation efforts be focussed on land protection and ecosystem restoration. Preserving the few remaining parcels of land that exhibit in-tact natural ecosystems is of utmost importance. However, the sheer rarity of these opportunities within the CDF dictates that the protection and subsequent restoration of degraded land will also play a vital role.

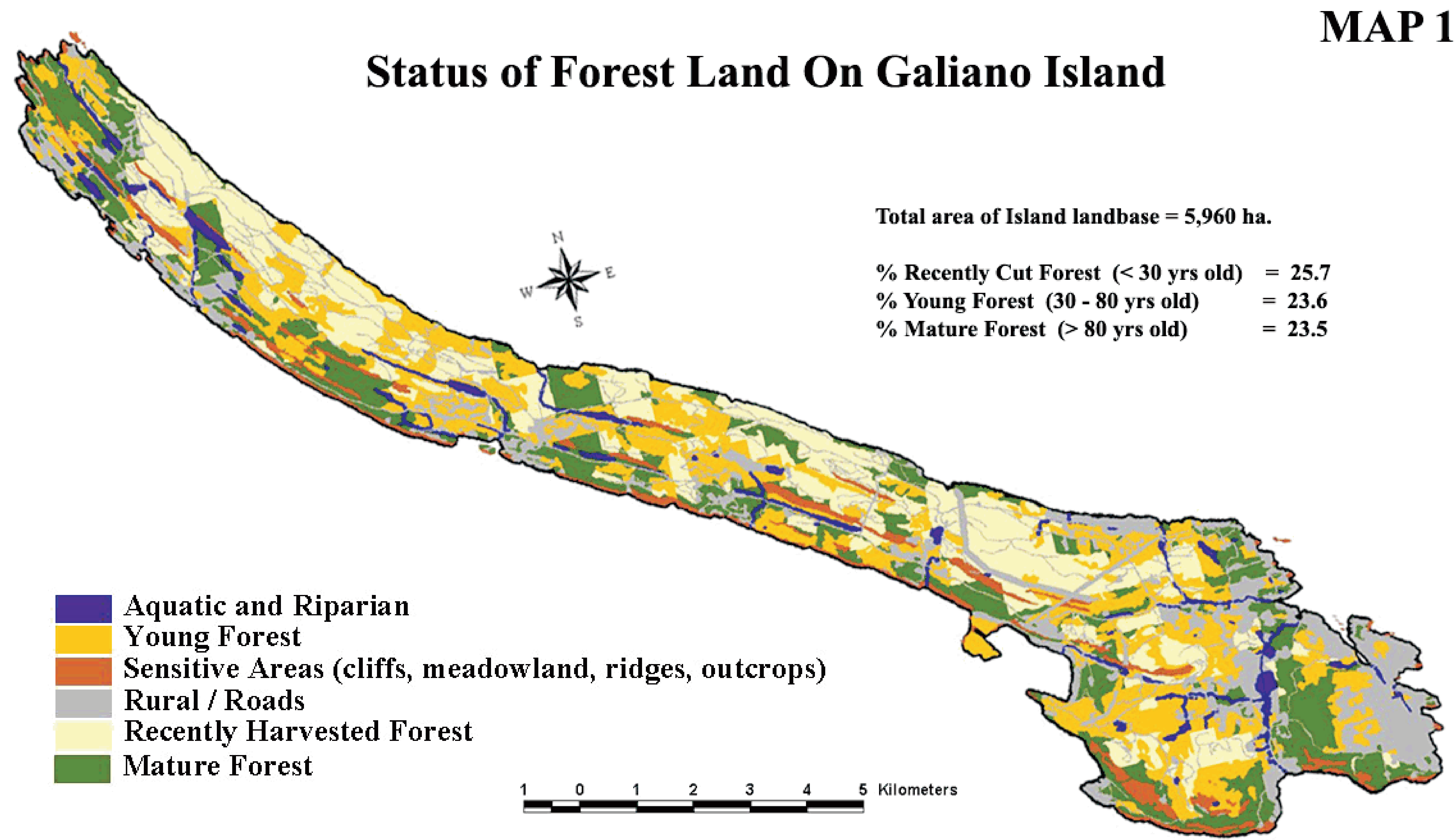
Galiano Island presents a landscape characteristic of the Coastal Douglas-fir Zone. It has undergone extensive timber removal over the past 100 years. Virtually no lot, across the near 6000ha land-base has been left untouched. Roughly one third of the Islands forest land-base (4,500 hectares) is now less than 30 years old, another third is between the ages of 30 and 80, and the final third is older than 80 years (Map 1[1]). Most of the mature forest is scattered amongst residential developments in protected areas, on crown land, on large privately owned residential lots, and on ridges or bluffs that are difficult to access. In contrast, recently harvested and young forests dominate the entire eastern side of the island.

Planning and analysis at a landscape level are necessary to ensure that conservation efforts are focussed in the most effective and beneficial manner. Activities such as ecosystem and land-use mapping identify opportunities for habitat connectivity and highlight natural linkages between existing protected areas. This provides insight into prioritizing land for restoration and protection by indicating where efforts might achieve the most benefit for wildlife, establishment of native vegetation, or maximizing the extent of interior habitat.

At the landscape level, Dionisio plays an important role in the protected areas strategy for Galiano Island. Connectivity between existing protected areas running from mid-island to the northern most point including Pebble Beach Nature Reserve, Laughlin Lake, Bodega Ridge Reserve, Ecological Reserve # 128 and finally Dionisio Point Provincial Park, is of highest conservation priority (MAP 2). Unprotected corridors of intact, rare and sensitive ecosystems are present throughout the island landscape and have been identified as possible additions to the network.

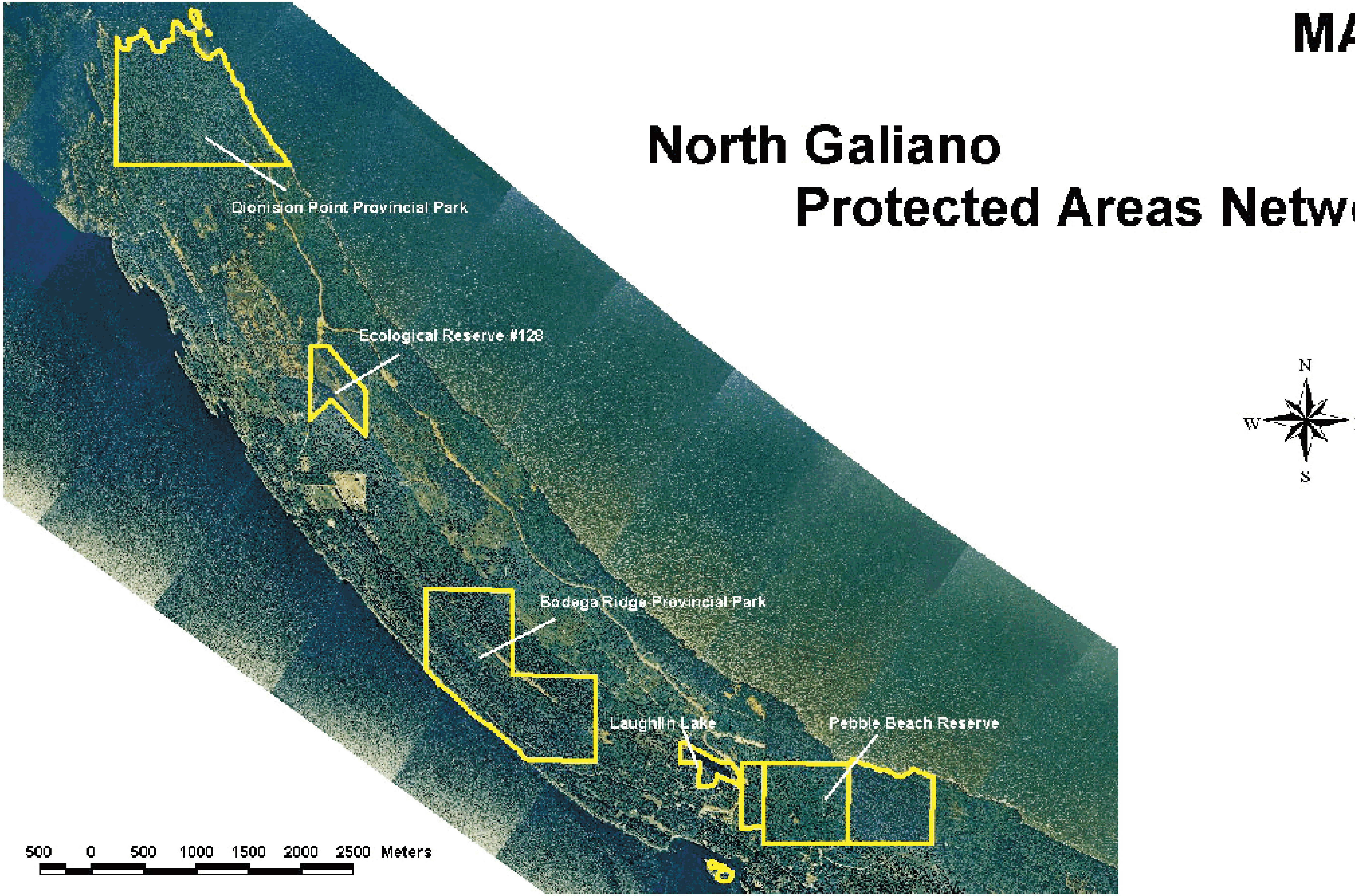
Dionisio represents the second largest protected area on the Island encompassing over 150 hectares. The majority of forest within the park is considered to be of maturing climax successional status and is well on its way to recovering from early 20th century high grade logging. However, recent clearcuts, road construction and recreational developments have resulted in more severe, longer lasting fragmentation amongst the now protected mature forest areas. Opportunities to assist natural processes in healing impacts from past disturbances should be explored. Restoration of these areas not only

[1] Map 1 is based on photo interpretation of 1998 aerial photography and 2000 satellite imagery. The map is currently in draft form. The map must undergo significant ground-truthing in order to meet Provincial mapping standards.


MAP 1
Status of Forest Land On Galiano Island
Total area of Island landbase = 5,960 ha.
% Recently Cut Forest (< 30 yrs old) = 25.7
% Young Forest (30 - 80 yrs old) = 23.6
% Mature Forest (> 80 yrs old) = 23.5
N
E
W
S
Aquatic and Riparian
Young Forest
Sensitive Areas (cliffs, meadowland, ridges, outcrops)
Rural / Roads
Recently Harvested Forest
Mature Forest
1 0 1 2 3 4 5 Kilometers

MAP 2

North Galiano Protected Areas Network



provides benefit to the flora and fauna within Dionisio's boundaries, but, will contribute to the ecological integrity of a landscape level protected areas network

II. Setting

The overall management goal as stated in the 1995 Master Plan of Dionisio Point Park is "to conserve, protect and enhance the ecological, cultural and aesthetic values in the park and to provide opportunities for education, recreation, and scientific research". Two of the stated commitments for resource management within the plan are "to restore and rehabilitate previously disturbed areas and ecosystems", and "to improve forest diversity in stands that have been harvested...".

Dionisio Point Provincial Park also falls within the management zone of the Islands Trust. In 1999 the Galiano Island local Trust Committee introduced bylaw #127 in which Dionisio Point Provincial Park is zoned "Park". This document regulates the use of "Park" zoned land strictly for parks, boat launching ramps, picnic facilities, playgrounds and sports fields, and moorage of boats in accordance with a provincial park management plan. No buildings or structures of any kind, other than signs, picnic tables, boat launch ramps, toilets and baseball backstops are allowed. Dionisio Point Provincial Park is also included in the Galiano Island Official Community Plan and has been given a land use designation of "Parks and Recreation". The first objective within the designation is "to ensure that recreational activities are non intrusive, do not endanger ecology or archaeologically sensitive areas, and are compatible with rural character". Dionisio Point Provincial Park is directly referred to as being located in an area of archaeological interest and fragile ecology.

The Penelakut Tribe Indian Reserve (IR No. 5) is located adjacent to Dionisio Point Provincial Park on the North end of Galiano Island. Archaeological findings within the park area have provided evidence of First Nation land and resource use in the forms of middens, house platforms and burials. The area was likely used for collecting eggs, bulbs, plants, roots, berries, and shellfish. Marine and terrestrial animals were also traditionally hunted within and adjacent to the park boundaries. The Park Master Plan objective with regards to Cultural and Archaeological Values is "To protect archaeological sites from disturbance" and "To consult with the Penelakut Tribe regarding park management issues". Dionisio Point Provincial Park is acknowledged as playing an important role in protecting evidence of traditional cultural land use and conserving an example of the Coastal Douglas Fir Forest.

III. Forestry History

First settlement of Galiano Island by Europeans is recorded during the 1860's (Elliot, 1984). Early homesteads were concentrated in the south end of the island. By 1909 there were but 39 registered voters on Galiano Island (Wilson, 1992), representing the relatively small Island population of the time. Many of the lower lying areas were cleared, and swampy areas and lakes were drained for agricultural purposes. By the 1920's extensive areas of forested land on the island had undergone some degree of high-grade logging. This traditional approach to logging was carried out using ocean landings to access and remove selected timber from the forests. The earliest cuts were made by hand plied cross cut saws and axes; men would have worked for hours on elevated springboards to fell a tree. Areas with easy access and desirable tree species would have been cleared and possibly burned.

By the 1940's logging was moving into a higher gear on the island with roads, saws, yarding cats and large logging trucks dramatically increasing the efficiency of logging operations. Larger areas were clearcut, burned, and replanted with Douglas-fir seedlings. The seedling stocks were from off island seed stock raised in off island nurseries. As technological advances developed efficiency, the ability to transform landscapes increased. Large industrial logging companies, with huge capital at their disposal, carried out large scale machine operations in the exploitation of forested lands.

Macmillan Bloedel obtained over half of the land area of Galiano Island in the 1950's. 1960's logging involved clearcutting, broadcast burning, and replanting with Douglas fir. Large scale clearcuts were the norm on the Island during the 1960's and have continued as the dominant 'forest management' approach through 2000. By the 1980's slash was piled and then burned, and the site subsequently replanted. Plantations were then managed through brushing and thinning, promoting larger tree volumes and faster growth. The resulting forests hold little semblance to any forest that has been shaped by a natural disturbance regime. Most forest structure has been eliminated in the name of efficiency, with the result that forest function is impaired.

Most of Dionisio Point Provincial Park's forest was highgraded in the early 20th century. Springboard stumps are scattered throughout the area. In the nineteen thirties and forties small areas were clearcut targeting patches of easily accessible, higher value trees. These activities removed most of the large tree structure from the forest community.

MacMillan Bloedel's acquisition of its Galiano Island Holdings included Dionisio Provincial Park. In 1964-65 an 18 hectare clearcut was established within the current park boundaries. This area was planted with a monoculture of Douglas-fir and then commercially spaced to maximize fiber production. In 1981-82 a large industrial clear-cut was created that is predominantly located outside the southern boundary along the eastern shoreline. This cut reaches into Dionisio Point Provincial Park on its southeastern boundary. It was also planted with a monoculture of Douglas fir. In 1987-88 MacMillan Bloedel continued logging operations within the park boundaries, again in the southeastern corner. This was part of a large-scale intensive plan to remove the remaining valuable timber from the area. Through community discussions with forest managers about the rate and location of logging activities on MacMillan Bloedel lands, the plan was discarded and in 1991 the land was acquired by the Crown for conservation purposes.

IV. Goal and Objectives

Goal:

To assess the restoration needs of Dionisio Point Provincial Park and determine appropriate restoration treatments. For the purposes of this project restoration will be defined as follows:

"Restoration is assisting natural processes to mend, replace, and develop:

- Natural Composition (the parts)
- Natural Structures (the arrangement of the parts)
- Natural Functions (how it works)"

(Hammond, 1999)

Objectives:

1. Identify and analyse human and natural history of the site.
2. Identify and describe current ecological conditions of the site.
3. Evaluate ecological impacts incurred by industrial logging of the site.
4. Develop appropriate restoration strategy.

V. Methods

The following list describes the methodology used to complete this restoration plan:

1. Identify land use history, the extent and timing of human induced impacts and any large scale natural disturbances that have affected the study area.
    - Reviewed available historical literature and reports including MacMillan Bloedel Forest Inventory Maps, Agriculture Canada soils maps and reports, any management plans completed for the area itself or for surrounding lands, any archeological reports or findings, original land survey maps etc.
    - Analysed historical aerial photography dating as far back as 1932. Stereo pairs of air photos were obtained from the Base Mapping and Geomatic

Services Branch of the BC Ministry of Sustainable Resources Management. Photos were viewed at the Air Photo Library in Victoria before purchase to ensure the correct coverage and to assess photo quality.

2. Create a map of the various ecosystems found within the study area.
    - Individual polygon units were delineated based on the following criteria:
        - Forest age
        - Stand structure
        - Aspect
        - Vegetative composition of forest canopy (greater than 75% conifer, greater than 75% broadleaf or mixed)
        - Density of forest canopy
        - Type and severity of historical human impact
    - The map was derived through air photo interpretation and land use history review.

3. Determine ecosystem units of interest for forest restoration.
    - Ecosystem units in need of forest restoration and their surrounding 'intact' forested areas were selected for further data collection. Selection was based on:
        - Whether ecosystem unit was forested or non-forested (cliff, stream, Garry oak woodland etc.)
        - Logging history including type of logging and year of timber removal.
        - Proximity of 'intact' forested ecosystem to restoration focus.
        - Degree of recreational use in forested ecosystem.

4. Devise field sampling strategy and collect field data to provide appropriate information on soils, vegetation, site characteristics, and all aspects of forest structure for the selected ecosystem units.
    - Data collection forms and techniques from the BC Ministry of Forests and BC Ministry of Environment, Lands and Parks "Land Management Handbook

#25: A Field Manual for Describing Terrestrial Ecosystems" were used for this study.

- Data collection was conducted in one 20m x 20m or 400 square meter plot located within each of the delineated polygon units.
- On ground visual inspections of each polygon were conducted to determine whether additional data collection plots were necessary to account for natural ecosystem variability. In polygons where visual inspections indicated a need, plots were added at an approximate intensity of one per hectare.
- Data collection plots were located on sites representative of the overall composition and structure of the target polygon unit.
- Two data collection intensities were used, Full Plots and Ground Inspection Plots. One full plot was completed for each polygon unit[2]. All additional data collection within each polygon unit was completed using ground inspection plots. In full plots, detailed data describing the site, soils, vegetation, and coarse woody debris was collected. Ground inspection plots included summary data describing the site, soils, and vegetation. Tree mensuration data was collected in the same manner for both plot types. The dimensions and ages of representative trees were taken and a diameter class, height class and species sweep of every tree within the plot boundaries was conducted.

5. Revise map of ecosystems based on collected data and visual inspections of polygon units.
    - Polygon boundaries were adjusted as necessary with some delineated into several new units and others combined into one.

6. Enter field data into digital databases.

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[2] Due to revision in step 4, many of the newly created polygon units were not characterized by full plots. After ground inspection, plots were added to the original polygon in order to account for natural ecosystem variation. As a result, there are some gaps in coarse woody debris data. These gaps could not be addressed due to time constraints.

- Programs developed in conjunction with the "Describing Terrestrial Ecosystems" field manual (called Venus and Gravi) were used for digital data entry. The programs were available as downloads from the Ministry of Water, Land and Air Protection web site. These programs were used to generate summary reports and to export data into a spreadsheet form for further or more detailed analysis.
- Information collected from the diameter class, height class and species sweep was entered directly into a spreadsheet for analysis and report generation.

7. Analyse collected data and address restoration needs of study area.
   - Data was represented in tables and charts or was transferred from a spreadsheet into a Geographic Information System (GIS) database where it was spatially linked to each polygon unit. This allowed for map production and a visual representation of the study results. Maps were created depicting attributes of forest composition and structure.
   - Data was analysed to provide insight into the current conditions of the study area.
   - Research, data analysis and personal observation were used to identify attributes of forest composition, structure and function in the study area that are altered, missing, or impeded as a result of human land use.
   - Attributes of forest composition, structure and function that can be feasibly or realistically manipulated through restoration treatments were identified.

8. Consult with experts in the fields of restoration, forestry and ecology.
   - Maps, data analysis and ideas for recommendations were presented and discussed.
   - Focal areas for restoration treatments were visited in the field.
   - Consultations provided insight into data interpretations and possible restoration recommendations. Consultations introduced different perspectives and offered a pool of knowledge from which to draw on.

9. Identify appropriate restoration treatments and develop recommendations.
    - Identified restoration treatments were developed based on ecological condition, feasibility, and landscape level significance.
    - Recommendations were considered over short, mid and long-term temporal scale based on results of the assessment of restoration treatments.
    - A low impact approach was taken when designing restoration treatments.

10. Design appropriate monitoring techniques for all restoration treatments.
    - Criteria for design included effectiveness for tracking changes in ecosystem composition and structure, and effectiveness for reporting on relative success or failure of specific restoration measure.

VI. Forest Structure, Compostion and Function Pertinent to Restoration Recommendations

Large Live Trees

Large living trees define the vertical extent of a forest ecosystem. The more large trees in a forest the greater the potential for canopy complexity. Large tree limbs have been shown to provide micro-habitats where soil can develop and sustain unique ecosystems. Large, ancient live trees become sentinels that influence a forest's local physical and genetic characteristics. When a large tree becomes a snag it provides incredibly valuable wildlife habitat. When a large tree falls it creates structural and compositional diversity through the creation of gap ecosystems and through it's contribution of large woody material to the forest floor.

Towering Douglas-fir trees are an integral part of all stages of natural forest succession in the CDF zone. Common disturbances such as fire and windthrow rarely deplete a stand of all it's veteran trees. The thick furrowed bark of old Douglas-fir trees is resistant to fire, leaving many standing even after intense burns. Windthrow is simply limited in scale and patchy by nature.

Snags

Standing dead trees, or snags, are important attributes within any forest stand. Snags are used by many species from fungi and insects to birds and mammals. Snag use includes perching, roosting, nesting, foraging, courtship, drumming and hunting (Neitro et. Al. 1985). The value of a snag varies with its species, size, and extent of decay. Large dead trees (>50cm dbh) offer greater value as habitat structural features. Larger dead trees tend to remain standing longer and provide a greater variety of habitat conditions, like sloughing bark, perching limbs and broken tops (Norse, 1990). Cavity nesting birds and mammals require large snags of various decay classes. Cedar and Douglas-fir remain as snags much longer than most deciduous species and most other softwoods, giving them high and long lasting habitat value. Snags also ensure a supply of coarse woody debris to the forest floor.

Coarse Woody Debris

The presence of fallen dead trees, or coarse woody debris, is an essential structural component of a healthy forest ecosystem. A tree's ecological role does not end with its death, whether it remains standing or falls, function may change but continues to play a key role in the forest ecosystem. Fallen trees slowly breakdown providing a variety of ecological functions as they return to soil organic components. Coarse woody debris plays a significant role in providing habitat for many forest creatures, ranging from bacteria and invertebrate species to amphibians to large mammals. The sponge-like qualities of decaying wood enable cwd to soak up and retain large quantities of water. Organisms such as mychorrhizal fungi depend on these moisture sinks for survival during dry summers in the CDFmm (Stevens, 1997). Coarse woody debris also provides initial soil stability on slopes, and is ultimately incorporated into the soil, enhancing nutrient content and structure (Bartels et. al. 1985).

Important functional attributes of coarse woody debris are often sorely missing within the majority of clearcut forests where site preparation or burning treatments have taken place. The decline of woody debris volume is often compounded by the small size of the material that is present. Small diameter downed wood decays rapidly, providing only short-lived nutrient input, very little moisture storage and limited habitat structure. Many of the functions inherent in large diameter debris do not translate to smaller pieces. Habitat value for fungi, vegetation and wildlife as well as moisture storage capacity are two of the primary deficiencies.

Root Disease

Gaps occasionally occur due to the presence of laminated root rot in the stand (*Phellinus wierii*). *P. wierii* induced gaps are prevalent throughout forested ecosystems on Galiano. Most of these gaps have *P.weirii* resistant deciduous and tolerant cedar trees taking advantage of the light, as well as herb and shrub layer development. This natural diversification of the forest should be regarded as being a positive impact on the structural diversity of the stand. The dying fir trees provide temporary snags and add coarse woody debris to the forest floor. As species diversification increases, the spread of P. weirii fungus will likely recede.

Tree Species Diversity

Structural complexity is enhanced by the presence of different tree species due to the various ranges of requirements, limitations and preferences characteristic of each species. Each species is a unique member of the ecological community. Each occupies space and affects its ecosystem in unique ways. Deciduous trees build soil by adding their leaves to the forest floor each fall. Red alder helps restore soils by fixing nitrogen, of particular importance when dealing with heavily disturbed sites. Bigleaf maples are excellent hosts for epiphytic plants and provide complex habitat with their huge lateral branching patterns. Different trees have evolved different plant and animal associations ie. Squirrels and Douglas-fir cones, maple trees and Licorice fern (*Polypodium glycyrrhiza*) that are important components of overall forest function. Diversity of tree species is often indicative of the overall compositional and functional diversity of a forest.

<u>Exotic Vegetation</u>

Exotic vegetation out-competes native plant species thereby simplifying ecosystm structure and function. Scotch broom (Cytosis scoparius) readily occupies well drained, excessively disturbed or naturally poor sites. Eliminating broom from a site is not just a matter of cutting down existing plants. Young plants re-sprout vigorously after cutting and seeds can remain in the soil for up to 30 years. Establishment of native plant species and protection from any future site disturbance is essential when removing broom from an area.

Himilayan blackberry (Rubus discolor) tends to invade disturbed sites, moist sites and streamside sites. The invasive shrub is heavily shade intolerant and will readily invade open areas such as gaps, roads and other clearings. Plants will re-sprout vigorously after pruning and will root from the ends of stems. Establishment of native tall shrubs or trees can provide the shading necessary to eradicate Himilayan blackberry from an area.

English ivy (Hedera helix) and English holly (Ilex aquifolium) are shade tolerant invasive exotics and can threaten native tree and shrub growth within forested areas. Although not as aggressive as broom or blackberry, these species do have the potential to cause significant impact within Dionisio Point Provincial Park.

VII. Results and Recommendations

As with all ecological restoration projects, there is a strong component of experimentation and adaptation that is necessary to ensure success. Each site brings a new combination of variables, which must be addressed to ensure treatment energies are well spent. Each targeted treatment area will require a fairly elaborate layout plan prior to carrying out the work. Layout should be focused on eliciting the most structure, function and native diversity possible on a site by site basis. Decisions must factor in spatial and temporal needs on the local site, but doing so in relation to stand, watershed and landscape characteristics. It may be prudent to carry out initial treatments on smaller scales, assessing them for success before expanding their application. This strategy is far more desirable than applying blanket prescriptions, which treat the entire district lot in a uniform manner. Starting small will allow for easier recognition of what works and will provide time for the adaptation of methodologies and approaches based on local conditions. As mentioned earlier, forests are complex systems, forest restoration is therefor not a simple process.

A total of 57 polygon units were delineated and classified. All polygons were categorized by general habitat type (MAP 3). The following is a list of general habitats and their respective definitions:

Shrub / Herb: Early successional stage or shrub communities maintained by environmental conditions or disturbance; dominated by shrubby vegetation; seedlings and advance regeneration may be abundant.

Pole / Sapling: Trees > 10m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually 10-15 years old), self-thinning and vertical structure not yet evident in the canopy; time since disturbance < 40 years for normal forest succession.

Young Forest: Self-thinning has become evident and the forest canopy has begun to differentiate into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole sapling stage; begins as early as age 30 and extends to 50-80 years; time since disturbance generally 40 –80 years, depending on tree species and ecological conditions.

Mature Forest: Trees established after the last disturbance have matured; a second cycle of shade-tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance generally 80 – 250 years. (One of the Mature Forest polygons was characterized by distinct closed canopy and gap dominated areas and was delineated into ‘dense’ and ‘gap’ categories accordingly.)

**** Mature and Young Forest ecosystems were further broken down into conifer (>75% of canopy characterized by conifer species), broadleaf (>75% of canopy characterized by broadleaf species) and mixed (neither >75% conifer or broadleaf) categories.

Shoreline Forest: Thin strip of conifer and broadleaf species directly adjacent to the foreshore and heavily influenced by the marine environment.

Ridge: Areas of land characterized by a steep slope or cliff on one side and a gentle or moderate slope on the other side, where soils are typically shallow and well drained and where forest understory exposure to light and weather is increased.

Cliff , Steep Slope: Steep, vertical or overhanging rock face and talus.

Stream: Watercourse formed when water flows between continuous, definable banks.

Wetland: Wetland, swamp or bog with water table at or above ground level throughout the year (< 2 m deep).

Herbacious Terrestrial: Naturally occurring grassland / herbaceous / sparsely vegetated ecosystem with no associated forest or woodland canopy.

Woodland: Grass / shrub understory with individual or clustered patches of Garry oak, Douglas-fir, Arbutus. No continuous or closed canopy.

Forest, Intensive Recreational Use: Areas heavily impacted by recreational use and developments, often coincides with partial removal of tree canopy.

Beach: Area characterized by sand or pebbles subject to tidal influences.

Various man-made clearings: Includes a parking lot, gravel pit, storage yard, road junction and areas cleared of vegetation and soil for unknown reasons.

Several polygons were selected for detailed, ground-based ecosystem assessment and were given specific polygon identifiers (MAP 4). Forested polygons deemed to be of interest for restoration purposes include 1, 2a, 2b, and 7. Forested polygons that were used as reference ecosystems include 3a, 3c, 4b, 6, 8a and 8b. Other polygons, including 4a, 8c, 9 and 10 were deemed to have structural and compositional components that warranted further investigation but were not seen to be in need of restoration. Roads and clearings were also delineated, and have associated restoration recommendations. All collected data is available on the CDROM provided with this report. Raw data can be viewed from the "Dionisio.mdb" database file using the Venus 42 program included on

MAP 3

Habitat Types

N
W E
S

Habitat polygon boundaries
Road

Wetland
Maple Creek

CC - Clearcut (date of cut completion)
u - unplanted
p - planted with Douglas-fir
s - pre-commercially thinned
SH - Shrub / Herb
PS - Pole / Sapling
YF - Young forest
MF - Mature forest
gap / closed - forest canopy modifier
c - conifer
b - broadleaf
m - mixed
SF - Shoreline forest
RD - Ridge
CSS - Cliff , steep slope
WT - Wetland
HT - Herbacious Terrestrial
WD - Woodland
FR - Forest, Intensive Recreational use
BE - Beach
GP - Gravel pit
SY - Storage yard
RJ - Road junction
PL - Parking lot
CL - Clearing (unknown land-use)

100 0 100 200 300 Meters

MAP 4

Polygon Identification for Ecological Assessment

the CD. All species, diameter and height information can be viewed in the Microsoft Excel spreadsheet “Dionisio Mensuration Report II.xls.”. Analysis of the raw data can be viewed in the Excel spreadsheet entitled “Dioraw.xls”.

In addition to spreadsheets and databases, a GIS was used to analyse collected data. Maps depicting the following forest attributes have been included in Appendix I of this report:

- Large tree occurrence and ranking
- Large snag occurrence
- Coarse woody debris occurrence
- Forest structure ranking
- Total tree density
- Douglas-fir density
- Broadleaf species density
- Tree diversity

The following pages constitute a summary report for polygons of restoration interest:

Polygon 1

Major Human Disturbances:

Polygon 1 was clearcut, broadcast burned and then planted with Douglas-fir in 1982. Although it is a smaller polygon (just over 1 hectare), it is part of an industrial clearcut exceeding 115 hectares in size.

Current State:

Structure

Structural stage: Pole Sapling, single storied, conifer

Polygon 1 has a very poor structural diversity. No large (>25cm) trees or snags were observed, and no large (>50cm) pieces of coarse woody debris were recorded. Cwd volume was calculated at 47 cubic meters per hectare. This was far below the average value of 236 cubic meters per hectare calculated from the results of all surveyed reference polygons. There are several gaps where tree planting efforts were not entirely successful.

However, the polygon is largely dominated by a single storied, Douglas-fir canopy. The dominance of this uniform canopy will only increase in the future as the stand moves into the Young Forest structural stage and stem exclusion processes intensify.

Composition

Soil Moisture Regime: Subxeric - Submesic

Soil Nutrient Regime: Poor - Medium

Site Series: 01 Fd - Salal

Dominant vegetation species on this site included Douglas-fir, Lodgepole pine, Salal, and Evergreen huckleberry. Douglas-fir had an average percent cover of over 70% with Salal coming in at just under 45%. Lodgepole pine presence increased with proximity to the shoreline. Pine accounted for 20% cover in a plot located near the shoreline and only 4% in a plot located just southwest of the road running through the centre of the polygon. This trend was observed (visually) in forests along the entire length of the parks eastern shoreline. Tree species diversity for this polygon was relatively average. This was due to a combination of the uniform plantation Douglas-fir on one hand, and the natural diversity, caused by pioneering broadleaf species on the other hand. A naturally regenerating forest at the same structural stage would most likely have a higher tree diversity rating. Genetic diversity is another concern on this site. Plantation Douglas-fir were most likely from off-island genetic stock and therefore may not encompass the natural variation and attributes that are developed through 1000's of years of local genetic adaptation.

Recommendations:

Point Source thinning and gap creation to help restore natural forest characteristics to a uniform Douglas-fir plantation.

- Map native seedling occurrence and collect detailed tree density data. This will provide the necessary level of information required to make accurate and detailed treatment plans.
    - Use a transect sampling technique. Transects should be oriented with or along the dominant slope at intervals of approximately 30 meters.

  - Special features such as seedlings, suppressed naturally regenerating trees, snags, large pieces of coarse woody debris, and canopy gaps should be mapped continuously along the transects. All features located within a 5m swath, either side of the transect should be recorded.
  - Circular plots, 3.99 meters in radius should be established at intervals of 40 meters along each transect where species, diameter class and height class information on all trees with stems within the plots should be taken.
- Thinning techniques, including tree topping, girdling and traditional cutting can be employed to reduce uniformity within the study area. Thinning can be utilized to meet the following objectives:
  - Increase structural diversity through: snag creation by topping and girdling; short-term coarse woody debris creation by direct cutting of existing trees; growth promotion in existing large trees, which will in turn provide large snags and large pieces of cwd in the future; and gap creation to encourage understory growth and to provide multi-storied canopy in the future.
  - Increase genetic diversity through the release of native to Galiano seedlings.
  - Increase species diversity through: release of under-represented species such as Grand fir and arbutus; release of rarely occurring species such as Western yew; and release of advanced regeneration such as Western Red cedar and Western hemlock.
- Select seedlings to release and determine gap sizes based on density and special feature data.
- Do not select trees around existing canopy gaps or within exotic vegetation removal areas as targets for thinning.
  - 5 to 10 meter buffer zones around natural forest openings will ensure that gap dynamics are allowed to continue without intervention. In the case of root disease caused gaps, many of the surrounding plantation

trees are likely to succumb to natural death in the near future, while more resistant, naturally regenerating deciduous and conifer species will likely survive.

    - Tree cover will provide shade and in turn deter Himilayan blackberry and Scotch broom growth.

- When creating snags, tree topping and the removal of green limbs is preferred in order to mimic better natural decay processes. Girdling should occur only when climbing a tree is not feasible. Girdled trees tend to rot from the outside in (rather than the inside out) and snap easily, limiting their value as snags.
- Designate control areas within each treated polygon so that comparisons can be made for monitoring purposes.

Remove Exotic Vegetation

Scotch broom and Himilayan blackberry are present within polygon 1, predominantly along the central logging road. Scotch broom should be removed. Blackberry will likely die naturally as the stand grows and shading from the canopy intensifies. Where canopy shading is not anticipated, blackberry should be removed by cutting at the base. Avoid point thinning treatments in areas affected by exotic vegetation in order to maximize canopy shading. Broom removal should be conducted as follows:

- Established woody plants can be removed by cutting at the base, juvenile seedlings can be pulled.
- Young broom plants that have not developed woody stems, and are too large to pull without significant soil displacement should be left and reassessed in the following season.

Polygon 2a

Major Human Disturbances:

Polygon 2a is a 3 hectare, naturally regenerating clearcut established in 1988. Polygon 2a is adjacent to the large planted clearcut described for polygon 1. The nature of the polygon's shape and location results in wind channeling that has had a noticeable affect on the forested areas immediately to the northwest, particularly in polygon 4a where intense windthrow has occurred.

Current State:

Structure

Structural stage: Tall Shrub to Pole Sapling

Polygon 2a has a very poor structural diversity. No large (>25cm) trees or snags were observed, and no large (>50cm) pieces of coarse woody debris were recorded. Cwd volume was calculated at 33 cubic meters per hectare. This was the least amount of coarse woody debris observed throughout the entire study area. Although lacking in many structural components, this polygon does have one significant benefit over polygon 1, it has not been uniformly planted with Douglas-fir. Polygon 2a is currently in the process of natural regeneration. Allowing this process to occur instead of planting, brushing and thinning has created a mosaic effect, with dense patches of trees interspersed with shrub dominated areas. This will likely result in a multi-storied, uneven aged forest in future years that will have a high level of structural diversity.

Composition

Soil Moisture Regime: Submesic, Subhygric (small area in middle of polygon)

Soil Nutrient Regime: Medium

Site Series: 01 Fd – Salal (05 CwFd – Kindbergia in subhygric area)

Dominant vegetation species on this site included Douglas-fir, Lodgepole pine, Salal, and Arbutus. The Subhygric area was dominated by Salal, Oceanspray and Himilayan

Blackberry. Douglas-fir had an average percent cover of over 32% with Salal coming in at 58%, Arbutus at 37% and Lodgepole pine at 15%. In the subhygric area, Oceanspray comprised 40% cover while Himilayan blackberry had over 30% cover. Himilayan blackberry was spreading outward from the central road running the length of the polygon. Tree species diversity for this polygon was very high as is expected in such an early successional forest. The polygons successional status combined with natural regeneration processes have created habitat for many different tree species. The highest diversity was found in the subhygric area where 10 different tree species were identified including two species not identified in any other plots: Western flowering dogwood and Bigleaf maple. Plots representative of the majority of the polygon indicated a presence of 9 different tree species including Black cottonwood that was not found in the subhygric area. It is anticipated that the genetic diversity of this site will not be a concern, as the current seedlings and saplings were most likely derived from seed released from the adjacent mature forests.

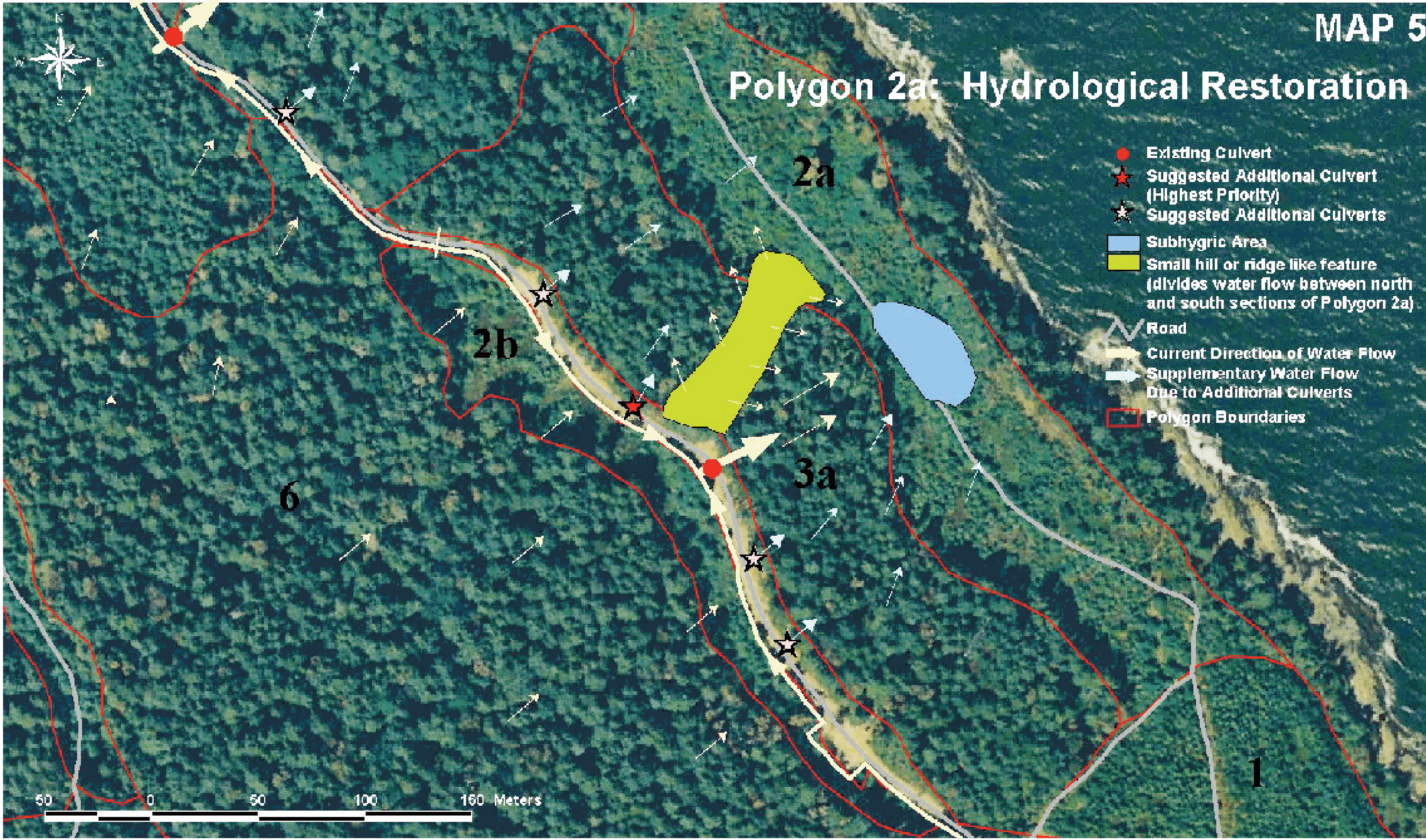
Recommendations:

Exotic Species Removal

Removal of exotic vegetation located within Polygon 2a is of highest priority. Allowing successional processes to take their natural course may result in extended periods of the shrub/herb dominated phase in patches throughout the polygon. Exotic vegetation has been and is likely to continue to take advantage of these treeless areas. Blackberry is rampant in the subhygric area and broom dominates the central road that runs the length of the polygon. The road will act as a hub for the spread of exotic vegetation into any remaining areas of high disturbance or sparse vegetative cover. Do not focus removal efforts in areas where tree canopies have been established and light demanding broom or blackberry will soon be shaded out.

Hydrological Issues

Examination of the subhygric area, both through air photo interpretation and on-the-ground site checks, has resulted in a possible restoration concern. Although the area is naturally moist, it may be receiving excess water due to the construction of the main access road to the west. The area seems to be at the foot of a draw, where water from upslope is concentrated or funneled due to the lay of the land and the decrease in slope angle. However, it seems that surface and subsurface flow, which would normally run through the northern section of Polygon 2a has been diverted into the subhygric area by the construction of the main road and the positioning of one of the culverts. It is recommended that additional culverts be constructed in order to restore a more natural hydrologic condition to areas of Polygon 2a (and 3a). Refer to MAP 5 for culvert positioning and for the direction of water flow.



MAP 5
Polygon 2a: Hydrological Restoration
Existing Culvert
Suggested Additional Culvert (Highest Priority)
Suggested Additional Culverts
Subhygric Area
Small hill or ridge like feature (divides water flow between north and south sections of Polygon 2a)
Road
Current Direction of Water Flow
Supplementary Water Flow Due to Additional Culverts
Polygon Boundaries
2a
2b
3a
6
1
50 0 50 100 150 Meters

Monitoring of Natural Regeneration

Monitoring of the natural patterns of regeneration within this polygon should occur. Information collected can be used as a template or comparison to aid restoration in plantations that exhibit similar ecological, temporal and topographic conditions. Data describing patterns of tree densities over time (natural stem exclusion process), development of forest structure and distribution of vegetation should be collected (mensuration including species, diameter class and height class sweeps, vegetation % cover and vertical layering, and a detailed site map).

Polygon 2b

Major Human Disturbances:

Polygon 2b is a 1 hectare, naturally regenerating linear clearcut established in 1988. The entire length of Polygon 2b's eastern boundary is adjacent to the main access road for the park.

Current State:

Structure

Structural stage: Low shrub – Tall Shrub

Polygon 2b has a very poor structural diversity. No large (>25cm) trees or snags were observed, and no large (>50cm) pieces of coarse woody debris were recorded. Cwd volume was calculated at 154 cubic meters per hectare. All but 3 pieces of woody debris were less than 20cm in diameter, with one piece at 23cm, one at 28cm and one at 45cm. The 45cm piece was likely left over from the pre-clearcut forest and the other two may have fallen in to Polygon 2b from Polygon 6. Although lacking in many structural components, this polygon does have one significant benefit over polygon 1, it has not been uniformly planted with Douglas-fir. Polygon 2b is currently in the process of natural regeneration. Allowing this process to occur instead of planting, brushing and thinning has created a mosaic effect, with dense patches of trees interspersed with shrub dominated areas. This will likely result in a multi-storied, uneven aged forest in future years that will have a high level of structural diversity.

Composition

Soil Moisture Regime: Subxeric

Soil Nutrient Regime: Medium

Site Series: 01 Fd - Salal

Dominant vegetation species on this site included Douglas-fir, Salal, Arbutus and Evergreen huckleberry. Douglas-fir had an average percent cover of over 18%, Salal 65%, Evergreen huckleberry 28% and Arbutus 10%. Tree species diversity for this polygon was relatively high. Like Polygon 2a it is in an early successional phase, giving opportunity for many different species to flourish. The long linear nature of Polygon 2b will ensure adequate tree seeding from surrounding mature forest. A small amount of

Himilayan blackberry was recorded within this polygon and Scotch broom was noted mainly along the roadside during visual inspections.

Recommendations:

Exotic Species Removal

Like Polygon 2a, this area is susceptible to invasion from exotic vegetation. It is recommended that any exotics within this polygon be removed. In addition, regular monitoring and removal of exotics growing along the main access road should occur. This area is the primary source of exotics and will help to control the invasion into Polygon 2b.

Monitoring of Natural Regeneration

Monitoring of the natural patterns of regeneration within this polygon should occur. Information collected can be used as a template or comparison to aid restoration in plantations that exhibit similar ecological, temporal and topographic conditions. Data describing patterns of tree densities over time (natural stem exclusion process), development of forest structure and distribution of vegetation should be collected (mensuration including species, diameter class and height class sweeps, vegetation % cover and vertical layering, and a detailed site map).

Polygon 7

Major Human Disturbances:

Polygon 7 was clearcut, broadcast burned and then planted with Douglas-fir in 1965. The cut has a total area of 18.3 hectares. Polygon 7 was also pre-commercially thinned.

Current State:

Structure

Structural stage: Young Forest – single storied, conifer

Polygon 7 has a poor structural diversity when compared to surrounding mature stands. Trees with diameters between 25cm and 50cm were abundant. Only one tree with a diameter greater than 50cm was recorded in a total of 10 plots. No large snags greater than 20cm in diameter were recorded in this polygon although some were visually observed within and around gaps caused by laminated root rot. No large pieces of coarse woody debris were recorded. All surveyed pieces were less than or equal to 20cm in diameter. Cwd volume was calculated at 69 cubic meters per hectare. Diversity of vegetative structure in Polygon 7 is very poor. A single story, single species (Fd) canopy dominates the ecosystem with relatively poor understory shrub, herb and moss development. Exceptions to these conditions exist in canopy gaps scattered throughout the polygon, most of which are associated with centres of laminated root rot that are slowly taking advantage of the evenly spaced Douglas-fir stand composition. All gaps identified from aerial photography have been delineated and are shown on MAP 6.

Composition

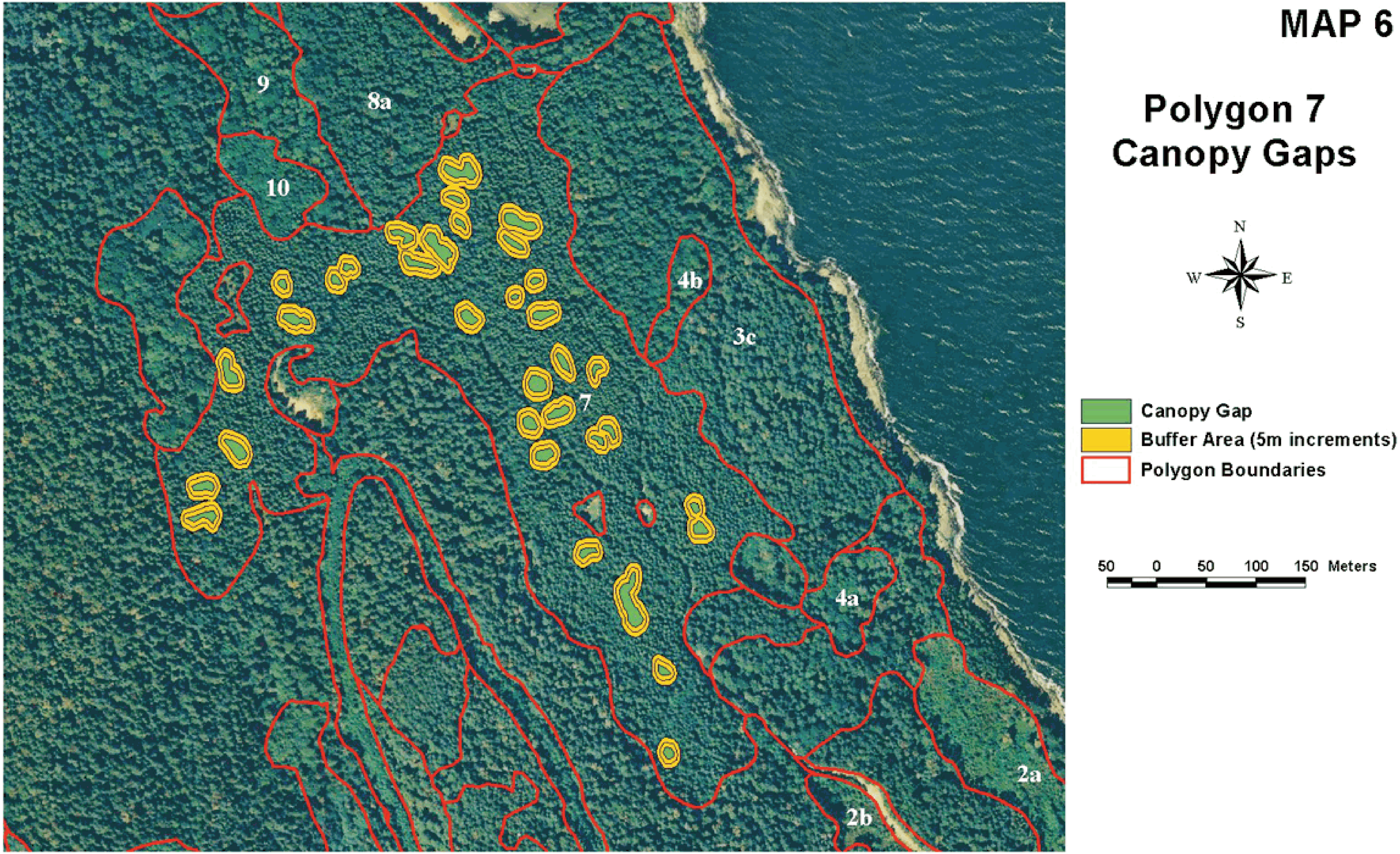
Soil Moisture Regime: Submesic

Soil Nutrient Regime: Medium – Rich

Site Series: 01 Fd – Salal / 04 Fd, Bg – Oregon grape

MAP 6

Polygon 7 Canopy Gaps



Dominant vegetation species on this site included Douglas-fir, Salal, and Oregon beaked moss. Douglas-fir had an average percent cover of over 63% with Salal coming in at just under 34% and Oregon beaked moss 23%. Western yew was recorded in two of the ten plots. Tree species diversity for this polygon was relatively average. This was due to a combination of the uniform plantation Douglas-fir on one hand, and centres of diversity created by root rot gaps on the other hand. Genetic diversity is another concern on this site. Plantation Douglas-fir were from off-island genetic stock and therefore do not encompass the natural variation and attributes that are developed through 1000's of years of local genetic adaptation.

Recommendations:

Point Source thinning and gap creation to help restore natural forest characteristics to a uniform Douglas-fir plantation.

- Map native seedling occurrence and collect detailed tree density data. This will provide the necessary level of information required to make accurate and detailed treatment plans.
    - Use a transect sampling technique. Transects should be oriented with or along the dominant slope at intervals of approximately 50 meters.
    - Special features such as seedlings, suppressed naturally regenerating trees, snags, large pieces of woody debris and canopy gaps should be mapped continuously along the transects. All features located within a 10m swath, either side of the transect should be recorded.
    - Circular plots, 3.99 meters in radius should be established at intervals of 40 meters along each transect where species, diameter class and height class information on all trees with stems within the plots should be taken.
- Thinning techniques, including tree topping, girdling and traditional cutting can be employed to reduce uniformity within the study area. Thinning can be utilized to meet the following objectives:
    - Increase structural diversity through: snag creation by topping and girdling; short-term coarse woody debris creation by direct cutting of

existing trees; growth promotion in existing large trees, which will in turn provide large snags and large pieces of cwd in the future; and gap creation to encourage understory growth and to provide multi-storied canopy in the future.

    - Increase genetic diversity through the release of native to Galiano seedlings.
    - Increase species diversity through: release of under-represented species such as Grand fir and arbutus; release of rarely occurring species such as Western yew; and release of advanced regeneration such as Western Red cedar and Western hemlock.

- Select seedlings to release and determine gap sizes based on density and special feature data.
- Establish 5-10 meter buffers around existing canopy gaps where no thinning should occur.
    - Buffer zones around natural forest openings will ensure that gap dynamics are allowed to continue without intervention. In the case of root disease caused gaps, many of the surrounding plantation trees are likely to succumb to natural death in the near future, while more resistant, naturally regenerating deciduous and conifer species will likely survive.
    - Tree cover will provide shade and in turn deter Himilayan blackberry and Scotch broom growth.
- When creating snags, tree topping and the removal of green limbs is preferred in order to mimic better natural decay processes. Girdling should occur only when climbing a tree is not feasible. Girdled trees tend to rot from the outside in (rather than the inside out) and snap easily, limiting their value as snags.
- Designate control areas within each treated polygon so that comparisons can be made for monitoring purposes.

Main Access Road

Recommendations

Remove Exotic Vegetation

Scotch broom was identified along the sides of the main access road. Areas where broom is concentrated include the length of road adjacent to Polygon 2b and in the parking lot area near the main camping facility. These areas are currently providing a seed source for broom invasion into surrounding regenerating forest areas.

Salvage Native Plants and Trees

Also observed along the main access road and in several small clearings were native tree and shrub seedlings growing on the exposed fill. If the road and clearing areas are regularly maintained, and vegetation growth there is not desirable, it is recommended that seedlings be salvaged and stored for use in future restoration projects. If nursery facilities are not available to BC Parks, the Galiano Conservancy Association has an existing restoration nursery that could accommodate any salvaged plants.

Gravel Pit

Recommendations

Restoration activities are recommended for the gravel pit located in the central region of the park (MAP 3).

Remove Exotic Vegetation

Scotch broom currently dominates the gravel pit site and should be removed. This area is a seed source for broom, which may spread into any nearby future disturbance areas. The broom is also inhibiting the natural regeneration of native shrub and tree species on the site.

Distribute Soil and Woody Debris and Re-vegetate with Native Plants

An intensive site survey should occur after the broom has been removed. Data collection should include the quantity and types of native regeneration, the degree and any variations of soil disturbance, the composition of top soil that has been piled in berms around the perimeter of the gravel pit, and determination of the best placement of microsites.

Top soil should be distributed to predetermined microsite locations. Any existing native vegetation should be salvaged before disbursal. The existing substrate in areas targeted for microsite creation should undergo decompaction before top soil distribution, providing the density and porosity required for establishment of healthy root systems. Microsites should be created in a manner that reflects common soil structure, having material with higher mineral content on the bottom and material with higher organic content on top. In addition to soil berms, the gravel pit hosts small piles of woody debris. It is recommended that piled wood be disbursed over the gravel pit site. Wood distribution may be concentrated on microsites in order to create local moisture, nutrient and habitat conditions that will aid the survival of plants and their associated fauna. The microsites should be planted with suitable native to Galiano Island shrubs and trees including those salvaged from the gravel pit. Areas of the pit exhibiting very high concentrations of natural seedling regeneration can be used as a source for planting material. If required, additional seedlings could be transplanted from the main access road (in coordination with plant salvage mentioned above) or from the Galiano Conservancy Native Plant Nursery. Plants should be selected for their adaptability to site specific nutrient and moisture conditions.

Trails and Campgrounds

Recommendations

Removal of Snags

Due to the very limited presence of large dead standing trees within the study area, it is recommended that snags occurring near hiking or camping facilities be preserved whenever possible. The BC Parks Conservation Program Policies (Conservation Management, Part 1), under Vegetation Management – Hazard Trees states, "If removal or modification of hazard trees threatens high conservation values, visitor use patterns may be altered to eliminate the need for such actions."

If a dead standing tree has been identified as a hazard for hikers or campers by a certified wildlife tree assessment officer and alteration of visitor use patterns is not possible, the following is recommended:

- Fall tree into the forest
- Leave as high a stump as possible
- Do not buck tree into small pieces

VIII. Monitoring

Monitoring techniques should be used to provide feedback on ecological responses to restoration treatments.

- All restoration treatments should be monitored.
- Monitoring techniques include permanent photo points, permanent data collection plots, repeated visual inspections and air photo interpretation.
- It is recommended that a combination of these techniques be used for each of the various restoration treatments.
- Monitoring should occur in treatment areas and in control areas. This will provide valuable data for determining changes in ecology over time and will in turn provide a foundation for measuring the relative success of restoration treatments. This will also indicate whether additional measures are required to ensure successful restoration (ie. continued removal of exotic species, additional native species planting or creation of larger gaps around targeted features)
- Permanent photo points and plot corners can be marked with iron pins and mapped with a Global Positioning System.

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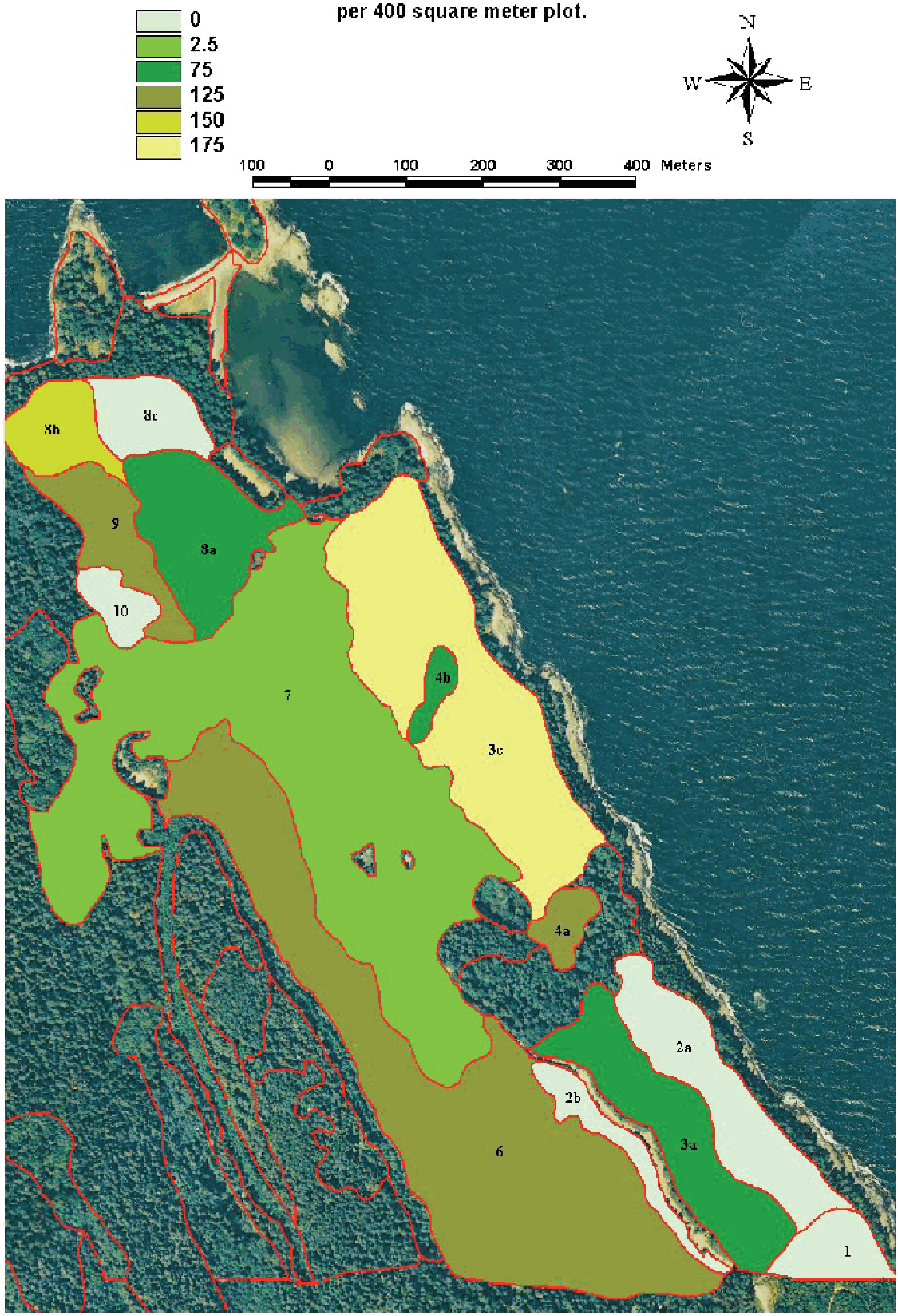
APPENDIX I

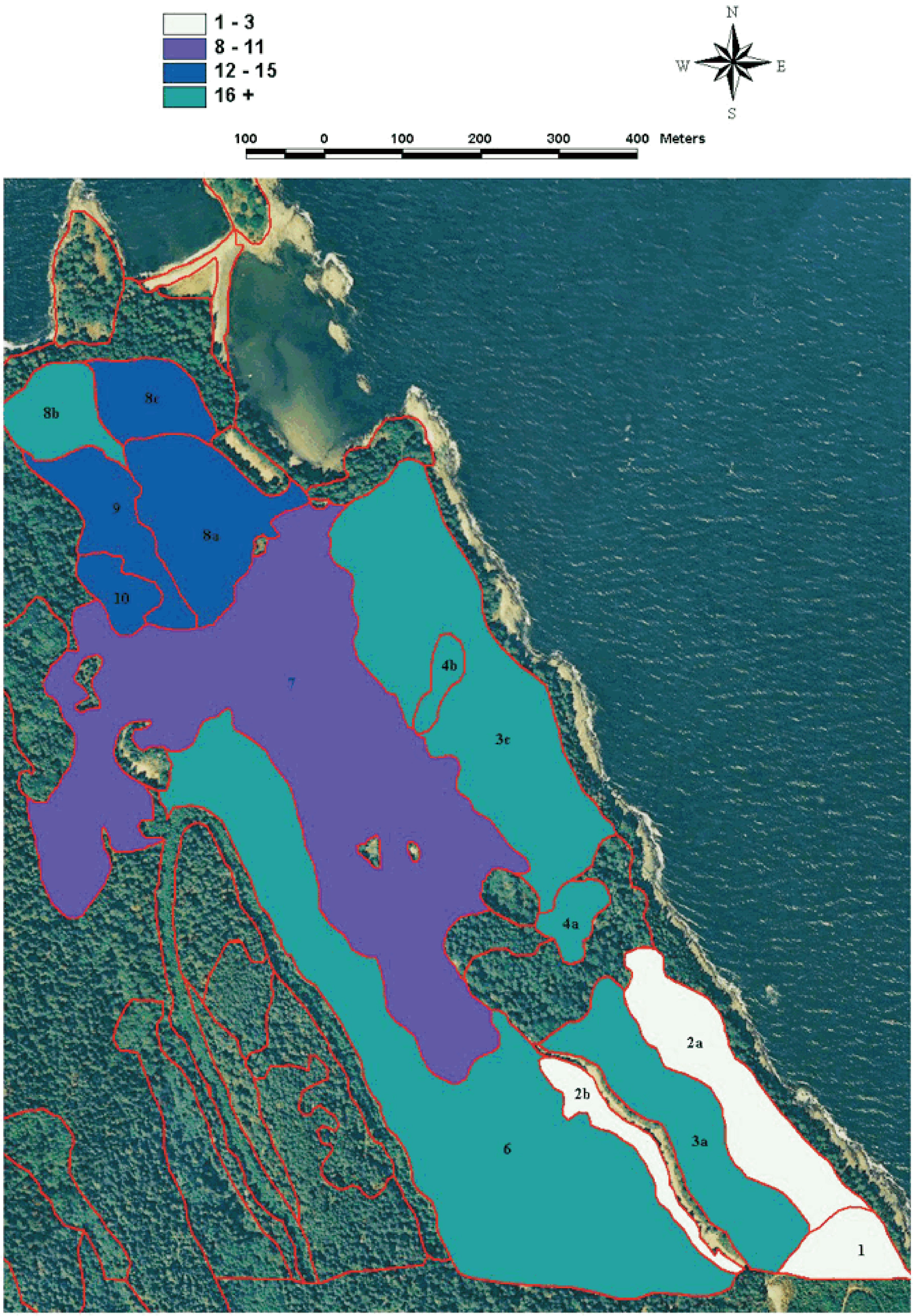
Large Tree Occurrence
- Diameters greater than 50cm -

Large diameter tree occurrence is measured in stems per hectare.
The values are based on the average number of stems
per 400 square meter plot.



Large Tree Ranking

Ranking is based on a point system representing the number of stems per hectare of larger diameter trees. The system is wieghted so that trees with a diameter greater than 50cm are worth two points and trees with diameters between 25cm and 50cm are worth one point.

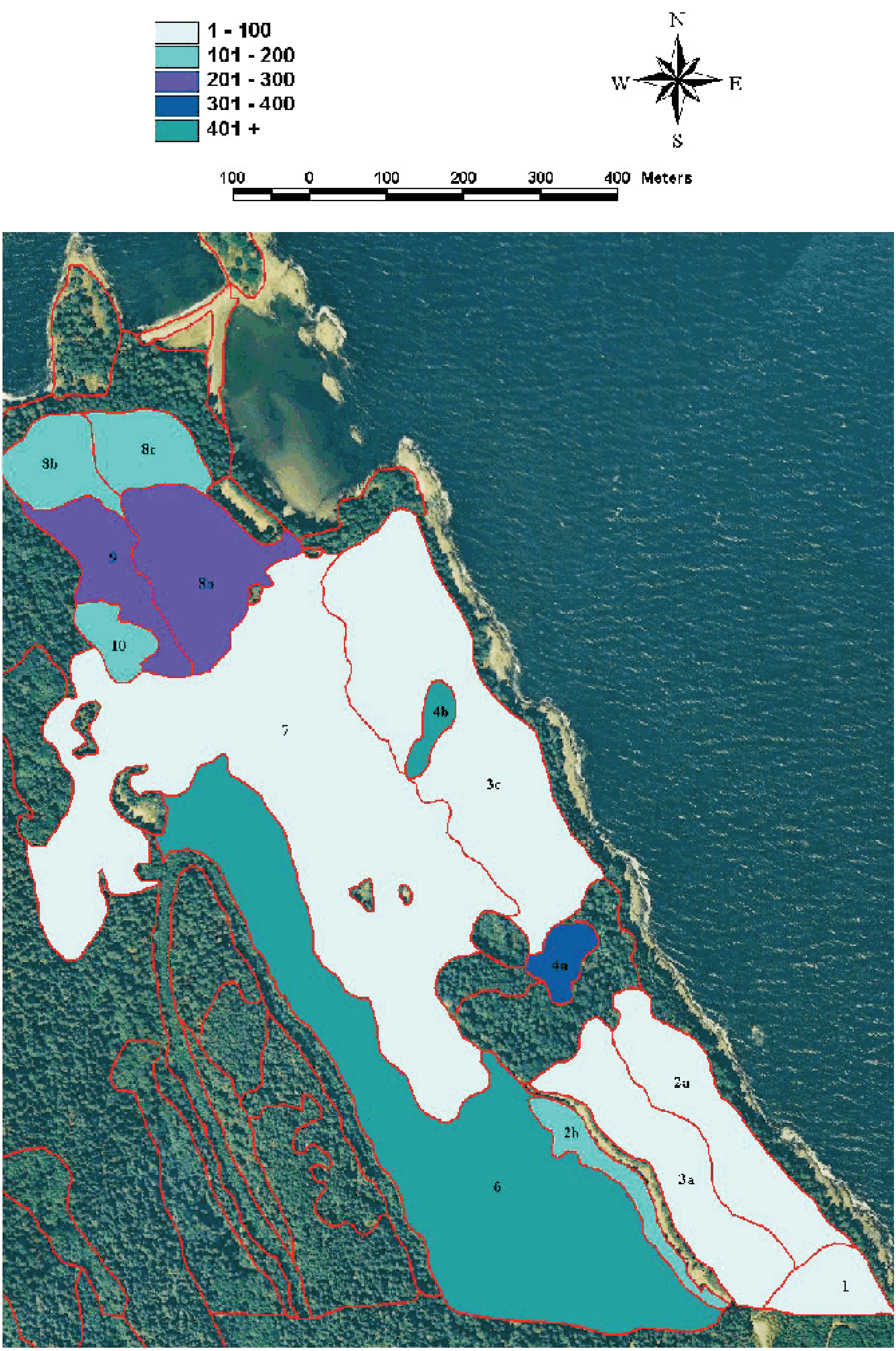


Large Snag Occurrence

Large snag occurrence is measured in stems per hectare.
All snags surveyed had diameters between 25cm and 50cm
except one that was greater thatn 50cm, found in polygon 4b.
The values are based on the average stems per 400 square meter plot.

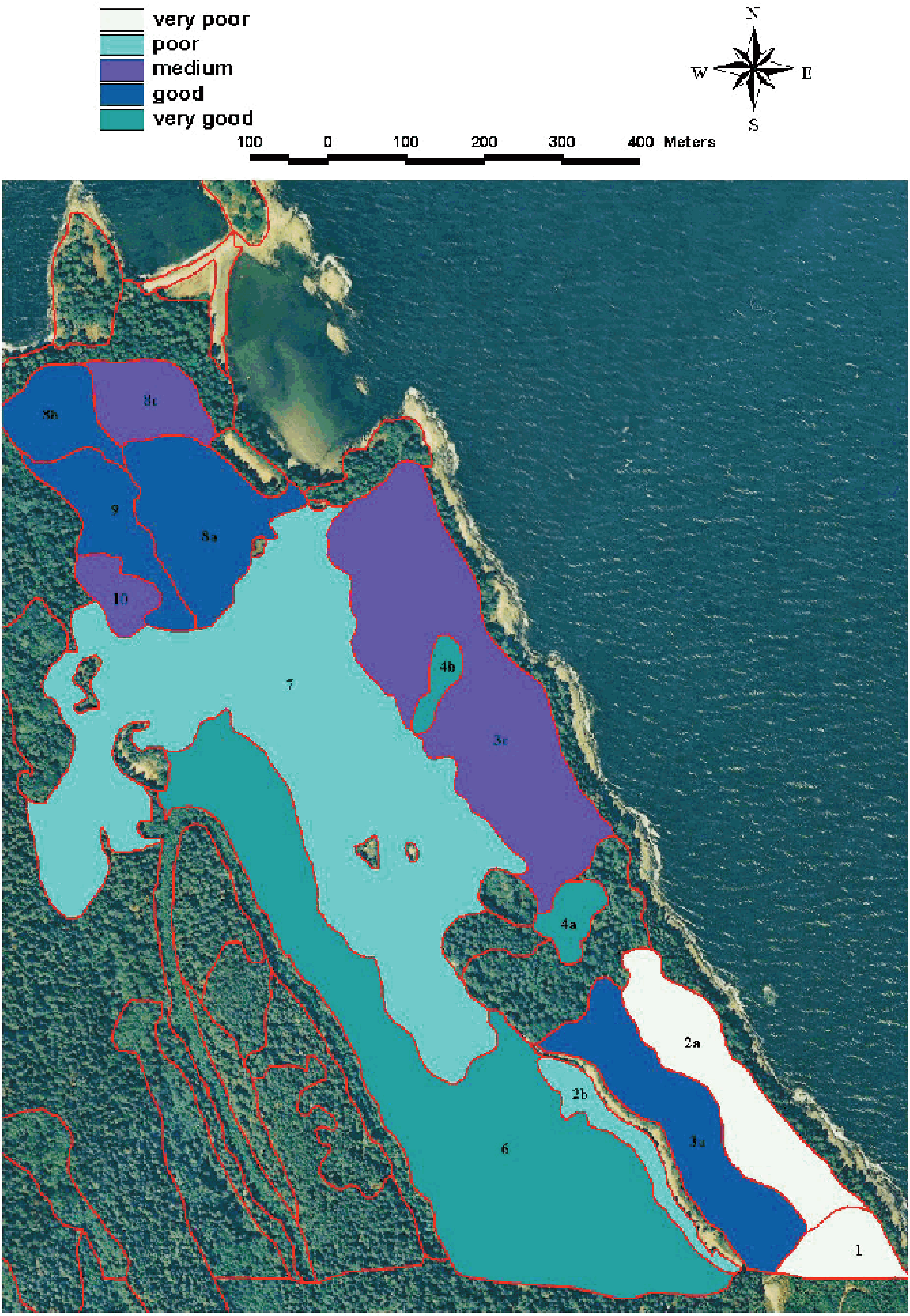
Coarse Woody Debris

Coarse woody debris occurrence is measured in cubic meters per hectare.



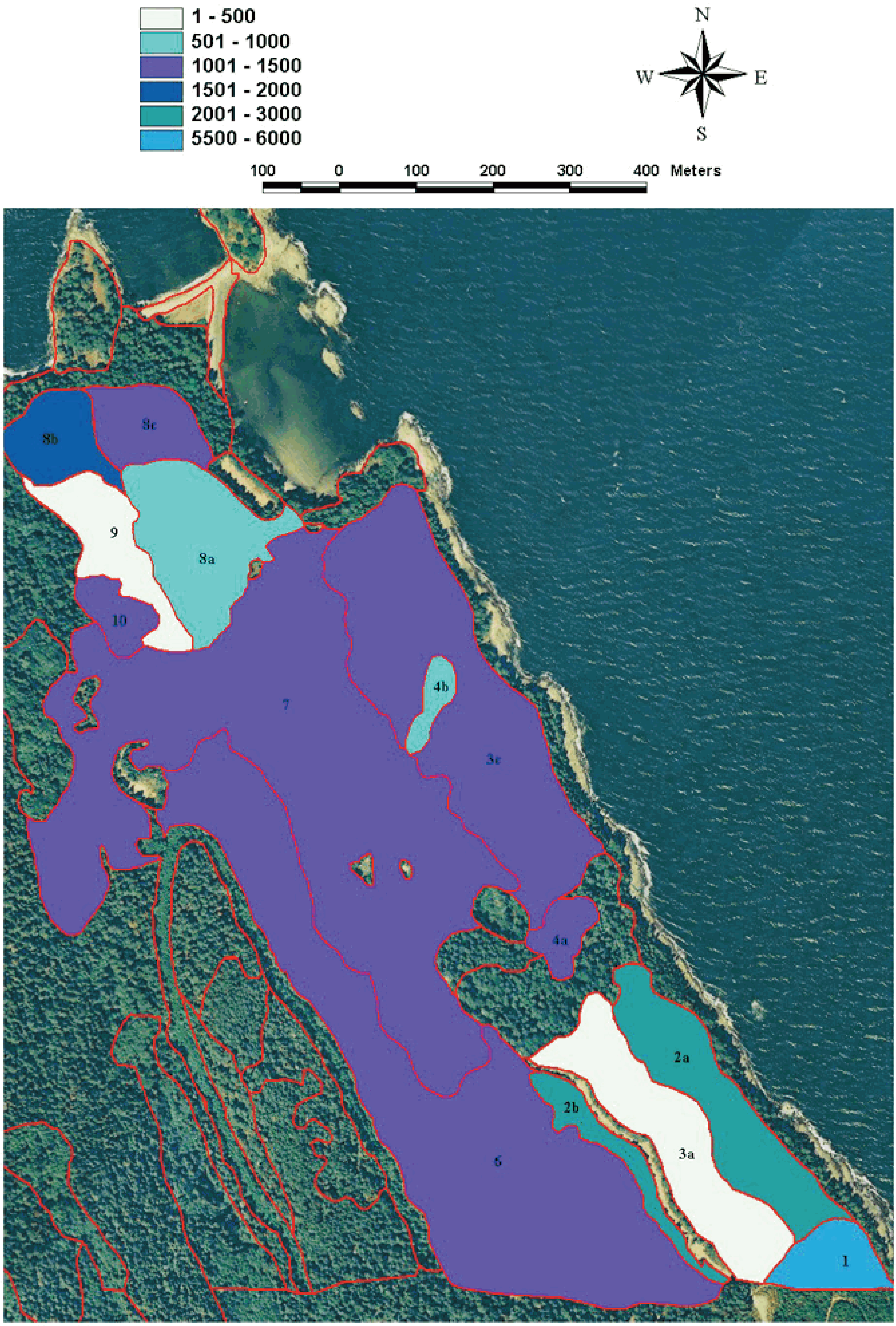
Forest Structure Rating

Forest structure rating is based on large tree occurrence,
large snag occurrence and coarse woody debris volume.
Relative ratings for each of the three attributes were assigned to polygons.
The sums of all three ratings were then compared, generating a
relative value on a scale ranging from very poor to very good for each polygon



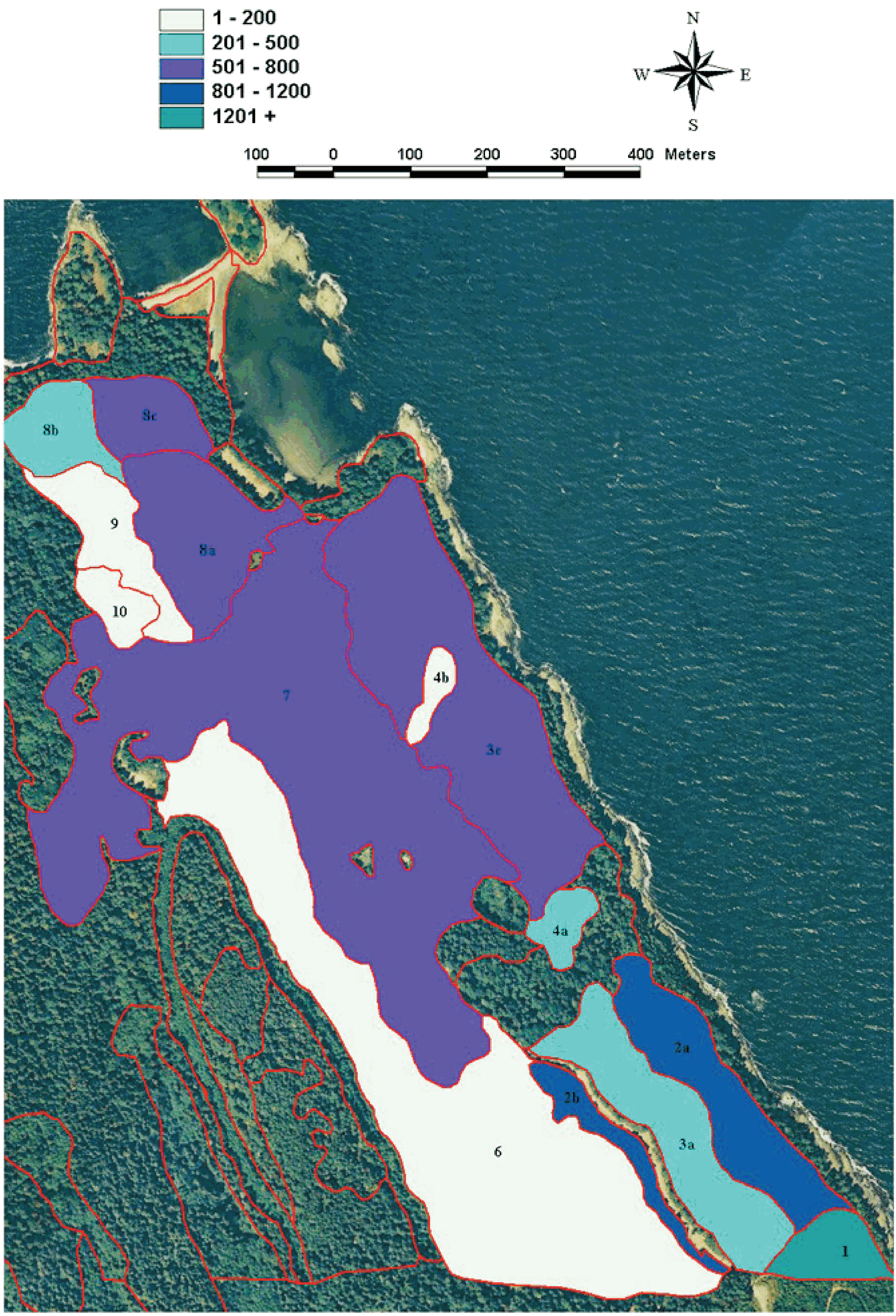
Total Tree Density

Total tree density is measured in stems per hectare. The values are based on the average number of tree stems per 400 square meter plot.



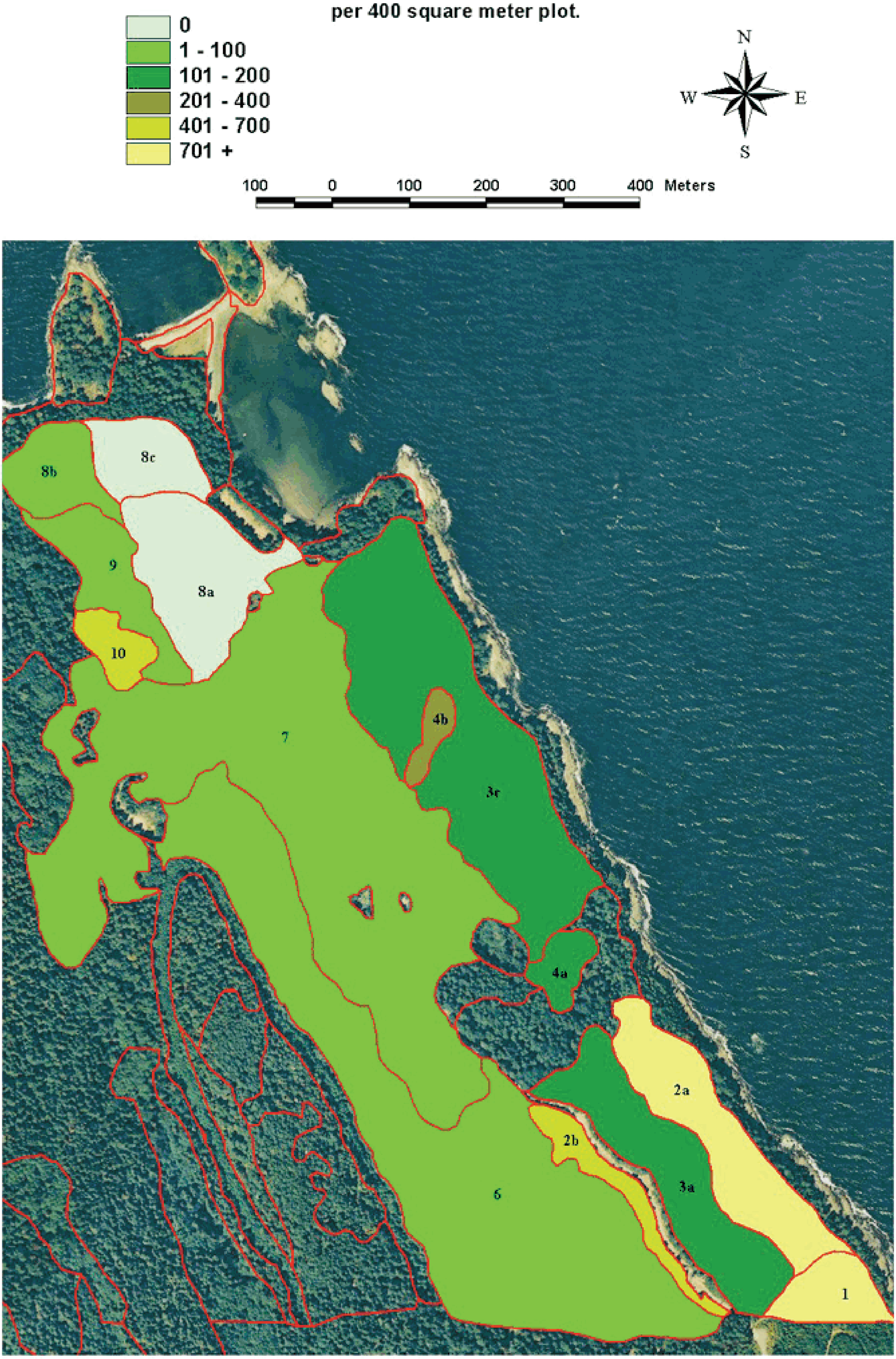
Douglas-fir Density

Douglas-fir density is measured in stems per hectare. The values are based on the average number of stems per 400 square meter plot.



Broadleaf Species Density

Broadleaf species density is measured in stems per hectare.
The values are based on the average number of broadleaf stems
per 400 square meter plot.



Tree Diversity

Tree diversity is measured with the Simpson's index. 0 represents the lowest end of the diversity spectrum and 1 represents the highest. Simpson's index is more sensitive to species evenness than it is to species richness