The Silva Forest Foundation

The Forest Sustains Us, We Do Not Sustain the Forest

Initial Report on Methodology and Results of Cortes Island Ecosystem Based Plan

prepared by

The Silva Forest Foundation

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Initial Report on Methodology and Results of Cortes Island Ecosystem Based Plan

1. Introduction

This report introduces the Cortes Island Ecosystem Based Plan prepared by the Silva Forest Foundation for the Cortes Island Forestry Committee. This report accompanies a set of 1:25,000 themed maps of Cortes Island, and provides background information on the sources, methodology, and interpretations used to produce the map set.

This report is an interim report. The CIFC stressed that map and written output was required by August 15 1996, at the latest, in order to facilitate an information exchange with the summer resident portion of their community. The SFF staff have met this deadline, but have not been able to complete all aspects of the planned analysis. Due to the time constraints, we have not been able to prepare a table and graph showing the distribution of land per the stratifications used on each of the main report maps. This task will be accomplished as soon as possible and appended to a revised edition of this report.

The Cortes Island Ecosystem Based Plan (CIP) is a work in progress. As the maps and report show, a great deal has been accomplished, with unprecedented input and assistance from the local community. However, some desirable analysis topics are yet to be completed (such as a history of logging disturbance on the island) and some analyses may need to be modified or improved over time as additional community input is received.

This project was carried out using funds contributed by the Cortes Island Forest Committee (CIFC) and the Silva Forest Foundation (SFF). The available funding is now exhausted, and further analysis will require additional funding or will have to be done by the skilled volunteers in the CIFC.

This ecosystem based plan is intended to fit within the framework of the approved *Cortes Official Community Plan*, adopted by the Regional District of Comox Strathcona in 1995. The usual SFF approach to landscape analysis includes study of and recommendations on all current human use patterns. However, in this case, on the direction of the CIFC, we limited our analysis to the identification of:

- ecologically sensitive terrain which is not suitable for resource extraction and development activities, and
- areas which should be protected from human use to maintain ecosystem functioning at the landscape scale

Planning human uses on the remaining landbase of stable and moderately stable terrain is left to the community and the existing Plan.

This brief report addresses many issues pertaining to ecologically responsible forest use and forest use planning. Readers wishing for additional information on these topics should consult the Silva Forest Foundation Web site at http://www.silvafor.org/ to access additional SFF publications.

This report is divided into six sections, of which this introduction is the first. Section 2 is a brief summary of the principles of landscape analysis and planning. Section 2 provides background information about planning in general and this plan in particular.

Section 3 discusses the methods used to produce the Cortes Island map set. Section 3 provides a general overview of the process, and a detailed description of the data sources, interpretations and stratifications used to assemble and/or create the basic data layers used in this analysis. Section 3 also contains tabular summaries of area by strata for the data levels described.

Section 4 presents the results of the project. This section currently contains only an estimate of the potential annual timber yield under wholistic timber management by land ownership class. This section will be expanded to include tabular summaries of the land stratification shown on each sheet in the map set this report accompanies.

Section 5 suggests further analysis work which is outside the scope of this project, but which may be valuable to the CIFC and the citizens of Cortes Island.

Section 6 contains the bibliography.

2. Landscape Level Planning: An Introduction

The Silva Forest Foundation has considerable experience in preparing landscape level plans. This section of the report identifies ecological features and limits that are assessed in a landscape level plan, and discusses some of the parameters that need to be used in the assessments. This provides background information which will aid in understanding the discussion on specific planning decisions and parameters in succeeding sections of this report.

The SFF and a growing number of ecologists and economists around the world believe that if we want to maintain sustainable human cultures and their economies, then human activities must be based upon protecting ecosystem functioning at all scales. An ecosystem based plan is one way to reach this objective.

An ecosystem based plan presupposes nothing in terms of human use, but conserves ecosystem function always. Ecosystem based planning does not start with a target for production (be it m^3 of timber, person days of recreation, or tons of salmon), but instead seeks to understand the landscape and site level ecology of the study area, and then to predict how human uses and economies can sustainably fit within the ecosystem.

This section of the report explains the concepts behind ecosystem based planning. We open with a discussion of ecological limits, and the processes used to identify and map factors that limit ecosystem functioning. Technical aspects of an ecosystem based planning process, such as community involvement and economic analysis, are also briefly discussed. Then the key components of an ecosystem based plan--large protected areas, the protected landscape network and designated forest use zones--are described. Some of these components, such as the designated human use zones, are not part of the CIP. However, we have included brief references to these topics for reference.

2.1 Technical Aspects of Ecosystem Based Planning

2.1.1 Ecological Limits - the Concept

The shape of the terrain, the slope gradient, the soil depth, the soil texture, the amount of moisture available, and local climatic conditions are key factors in defining the ecological limits to human use of forest ecosystems. Technologically equipped, industrial resource exploitation virtually knows no limits. Modern industrial timber extraction seeks to mitigate ecological limits by application of different technology on more sensitive sites and/or slower removal of timber from more sensitive ecosystems. This approach is rooted in short-term economics, where the value of current returns exceeds the value of long-term productivity. Logging sensitive sites often results in impacts which exceed the capacity of an ecosystem to absorb disturbance without substantial ecological change, that is, the impacts of the disturbance exceed the ecological limits. Disturbance and change are required in ecosystems, but disturbances which exceed ecological limits result in change to the ecosystem, not fluctuations within the ecosystem. Disturbances which exceed natural limits result in site degradation such as soil erosion and landslides. These events result in long-term ecological change, negatively impact the logging site, damage downstream water supplies, and cause population losses in wildlife populations which depended upon the resources of the undisturbed area to meet a portion of their needs.

Ecosystem based planning and activities require that ecological limits be respected, and that human uses be designed to **prevent** (as opposed to mitigate) damage to ecosystem functioning. Thus, identifying ecological limits is the starting point for the development of ecosystem based plans.

Our landscape analysis and planning methodology is based upon the principle that economies are subsets of human cultures or societies, which are subsets of ecosystems. In other words, human societies and their economies are dependent upon the natural diversity and integrity of the ecosystems they are part of. The primary objective of an ecosystem based plan must be to maintain fully functioning ecosystems at all scales through time in the landscape being planned. To a large extent, this is achieved by respecting ecological limits through identifying and protecting ecologically sensitive areas.

2.1.2 Delineating Ecologically Sensitive Areas

The SFF uses an “Ecosystem Sensitivity To Disturbance (ESD)” rating system to estimate the sensitivity of parts of the landscape to human uses, in this case timber extraction. Map and air photo interpretation, coupled with field assessments, are used to determine the characteristics of the landscape through this rating system, which has been developed and refined by the SFF staff over the past 15 years. Further information on the SFF ESD Ratings system is contained in Appendix 1.

Biological and temporal factors are also included in describing the characteristics of a landscape.

The ecological sensitivity to disturbance rating or classification system is based upon ecological limits as described by a group of physical factors which are:

- slope gradient
- slope shape or complexity
- soil depth to a water impermeable layer
- site moisture conditions

Various combinations of these factors result in high or extreme ecological sensitivity to disturbance ratings. Timber management, road construction, mining, and other activities that require extensive modification of ecosystems are excluded from all but the stable and moderately stable areas, and inclusions of stable and moderately stable areas within larger areas of high and extreme ecosystem sensitivity to disturbance ratings. Sites which generally are rated with “high” or “extreme” sensitivity include:

- Riparian ecosystems
- Steep Terrain (slopes greater than 60%)
- Wetlands
- Complex Terrain
- Areas of shallow soil
- Dry sites, such as ridge tops and deep gravel soils
- Areas dominated by avalanche chutes
- High elevation transition forests

In the SFF’s opinion, the ecological limits indicated by high and extreme ecosystem sensitivity to disturbance ratings are such that unacceptable losses of ecosystem functioning will result if timber management, road construction, mining activities, and other consumptive resource extraction occurs in these ecosystem types. Mitigation measures and high-quality conscientious operations cannot overcome or obviate the ecological limits. This assessment is based on the principle that prevention of ecosystem degradation must be placed ahead of mitigation of ecological limits. Indeed, “mitigation” of ecological limits is seldom, if ever, successful in maintaining ecosystem functioning, particularly in the long term.

Ecologically responsible timber management, road construction, mining, and other consumptive resource extraction activities are permitted within moderate and low ecosystem sensitivity to disturbance (ESD) ratings. Such activities can also be carried out in low and moderate ESD inclusions located within larger high and extreme ESD rating areas.

2.1.3 Characteristics and Condition of Landscape

Our planning process includes a landscape analysis to understand the characteristics and condition of the a study area. The “characteristics” describe the pattern of ecosystems through time and space that sustain landscape level functioning. In other words, the characteristics of the landscape explain how the ecosystem functions and give us the basis to determine essential composition and structures necessary to protect and maintain ecosystem functioning while meeting human needs. The “condition” of the landscape describes how past and present human uses have impacted the functioning of the landscape. On Cortes Island, the current ecological condition of the landscape has been largely determined by a history of human use: logging, settlement, farming and road building.

As noted in the introduction, human land uses such as settlement and farming are outside the scope of this analysis. Timber extraction is considered in this ecosystem based plan, both in the design of a protected landscape network and in the delineation of land which is sufficiently ecologically stable to absorb the impact of timber extraction while maintaining ecosystem health.

The condition of the landscape is determined through air photo analysis and map analysis correlated with ESD ratings and successional vegetation patterns. In other words, from air photo interpretation which tells us the locations of human modifications to the landscape, vegetation patterns, and ecosystem sensitivity to disturbance, we are able to describe the severity of impacts such as fragmentation, loss of old growth, and soil erosion, that have been caused by human activities such as road construction and logging.

2.1.4 Economic Analysis and Planning

Economies are not composed of only business activities. Stable, sustainable economies mean people relating to people in order to provide for each others' needs in diverse ways. The character and condition of the landscape and of individual ecosystems that make up the landscape are the foundation for a sustainable economy. Therefore, careful, practical economic analysis and planning is required at the community level to make an ecosystem based plan work.

Sustainable timber cutting rates or allowable annual cuts (AACs) are determined for stable and moderately stable parts of the landscape that are socially suitable for ecologically responsible timber management. AACs must be designated on a small or primary watershed basis within the overall study area. Failing to adopt this approach to timber cutting rates will result in degradation of the landscape, because the AAC for large parts of the watershed will continue to be cut in individual small watersheds.

While economic planning is beyond the scope of this project, the proposed protected landscape network has many benefits for the local economy. Tourism employment and economic opportunities are possible within protected areas, within portions of the protected landscape network, and throughout areas of stable terrain. A high quality environment is known to aid a diverse selection of small and home-based businesses. Maintaining a healthy ecosystem requires landscape level planning and balanced human uses based on ecologically responsible standards.

In coastal landscapes, the commercial and sports fisheries are critical components of an ecosystem based economy. These fisheries depend upon the protection and maintenance of fully functioning forests that provide the creek habitat and water quality required by fish.

Potential components of the economy must pass a "sustainability test" to be sure that the proposed activity maintains fully functioning ecosystems at all scales through time. Activities that the pass the sustainability test are evaluated by:

- dollar benefits

- dollar costs
- unpriced benefits
- unpriced costs
- employment generated

Economic analysis considers long time frames and does not discount or devalue future benefits and costs, because this devalues the future and results in non-sustainable economies.

2.1.5 Community Participation

Community participation is a critical, required component of ecosystem based forest use planning. We have received unprecedented community input from the CIFC throughout this process. All map and photo interpretations developed by the SFF have been reviewed by David Shipway of the CIFC while in draft, and suggested changes and revisions have been incorporated in the final products. Now that initial maps of the findings and this report have been prepared, the CIFC will communicate the contents of this plan to the community, and will receive and record constructive criticism and suggested amendments. We hope that further refinements to the plan can be made over time, as finances and other commitments allow.

2.1.6 Mapping and Analysis

Ecosystem based planning requires the use of a geographic information system (GIS) to organize and analyze data, to quantify ecosystem based activities such as timber cutting rates and employment from tourism, and to produce interpretive maps. Without the assistance of GIS, planners cannot carry out the sophisticated analyses required to guide decision making, and to assess the impacts of decisions. Once the required data has been assembled and organized (a time consuming task) GIS allows planners to monitor the impacts of decision, and to weigh the impacts of various possible scenarios in a meaningful way. We are now able to link ecological and economic factors in ways that, before the availability of GIS, were simply not possible within any reasonable time frame. Ecosystem based planning assisted by GIS and interactive databases is a particularly important tool for landscape level planning where divergent interests and values need to be considered.

GIS maps can also be updated or revised much more readily than maps drawn by hand, and programs can be written which reprocess data to revise “the bottom line” on demand. GIS furnishes a flexibility and breadth of interpretation that is not possible without this computer application.

This planning exercise has been carried out using PAMAP GIS by PCI Pacific Ltd., of Victoria B.C. The CIFC has a resident GIS expert in the person of Dave Hughes, who uses a variety of GIS systems in his professional life. We have successfully exchanged GIS data with Dave in the past, and will provide him with digital copies of all data layers we have prepared for his and the CIFC’s future use.

2.1.7 Forest Fragmentation

All ecosystem based plans must deal with the impacts of past human uses of the landscape. In forested landscapes, fragmentation is both a spatial and a temporal problem.

Clearcutting, roads, and clearings for various human activities break necessary connections in the landscape ecology. The movement of plants, animals, water, nutrients, and energy is interrupted or blocked by spatial fragmentation. Healthy landscape ecology requires a natural and connected distribution of forest ecosystem types and forest successional patterns (i.e. forest ages) across the landscape.

Clearcut logging and short rotation timber cropping as practiced by the Ministry of Forests and the timber industry interrupt or fragment the natural pattern of forest disturbances and forest succession across the landscape. Industrial timber management fragments the forest landscape in time by shortening or eliminating the early successional shrub/herb phase and eliminating the late successional mature and old growth phases. Each of these phases has unique contributions to forest functioning at both the stand and landscape levels. For example, the shrub/herb phase and the old growth phase are the major nutrient input phases in the forest successional pattern. Thus, shortening or eliminating these phases will result in long-term nutrient impoverishment of forest landscapes. Eliminating mature and late successional phases also eliminates vital habitat for a wide variety of animals, ranging in size from soil microorganisms to large mammals.

Removing late successional or old growth forests from the landscape also damages aquatic ecosystems and degrades water quality and timing of flow, resulting in overall degradation of ecosystem functioning.

The southern Cortes Island landscape has been overwhelming impacted by logging. The scattered old growth Douglas-fir trees which stand like sentinels in small groups throughout the southern island were once average sized trees. The lush second or third growth forests we now see on Cortes are beautiful, but are ecologically very different from the old growth fir, cedar and hemlock forests they have replaced. The magnitude of the ecological difference will increase over time, unless management plans are implemented to restore old growth structures to all stands, and to restore old growth patches to the forest landscape.

2.2 Large Protected Areas

Protected areas are large reserves that provide critical reservoirs for ecological communities, species, and genetic diversity. Undeveloped watersheds in Cortes Island are well suited for designation as large protected areas. All landscapes need large protected areas. Large protected areas, in conjunction with the protected landscape network, are a buffer to help the Cortes Island landscape to withstand future changes. Change and disturbance may arise from human activity, such as global climate change, or from natural events, such as major storms. Large, protected areas also provide essential blueprints of fully functioning ecosystems at all scales which are necessary to provide the template to restore degraded ecosystems. Other than small-scale recreational and tourism activities which result in minimal impacts, no human uses are permitted within protected areas.

Cortes Island is not a large landscape. In fact, if Cortes were uninhabited, an excellent case could be made to declare the entire island a protected, medium sized landscape to help maintain regional biodiversity. Given the human presence on Cortes, this is not an option, but we note it to give an indication of the scale of "large" protected areas.

Current moderately sized protected areas on Cortes are limited to Von Donop Marine park. Manson's Landing and Smelt Bay Provincial Parks are, of course, protected from resource extraction, but are densely populated recreation areas. Proposals for a variety of other small protected areas, including Carrington Lagoon and Gunflint and Hague Lakes are in various stages of approval. All of these protected areas were considered while developing the proposed protected landscape network for Cortes Island.

In North America, we are often inclined to think that we are leaders in large protected areas, and often we suggest that only the North American socio-economic situation permits the "luxury" of large protected areas. However, these thoughts are misconceptions. There is a clear consensus of scientists around the world that large protected areas, joined by protected landscape networks, are necessary to maintain both the short- and long-term ecological integrity of Earth. In Russia there is a system of zaporvedniks, or nature reserves, which are large protected areas distributed across the Russian landscape . A significant portion of each zaporvednik excludes all human activities except scientific research. Clearly, there is a long-standing and growing international understanding of the need to protect an interconnected and significant area of ecosystems from extensive modification by industrially-based societies, <u>if</u> we are to sustain the long-term functioning of Earth.

2.3 Protected Landscape Network

Forest landscapes (or, for that matter, all landscapes that are essentially unmodified by technologically equipped human cultures) contain a full array of ecosystem types and have a successional pattern through time that is tied to unpredictable natural disturbance regimes. Such natural landscapes are fully occupied by plants, animals, water, nutrients, and energy. Extensive modification of these landscapes results in degradation, loss of ecological integrity, and, if human perturbations are persistent, in ecological collapse. Scientists and planners now recognize the need to maintain, protect, and/or, where necessary, restore a framework of ecosystems throughout the landscape to ensure connectivity and ecosystem functioning at all scales, from the small patch or stand to the large landscape. This "framework" must be an interconnected web within which natural ecosystem functioning remains essentially intact and undisturbed by all but the softest of human interventions. It is hoped that such "protected landscape networks" will ensure the short- and long-term health and ecological functioning of forest landscapes at all scales. Protected landscape networks are thus necessary not only for ecological health, but also for the long-term survival of healthy human societies and economies.

A protected landscape network consists of:

- riparian ecosystems
- old growth nodes
- ecologically sensitive areas

- cross island corridors
- some areas of moderately stable terrain
- some areas of stable terrain
- representative ecosystem types

This protected landscape network is maintained as a permanent, undisturbed network of ecosystems, and provides the basic framework for landscape level functioning through time. The protected landscape network must be connected to large protected areas, such as Von Donop Park, in order to ensure ecological integrity of the landscape through time. It is possible to move components of the protected landscape network over long time periods (i.e. 250+ years). For example, a part of a cross island corridor and a timber zone could trade places, provided that the timber zone had developed old growth composition and structure, or forest ecosystem types similar to those in the cross island corridor. This type of change in the timber zone will require time frames of more than 250 years following logging to enable former timber zones to develop old growth composition and structure. Thus, for all intents and purposes, a protected landscape network is a permanent feature in terms of human time frames.

After defining the protected landscape network, human use zones are usually designated throughout the landscape. Human use zones designate a priority use that dictates the terms of other human uses within a particular zone. However, more than one use is frequently encouraged within human use zones. Consumptive human uses, like timber and mining, are generally limited to the stable and moderately stable portions of the landscape. Human use zones were not designated by the SFF for Cortes Island because the *Cortes Official Community Plan* is already in place.

Some human uses may also be expected to occur in selected portions of the protected landscape network. In other words, hiking trails, built and used to ecologically responsible standards, may be designated in various portions of the protected landscape network. Likewise, ecologically responsible timber cutting may occur on stable inclusions within ecologically sensitive areas and on the edges of riparian ecosystems. However, generally speaking, human activities are discouraged from components of the protected landscape network.

Elements of a protected landscape network should not be confused with large protected areas, parks, or wilderness reserves. Large protected areas are required throughout the landscape to provide reservoirs of fully functioning ecosystems and the biological blueprints required to reestablish functioning in landscapes degraded by human activities. The protected landscape network is the minimum ecological fabric that connects large reserves and ensures long-term ecological functioning within the landscapes that are modified by technologically equipped human cultures.

The SFF has incorporated protected landscape networks in our ecosystem based planning methodology for more than seven years. In the past several years, the British Columbia Ministry of Forests has recommended that forest ecosystem networks or “FENs” be established in industrial timber management plans. The concept of FENs is very similar to the SFF’s protected landscape network. When we compare FENs with a protected landscape network, two important differences arise:

1. FENs usually constitute minimal area, often exclude commercially valuable timber stands, and do not provide full connectivity across the landscape. In contrast, protected landscape networks err on the side of being inclusive of the full range of ecosystems and on the side of protection, not on the side of exploitation. We believe this is necessary, both to maintain ecosystem functioning and to provide future social and economic options.
2. FENs are viewed by the Ministry of Forests and the timber industry as temporary or moveable parts in a timber management plan. The SFF has reviewed plans containing FENs that call for the movement of FENs once areas outside the FENs have been logged. In this approach, degraded ecosystems will be incorporated in FENs in order to gain access to commercial timber supplies contained within initially established FENs.

In contrast, The SFF's protected landscape networks constitute permanent networks of representative, protected, and interconnected ecosystems across the landscape. While it may be possible to shift portions of the protected landscape network into the commercial timber landscape and to move portions of the timber landscape into the protected landscape network, such "movement" would occur on very long time frames (e.g. 250 years). These long time frames are necessary to ensure the development of fully functioning ecosystems within logged or otherwise modified portions of the landscape.

If long-term studies (i.e. 150+ years of observations) demonstrate that the protected landscape networks are fulfilling their ecological roles, limited timber extraction and other human activities may be able to occur to ecologically responsible standards within <u>some</u> portions of the protected landscape network. For all intents and purposes, protected landscape networks are permanent fixtures, in human time scales, within the forest landscape. Hopefully, together with large protected reserves and the maintenance of ecological integrity in areas modified by human activities such as timber management, protected landscape networks will ensure the maintenance through time of forest landscapes that are able to withstand the spectrum of natural disturbances.

2.4 Human Use Zones

Human use zones are generally established between the components of the protected landscape network and in some parts of the protected landscape network. However, human use zoning was not carried out in this analysis because of there is an existing land use plan, the *Cortes Official Community Plan.* We have included this brief discussion of zoning for reference purposes only.

The SFF believes that all human uses, whether timber, tourism, watershed protection, or wildcrafting, must be carried out to ecologically responsible standards. This simply means that any human use within the Cortes Island landscape must ensure the protection and maintenance of fully functioning ecosystems at all scales through time. Human use zones identify the priority use or the human use that dictates the terms (within the limits of ecological responsibility) under which other uses may be carried out within a particular zone. Thus, commercial tourism zones may include ecologically responsible timber extraction. However, any timber extraction that occurs within these zones must, as a first priority, protect any and all aspects of the zone that are necessary for current and future tourism activities.

Human use zones are also located in some portions of the protected landscape network. However, human uses within the protected landscape network must not occur in ways that alter the composition and structure of the forest, thereby resulting in loss of forest functioning.

Human use zones commonly used in an ecosystem based plans include:

1. ***First Nations Cultural Zones:*** These zones are delineated by taking direction from First Nations.
2. ***Commercial Tourism Zones:*** The priority use for these zones is commercial tourism activities. Because ecologically responsible timber management maintains the composition and structure of natural forests, we assume that ecologically responsible timber management can occur within some commercial tourism zones. However, the exact nature and extent of timber management is at the discretion of the commercial tourism operators.
3. ***Potential Wholistic Timber Zones:*** These are areas of stable or moderately stable terrain. Where this stable and moderately stable terrain can be accessed by road in an ecologically responsible manner, timber zones are managed using logging systems that employ roads. However, where this is not the case, wholistic timber zones are designated as "heli", indicating that any timber extraction in these area must be carried out with aerial logging systems that exclude the construction of roads.

   The annual allowable cut (AAC) for timber zones is determined and administered on a small watershed basis. To protect forest functioning at landscape and stand levels, AACs must be determined and implemented for each small watershed that is part of a landscape analysis unit. Without this approach, timber cutting activities will systematically over-cut each watershed within the landscape, resulting in short- and long-term degradation of ecosystem functioning.

   Wholistic timber management is carried out only by partial cutting or selection systems. Approximately 30% of the growth potential of the site should be directed into large trees which will remain on the site in perpetuity, and which will eventually die and fall on the site. This process is started by protecting a minimum of 30% of the large trees, well distributed spatially and by species, from logging. This population of trees will be managed to consume about 30% of net site productivity. (As the trees grow older and larger, this target will likely require less than 30% of the current population.) These trees will be permitted to grow old and die, thereby replacing important structures like large snags and large fallen trees. A permanent overstory is required to maintain wildlife habitat, genetic diversity, soils, and general ecosystem functioning. Eventually, as permanent leave trees die, replacement trees will be designated, ensuring that the minimum cover of large old trees will always be maintained.

4. ***Wildcrafting Zones:*** Gathering of edible plants, mushrooms, medicinal herbs, and other non-timber forest products occurs in this zone. Care must be taken to set sustainable limits for extraction of non-timber forest products. Ecologically responsible partial cutting may be compatible with wildcrafting in many locations.

5. ***Restoration Zones:*** By removing all large old trees and snags, and removing or damaging large fallen trees, clearcuts degrade forest functioning at the patch or stand level. Roads, landings, and high lead yarding corridors also degrade soil, cause soil erosion and landslides, and damage water quality. Removal of all large trees in an area results in higher spring runoff, which damages stream channel structures, results in high levels of turbidity, and contributes to landslides and debris flows. Clearcuts, particularly extensive clearcutting in a landscape, result in loss of plant and animal habitat, and may result in the local extirpation of some plant and animal species.

   Therefore, all existing clearcuts may be classified as Restoration Zones. Restoration requirements in older clearcuts on stable terrain may be very limited, while restoration requirements in actively eroding logged areas in steep terrain may be very high. Restoration Zones are subdivided into:

   - **Restoration/Protection--**Following forest restoration, these areas will be added to the protected landscape network.
   - **Restoration/Potential Wholistic Timber Zones--**These are clearcuts which have occurred on stable and moderately stable terrain, and are in areas that are not needed for the protected landscape network. Therefore, once composition, structure, and functioning are restored to these sites, they may be used for ecologically responsible partial cutting.

   Forest restoration is the price of timber exploitation. However, employment from forest restoration activities is an important part of an economic transition strategy for moving from an externally controlled, non-sustainable economy to a locally controlled, sustainable economy.

2.5 Summary of Ecosystem Based Planning

Ecosystem based forest us planning seeks to find a balance between human needs for products from the forest and the need to maintain intact, healthy forest ecosystems to maintain forests. We believe this balance can only be achieved by focusing on what to leave behind in the forest to maintain ecosystem functioning, not on what to take to satisfy human demands.

A landscape level plan identifies areas which should be “left”. These include:

- ecologically sensitive areas
- riparian ecosystems
- old growth nodes
- cross island movement corridors
- large protected areas

These areas form the protected landscape network. Protecting these areas from human use avoids stand and landscape level site degradation from logging in sensitive ecosystems, and (hopefully) provides a framework of ecological linkages and protected areas which will maintain stand and landscape ecosystem composition and function over time. The flow chart in Figure 1 summarizes this discussion of ecosystem based planning.

SEQUENCE OF ECOSYSTEM BASED PLANNING

PERFORM LANDSCAPE ECOLOGY ANALYSIS

*** Spatial and temporal characteristics.**
*** Ecosystem sensitivity to disturbance.**
*** Impacts of past and present human uses.**
*** Identifies Protected Landscape Network (PLN).**

↓

ESTABLISH FOREST USE ZONES

*** Allocates *priority* human uses to specific zones within the PLN.**
*** Protects fish and wildlife habitat and ecologically sensitive zones not identified at the large landscape level.**

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DESIGN ECOSYSTEM-BASED ECONOMY

*** Protects natural capital.**
*** Ecologically responsible activities.**
*** Reduce imports.**
*** Maximize value added.**
*** Profits are sustainable: jobs and fully functioning ecosystems.**

↓

TRANSITION STRATEGY

*** Shift control of land and resources to the community.**
*** Local timber markets.**
*** Forest restoration.**
*** Community lending institutions.**
*** Retraining by choice.**
*** Equipment conversion & equipment co-ops.**

The decision making process for this entire sequence is community based consensus.
All decisions are based on:

PRIORITY ONE: All uses are ecologically responsible, requiring the protection of biological diversity at all scales, and,

PRIORITY TWO: Human and non-human uses are balanced across the landscape.

Figure 2: Flow Chart of Ecosystem Based Planning process.

3. Methodology

This section of the report is divided into two subsections. In the first subsection, we discuss the general methodology used to produce all of the map sets, starting with air photos and maps, incorporating community input, and producing finalized GIS data layers. In the second subsection, we discuss the specific methods and parameters used to produce each of the main data layers used in the CIP:

- forest cover, non-forested areas and non-productive forest
- wetlands
- creeks and watercourses
- ecological sensitivity to disturbance zones and riparian ecosystems
- old forest areas
- cross island linkages
- land ownership

The results of the overlay processes which combine and interpret the relationships between these baseline data layers are discussed in Section 4.

3.1 General Methodology

This landscape plan is based largely on air photo interpretation, with some verification of photo calls through field examinations.

A first approximation of Silva Ecological Sensitivity to Disturbance (ESD) typing was carried out in July 1995 using air photo interpretation on 1:17,000 black and white air photos from 1988. Color air photos at 1:15,000 scale from 1994 were also utilized to update the black and white air photos for recent logging activity and road building.

We had originally planned to use 1:70,000 air photos for this analysis. However, we quickly found that the level of detail expected by the CIFC could not be achieved using small scale photographs, so we switched to the large scale photos. The increase in photo scale resulted in a desirable increase in the precision and reliability of photo interpretation, but also resulted in an exponential increase in the time required for photo interpretation and map creation.

Tom Bradley and Jason Kubian of the SFF carried out 5 days of field assessments on Cortes in July 1995. The goal of the field work was to assess as many types of the "difficult to classify" areas identified in the photo interpretation as possible. Field work consisted of traversing and traverse mapping to note site conditions, establishing site assessment points, and measuring height and age pairs to determine site index[1] of forest stands. The locations of the field traverses are shown in Figure 3. Photocopies of field notes are contained in Appendix 2. The information gathered in the field was used to revise the initial air photo terrain typing.

[1] Site Index at breast height age 50 years. A system of assessing the height and age of representative trees to estimate the growing potential of a forest site. (Nussbaum 1996)

Figure 4: Map of SFF Field Traverse Lines on Cortes Island.

At the end of the field work, David Shipway of the CIFC retained the 1:15,000 color air photos, which he used throughout the rest of the project for detailed photo interpretive work to identify old forest areas, wetlands, and sensitive sites.

At the same time as the initial photo interpretation and field work was being carried out, we were assessing the forest cover map data for the island. The SFF uses B.C. Ministry of Forests forest cover mapping as the base for our landscape analysis because:

- It provides useful, if generally imprecise, mapping of a variety of important and identifiable cultural features.
- Forest cover typing is a vital data source for developing wholistic timber management plans.
- The forest cover data files provide the best vegetation type mapping available for most areas in the province. Besides information on tree cover, the forest cover data files provide information on a variety of non-forested sites.

Our initial assessment of the forest cover mapping and our subsequent discussions with the CIFC revealed more than the usual shortcomings with the forest cover data. The identified problems were:

- Very few creeks are mapped. Many year round and seasonal water courses are omitted from the forest cover maps.
- Information on old forest remnants was inadequate. The main function of forest cover data is timber inventory. While reference is often made to remaining old growth structures in a stand, the information was not sufficiently precise for us to determine the type and density of old growth remnants on the island.
- The mapping of wetlands is inadequate. The CIFC noted that many forest wetland areas had been omitted.
- Intertidal zones are not shown on forest cover maps. These are critical components of biodiversity and movement corridors.

After discussion, the CIFC and Silva decided the only suitable course of action was to improve or recreate the inadequate data layers. The steps involved are described in detail in Section 3.2. Creating the watercourse, old forest, and wetland layers was a lengthy and complex process involving photo interpretation, digitizing, plotting draft maps, field checking, revision, and exchange of information between David Shipway of the CIFC and the SFF. This phase of the project lasted from October 1995 to June 1996.

During the period from February to June 1996, Tom Bradley of the SFF was on Cortes Island several times teaching a course on Wholistic Forest Use to members of the Klahoose Band. In this period, he was able to do further informal field checking of photo interpretation.

David Hughes of the CIFC supplied 1:20,000 scale color prints of Landsat TM satellite data to us for use in the analysis process. The Landsat prints were used as an interim medium to transfer type lines from the air photos to the GIS. The Landsat image data is obtained from a satellite in space; the greater altitude of the satellite "photography" and subsequent georeferencing and image processing largely eliminate the scale distortion problem common to air photos. We have found that lines digitized into a GIS from a satellite print are acceptably accurate for landscape planning purposes.

The polygon boundaries on the air photos were transferred to the satellite image by using a simple "relation to visible landforms" method. Many terrain features which are visible on the air photos are also visible on a Landsat image. Exposed rock, wetlands, forest type boundaries, water bodies, and cut blocks are readily visible on the satellite print. The polygon boundaries on the air photos were transferred to the satellite image based on their distance from or congruence with features common to both images. For example, a polygon boundary which extends around the end of a wetland, through a forested area to a small rock opening on the air photo would be drawn through the same set of points on the Landsat overlay. The type lines were then digitized from the Landsat image into the GIS. This approach was used for the SFF ESD and old forest layers.

The end result of this iterative process was a set of GIS data layers for Cortes Island. Table 1 lists the layers and briefly describes their contents and origin.

Data Layer	Data Contained and Source of Data
Forest Cover	Ministry of Forests standard forest cover information, listing tree species, age, height, site index, MoF site sensitivity (where applicable), and information about non-forested and non-productive sites.
SFF Ecological Sensitivity to Disturbance	SFF ESD rating. Derived from SFF photo interpretation and ground truthing, revised by CIFC. Indicates land which is ecologically unsuitable for resource extraction, and areas which are ecologically stable enough for timber management (may or may not be socially suitable for timber management).
Old Forest Areas	Areas containing old growth remnants. Subdivided into high and low density old forest areas. Photo interpreted by SFF and CIFC, ground checked by CIFC.
Wetlands	Wetland and swamp areas which were added to the wetlands and swamps shown on MoF forest cover maps. Photo interpreted by CIFC, ground checked by CIFC.
Streams	Watercourses which were added to the watercourses shown on MoF forest cover maps. Photo interpreted by CIFC, ground checked by CIFC.
Riparian Buffers	Protected areas surrounding watercourses, wetlands, lakes and running along the coastline. Some photointerpreted, but most computer generated by GIS around mapped watercourses and wetlands.
Ownership	The ownership status of land. Identifies crown land, parks, small reserves, proposed parks, private land and MacMillan Bloedel holdings. Based on MoF Forest Cover data, but supplemented with data from many sources to identify ownership status of specific features.
Cross Island Corridors	Connecting corridors which join the components of the protected landscape network, and which provide protected habitat themselves. Main corridors photointerpreted by the SFF, reviewed by the CIFC.
Islands	Small islets which were not included on the MoF forest cover map. Also includes CIFC delineated intertidal zones. Identified and mapped by the CIFC.

Table 2: GIS Data Layers used in Analysis

The layers listed in Table 3 were overlain to form a single layer of GIS data, which was then used to produce the map set which this report accompanies and to produce the summary tables in this report. Combining the data into one layer allows us to explore the relationships between various data layers and combinations of layers, which is the chief benefit of GIS analysis.

In summary, the decisions to increase photo scale from 1:70,000 to 1:17,000 and to recreate inadequate data layers resulted in very large increases in the time, effort and funding allocated to basic data assembly. A lengthy process of development, review, and modification of data layers was also required. While these choices were completely appropriate given the size of the study area and the needs of the CIFC, the time required was not foreseen in the original project proposal. The result has been extensive cost overruns and delayed project delivery dates.

3.2 Specific Methodology by Data Layer

This section of the report provides details about the source, interpretations, and procedures used to produce the information layers which the CIFC and the SFF added to the basic forest cover information. The data levels discussed are:

1. Forest Cover, Non-Forested Areas and Non-Productive Forest
2. Wetlands
3. Creeks and Watercourses
4. SFF ESD Zones and Riparian Ecosystems
5. Old Forest Areas
6. Cross Island Linkages
7. Land Ownership

3.2.1 Forest Cover, Non-Forested Areas and Non-productive Forest

Standard B.C. Ministry of Forests forest cover data files were used as the digital base mapping for this project. The digital files we used were obtained by the CIFC. The maps were digitized in 1982, but have been updated by computer modeling of forest stand growth to 1994. Forest cover disturbances (logging, clearing, fire, etc.) have been updated to December 1993.

The digital files are the source of the paper forest cover maps which are readily available from the MoF, but the digital files contain much more information than is shown on the paper maps. The digital "map" is linked to a data base which contains a wide range of information for each layer within each forest stand.

The SFF selected and imported a subset of the MoF data into our GIS system. The full range of original data is still available on the original files. A listing of the data fields used by the SFF would not be helpful without an explanatory guide to the contents of the fields, which is beyond the scope of this report. A guide to the field contents will be prepared and shipped with the data files when they are supplied to Dave Hughes.

We used the forest cover data for four purposes in this analysis:

1. To determine the species composition and growth potential (site index) of forested areas. This information was utilized to estimate the potential annual timber yield from forested areas. This information is required to estimate the potential annual cut from potential wholistic timber management areas.
2. To identify non-forested areas. Non-forested areas include wetlands, rock and clearings (man made or otherwise). These areas were removed, or netted out, of the potential timber management landbase. The additional swamps identified by the CIFC were included in this netdown.
3. To identify non-productive and non-merchantable forested areas. Non-productive forested areas support tree growth, but at low densities and/or very low growth rates. These sites do not "produce" commercial quantities of timber, but often produce valuable ecological structures and functions. Open forests on rocky knolls and forested wetlands are often classified as non-productive. Non-merchantable forests generally have closed canopies, but have extremely low growth rates due to site limitations. Non merchantable sites were identified using the parameters given in the *Sunshine Coast TSA Timber Supply Analysis* (MoF 1995). These areas were netted out of the potential timber management landbase.
4. To identify areas which the MoF ha classified as environmentally sensitive (ESA) due to steep terrain, sensitive soils, and or expected regeneration problems. The MoF removes a portions of each ESA terrain polygon from their timber management landbase, as shown in Table 4.

ESA Code	ESA Description	Percent Area Netdown
ES1	Very steep sensitive soils	90%
ES2	Steep Sensitive Soils	40%
EP1 or EP2	Difficult regeneration	90%

Table 5: MoF ESA Area Netdowns used in Landscape Plan

We removed the indicated proportion of each MoF ESA area from the landbase. Other ESA classes exist, but are not found on Cortes Island, with the exception of ER, or Environmentally Sensitive for Recreation areas. We felt that the recreation designation, while interesting, was a human use interpretation, not a factor of site ecology. We therefore did not net out the MoF ER polygons..

As the MoF nets out a portion of most ESA polygons; part of the ESA area is assumed to remain in the timber landbase. We followed this method in our data summaries, so part of the area identified by the MoF as ESA could possible end up in a SFF potential wholistic timber management zone. However, this happens only rarely because the MoF ESA and SFF ESD zones usually coincide.

The MoF also removes all stands with deciduous leading species from the landbase in the *Timber Supply Analysis.* We did not follow this procedure because alder is a commercially valuable species, with growing market demand. Therefore, deciduous stands may be part of the SFF potential wholistic timber management landbase.

In the *Timber Supply Analysis,* the MoF notes:

> To account for existing roads, trails, landings and other right of ways that are not already accounted for in the inventory file, 5.8% of the area with timber harvesting history (assumed to be all age class 1 through 4 stands - stands 80 years or younger) were excluded from the timber harvesting landbase.

We respected this netdown in our landbase summary tables, but it is not possible to map such partial exclusions.

Figure 5 shows the type and location of land which was removed from the timber management landbase based on MoF forest cover information. Table 6 summarizes this information.

MoF Stratification	Area (ha)	Percent of Total
Wetlands	277	2%
Rock or Barren Area	14	0%
Clearings, Built Up Areas	394	3%
Non-Productive Forest	398	3%
Non-Merchantable Forest	129	1%
MoF ESA 2 Terrain	294	2%
MoF ESA 1 Terrain	256	2%
MoF Potential Timber Management Landbase	11,934	87%
Total Area	13,698	100%

Table 7: Area of MoF Netdowns to Timber Management Landbase

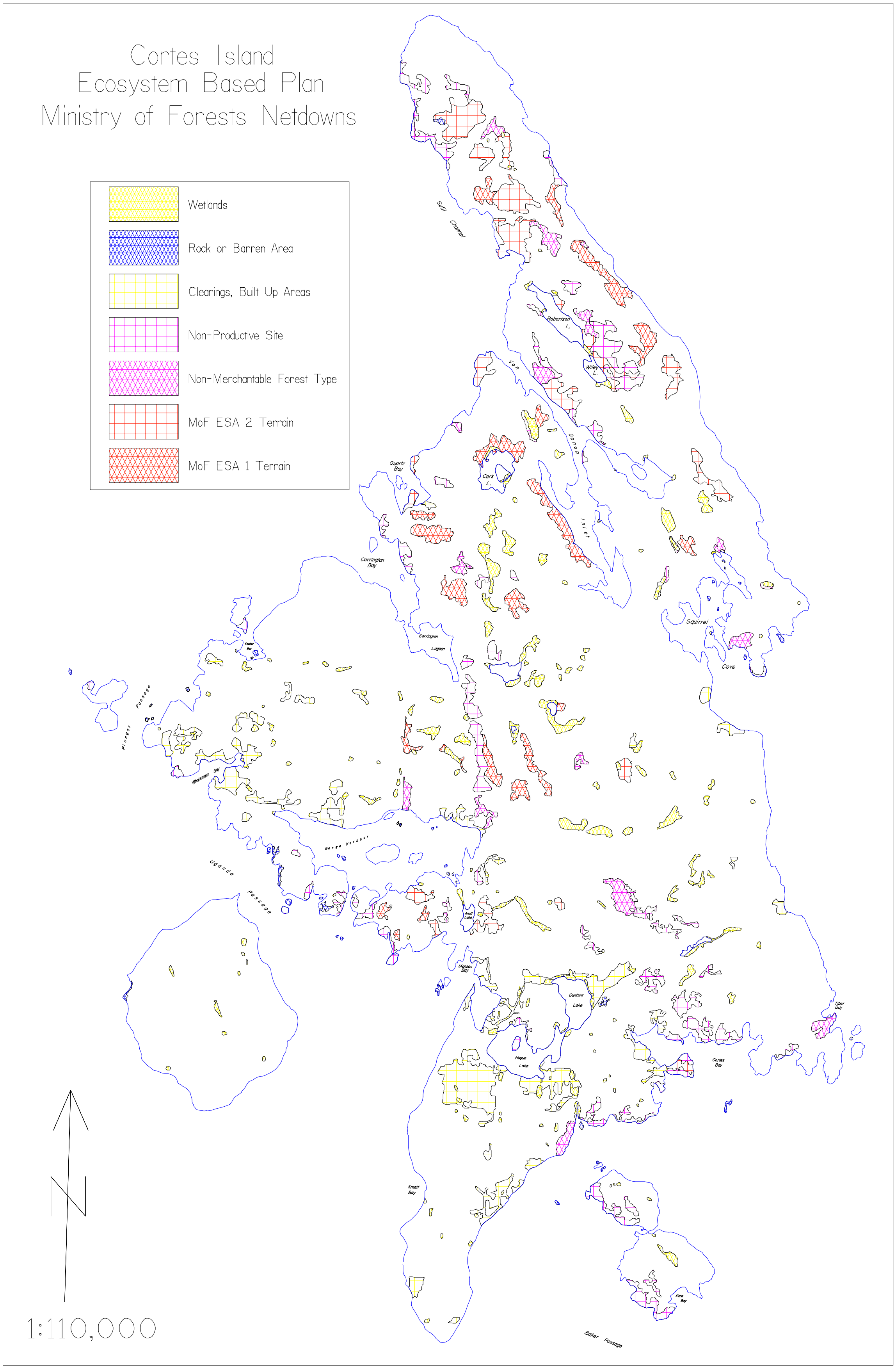

Figure 6: Map of MoF Netdowns used in Ecosystem Based Plan

3.2.2 Wetlands

The wetland layer was created in response to the observation by the CIFC that the MoF forest cover data omitted many small to medium size wetlands. Wetlands are extremely important habitats in forested landscapes, providing a diverse range of ecological resources in a small area. Wholistic forest use requires that wetlands be protected during and after logging activity (as does, to a lesser extent, the Forest Practices Code.) However, modeling adequate wetland protection was not possible unless the wetlands were mapped.

The SFF provided the CIFC with a paper plot of the wetland areas shown in the forest cover data. David Shipway and others amended this map using photo interpretation, local knowledge, and ground checking.

Table 8 shows the distribution of the final wetland layer by the origin of the wetland designation. The map in Figure 7 shows the final wetland stratification, without differentiating between MoF and CIFC wetlands.

Stratification	Area (ha)
Wetlands Identified on MoF Forest Cover	127.8
MoF Non-Productive Areas Reclassified by CIFC as Wetland	
Non Productive Forested	8.6
Clearing	0.6
Urban	14.4
Meadow	6.6
MoF Productive Forest Reclassified by CIFC as Wetland	114.5
Total Area of Wetlands Identified by CIFC and SFF	272.5

Table 9: Area of Wetlands Identified by MoF and CIFC

3.2.3 Creeks and Watercourses

The inadequacy of the creek mapping on MoF forest cover maps was discussed at a meeting between SFF staff and the CIFC in July 1995. At that time, it was agreed that the CIFC would provide an improved map of island watercourses, using a 1:20,000 topographic map as a base. Several iterations of input from CIFC, digitizing, plotting draft maps, and review were performed to produce a final product. Figure 8 shows the final creek mapping which was used in this analysis, by source of data. Wetlands are also shown to fill the gaps in some creeks.

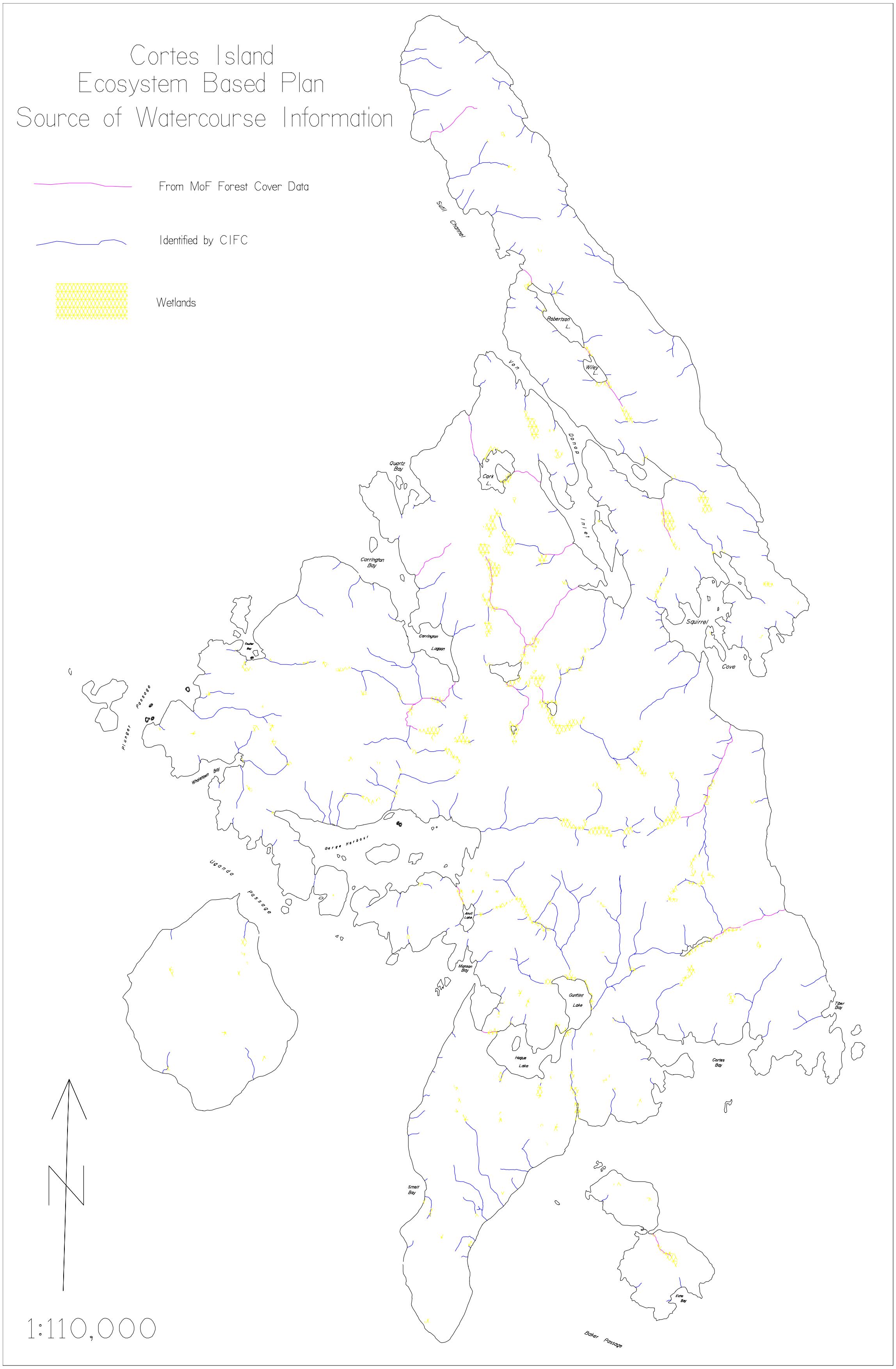

Figure 9: Map of Watercourse Data by Source of Information

At the request of the SFF, the CIFC also stratified the watercourse data into the following classes:

- Intermittent creeks
- Year round creeks
- Creeks inhabited by salmon
- Creeks inhabited by trout

The creek classes were added to the GIS stream data layer. These classes were used to vary the width of the computer generated riparian buffers placed around the mapped creeks. Figure 10 shows map of the stratified watercourses.

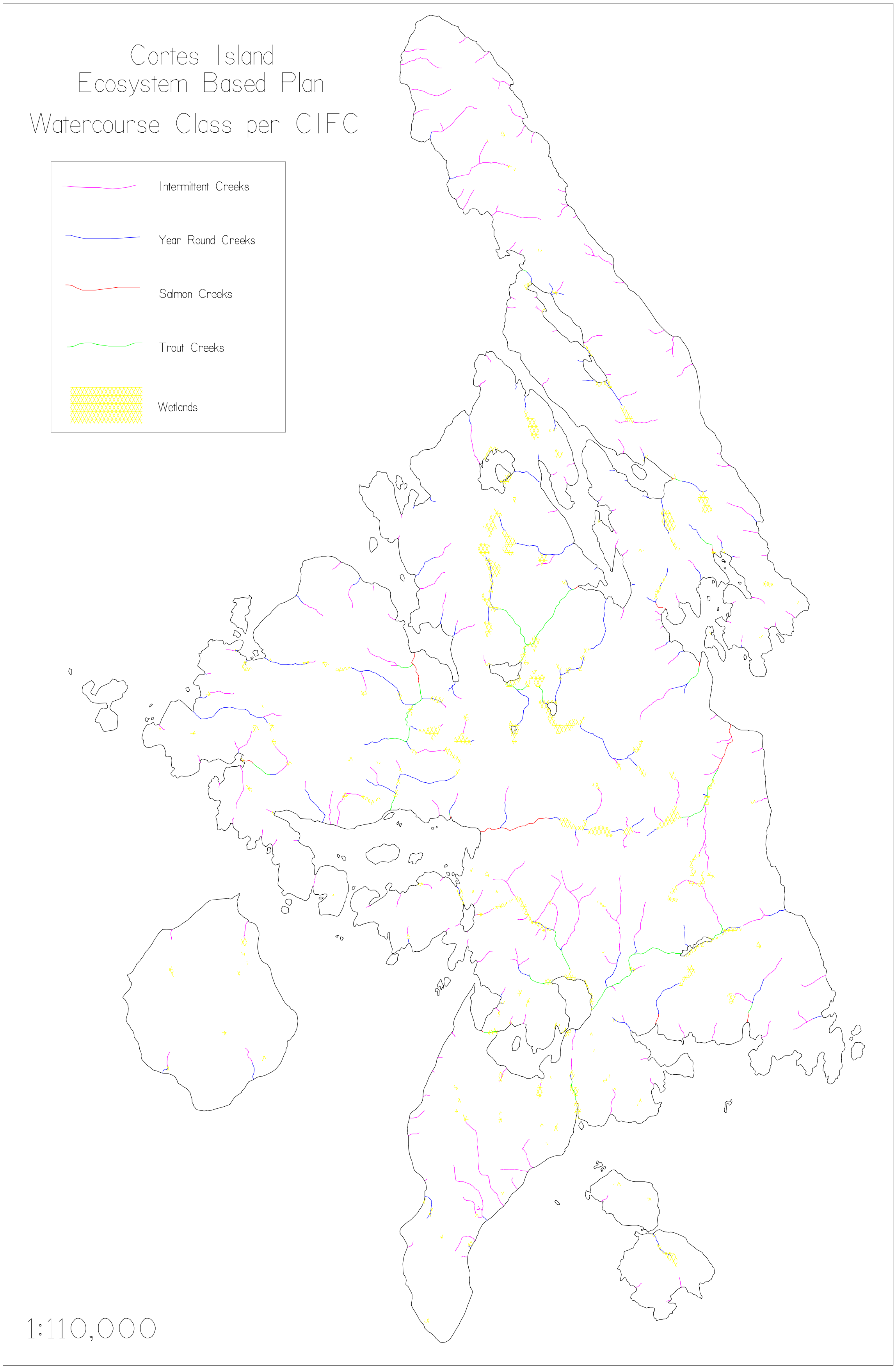

Figure 11: Map of Stream Classes per CIFC

3.2.4 SFF ESD Zones and Riparian Ecosystems

This main data layer is derived through a combination of air photo interpretation and GIS modeling. The Ecological Sensitivity to Disturbance zone types are delineated on air photos, and then imported into the GIS. The riparian ecosystems are modeled by creating a variable width buffer around water features in the GIS, which is then added to the digitized ESD layer. Figure 12 shows a map of the final results of this process. Table 10 summarizes the areas of the stratifications shown in Figure 13 . The theory of SFF ESD rating was previously discussed in Sections 2.1.1 and 2.1.2.

In summary, Silva ESD ratings are based on combinations of soil depth, slope, soil moisture, and terrain complexity. We used 1:17,000 black and white air photos and 1:50,000 topographic maps to identify the following terrain types on the air photos:

- **ES 1** - Large Riparian Ecosystems
- **ES** 7 - Wetlands
- **ES 2** - Steep Terrain
- **ES 4** - Complex Terrain
- **ES 5** - Areas of Shallow Soil
- **MS** - Moderately Stable Terrain
- **S** - Stable Terrain

The code before each listing above is used in our internal mapping, photo interpretation and data summary procedures. Combinations of codes are common. For example, ES 1,7 and ES 2,4,5 areas are common on Cortes Island. Definitions of the terrain classes identified on Cortes island follow:

- ES1 and/or ES 7 areas are predominantly located in valley bottom areas, or near lakes. Only larger riparian ecosystems or wetland complexes were identified on air photos, and computer generated buffers around wetlands and streams were added in later steps. Photo identified riparian ecosystems were delineated only in locations where the SFF staff believed that the computer generated buffers may be inadequate.

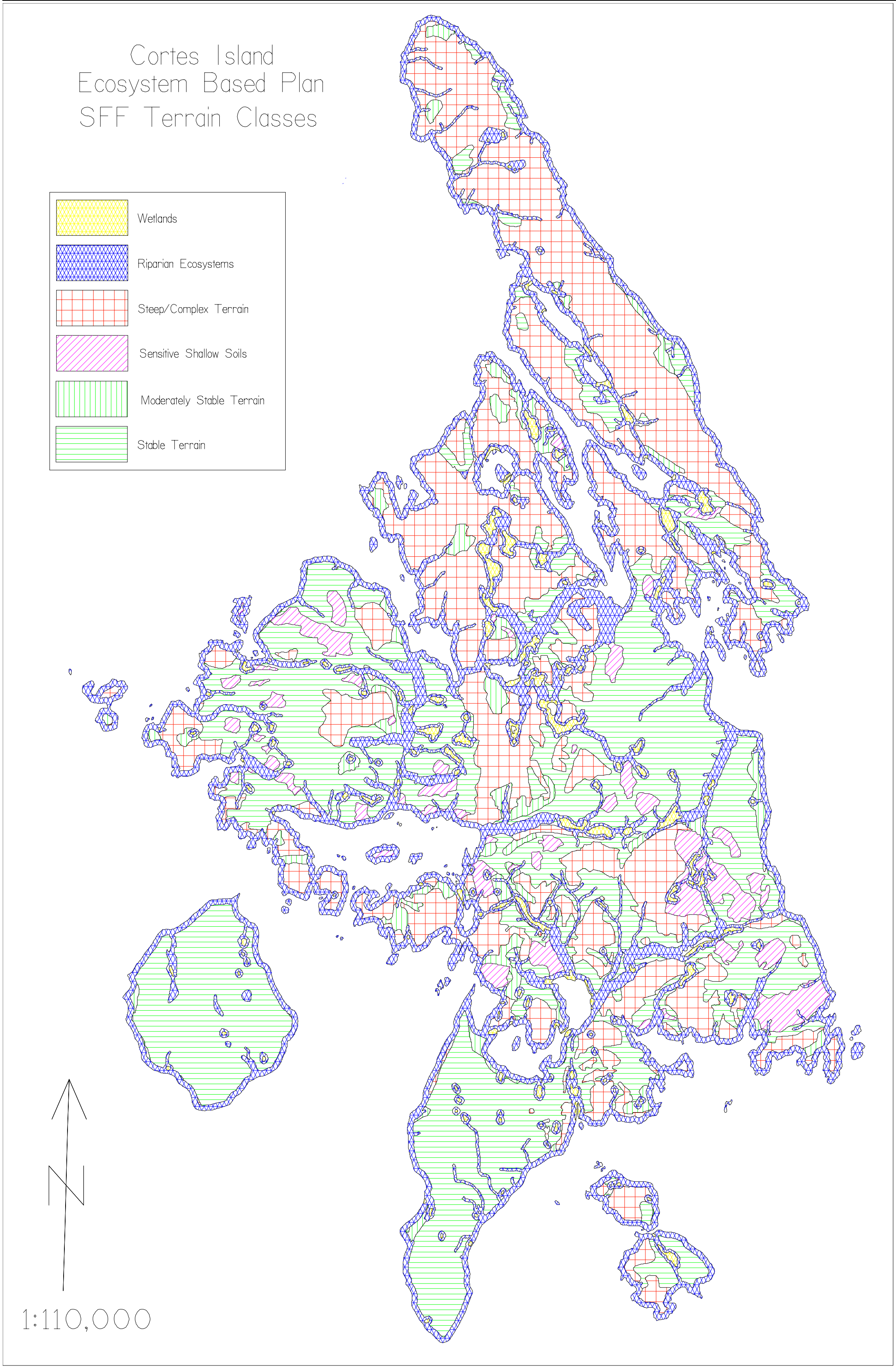

Figure 14: Map of SFF Terrain Classes on Cortes Island

SFF Stratification	Area (ha)	Percent of Total
Protected Ecologically Sensitive Terrain		
Wetlands	277	2%
Riparian Ecosystems	3,421	25%
Steep/Complex Terrain	4,128	30%
Sensitive Shallow Soils	594	4%
Stable Terrain: Potentially Available for Resource Extraction		
Moderately Stable Terrain	464	3%
Stable Terrain	4,814	35%
Total:	13,698	100%

Table 11: Area of SFF Terrain Classes

- ES 2 terrain includes all areas with slopes greater than 60%[2] gradient. Such slopes are unstable and prone to landslides and other forms of erosion, especially after logging and road construction. The stability of these slopes may continue to decrease for many years after logging. As Wilford (1987) notes:

  > Tree roots are an important stabilizing element on forested slopes. When trees are harvested the roots decay and slopes can become unstable. Significant root strength losses occur over a 2 to 7 year period. There is a period while regeneration is getting established that the root component of slope stability is low (up to 30 years).

  Due to the high risk of slope failures, we removed all areas with slopes over 60% from the potential wholistic timber management landbase. Steep sites can be economically logged with modern equipment, but we believe that they are too ecologically sensitive to be sustainable timber management sites.

- ES 4 sites are areas which are dissected by gullies or which contain convoluted, hilly terrain. While the overall slope gradient of a site may be low, the micro slope gradient on gully sides or hillock sides is often over 60%. In addition, complex terrain contains many small ridge and hill crests which receive no water inputs other than precipitation. These areas also often have shallow soil. The combinations or small steep slopes, dry sites, and areas of shallow soil make these sites unsuitable for timber management.
- ES 5 sites have soil less than 50 cm deep over bedrock. While soil depth cannot be measured on air photos, signs such as open forests, patches of exposed rock in the forest canopy, and complex rocky terrain all indicate areas which likely have shallow soil.
- MS or Moderately Stable sites are “in between” ES terrain and Stable terrain. These are generally areas with:

[2] A 60% slope rises 60 m for every 100 m of horizontal distance.

  - continuous slopes in the 30 to 60% range, or
  - fine grained mixtures of stable and ecologically sensitive sites which cannot be differentiated at the scale used in the analysis.

  We included 75% of forested area[3] of the MS terrain in potential timber management zones on Cortes, and filed the other 25% as sensitive terrain. This netdown is to allow for the inclusions of inoperable areas which are expected to be found upon closer examination of MS areas.

- S or Stable sites are areas with moderate slopes, deep well drained soils and even terrain. We included 100% of the forested area of S terrain in the potential timber management landbase.

Information gained during the field assessments was used to revise and improve the initial ESD interpretations. The highlights of the information gained from the field work are:

- Rocky knolls and ridges are common in elevated parts of the island. Areas which showed any hint of rock patches or open areas on the air photos were generally found to have very thin soils over strongly complex, and often steep, rock formations.
- Streams and creeks are difficult or impossible to see on the air photos of Cortes Island. Natural drainage patterns are visible, but the dense vegetation in moist areas prevents any assessment of stream presence or width.
- The 1:17,000 air photos understate ground slope, leading to a tendency to underestimate slope steepness and ecological sensitivity. This was addressed through careful adjustment of photo interpretation parameters and though use of contour maps to measure ground slope.

After revision, the SFF ESD lines were transferred to the Landsat print and digitized into the GIS. A draft GIS map was sent to David Shipway of the CIFC, who carried out further ground checking and air photo interpretation, and revised the map to the satisfaction of the CIFC. The suggested changes were digitized into the SFF GIS system, completing the process of delineating the SFF photointerpreted ESD zones.

The riparian ecosystems shown in Figure 15 are largely computer generated. We used the buffer generation capabilities of PAMAP to place a fixed width buffer around all water features and wetlands, and then combined the resulting buffers into a single layer. The single buffer layer was then added to the final overlay map layer. Table 12 lists the buffer widths used by originating feature.

Our literature review of riparian buffers in current use (see Appendix 4) indicated that while these buffers are wider than those proposed by the Forest Practices Code, they are not out of line with buffer widths in use in other jurisdictions. Most watercourses on Cortes are offered the protection of a tree length (50 m) buffer on each side of the water course in this plan. The protection is doubled on ecologically and economically important waterways, such as fish bearings streams. Remember that under wholistic forest use, the

[3] Sites identified by the MoF as capable of growing merchantable crops of timber. Excludes non-forested sites, non-productive forest areas, and non-merchantable forest types.

areas outside the buffers will not be clearcut, but will be managed in an ecologically sound manner which maintains forest ecosystems on the site at all times.

Feature Class	Buffer Width
Intermittent Creek	20 m
Year Round Creek	50 m
Fishbearing Creek	100 m
Wetlands	50 m
Lakes and Ocean Shoreline	100 m

Table 13: Riparian Buffer Widths by Water Feature Class

The riparian buffers took precedence over the SFF photointerpreted ESD zones. That is, where an area was classed as, for example, stable terrain, and fell within a computer generated riparian buffer, it is classed as riparian ecosystem on the final maps and data summaries.

We removed 90% of the buffer area from the timber management landbase, and left 10% in the landbase. This was to allow for accidental inclusions of "non-riparian" areas in the computer generated buffers, and to allow for some careful logging at the edges of riparian zones in select instances and after a track record of sound forestry and logging have been established.

3.2.5 Old Forest Areas

Our initial field work on Cortes Island and discussions with the CIFC indicated that there were significant problems with our usual approach of identifying old growth forest areas from the MoF forest cover maps. Identifying old growth forest areas is a vital part of forest landscape planning because old growth forests play a unique, important, and irreplaceable role in forest landscape ecology.

To ensure long-term forest health, old growth forests must be maintained throughout the forest landscape. In addition, old growth structures[4] must be well-distributed in each forest stand. Late successional or old growth forests provide a variety of specialized functions not available in other successional phases, including:

- production of the highest quality water
- regulation of herbivorous "pest" insects by supporting balanced populations of insect carnivores
- storage of a greater amount of carbon than other forest successional phases
- production of the highest quality, highest value, and highest volumes of wood for potential timber supplies

[4] Large green trees, large standing dead trees (snags), and large fallen trees. The dead tree component is often referred to as coarse woody debris. The large diameter and huge mass of old growth trees gives them special ecologically functions which can not be replicated by smaller trees.

- production and storage of soil nutrients necessary for other forest successional phases, particularly the young and early mature forest phases
- provision of unique habitat necessary for the persistence many animals species
- provision of a source of specialized species, including soil flora, fauna, and microorganisms necessary for the healthy development of other forest successional phases

Old growth forests are required in significant quantities throughout the landscape to maintain both short- and long-term forest functioning. Unfortunately, in many parts of the world, this ecological reality has not been recognized until most of the old growth forests have been liquidated or so seriously fragmented that most of their important functions have been lost.

The southern Cortes Island landscape has been overwhelming impacted by logging. The scattered old growth Douglas-fir trees which stand like sentinels in small groups throughout the southern island were once average sized trees in an old growth forest. The lush second or third growth forests we now see on Cortes are beautiful, but are ecologically very different from the old growth fir, cedar and hemlock forests they have replaced. The magnitude of the ecological difference will increase over time, unless management plans are implemented to restore old growth structures to all stands, and to restore old growth patches to the forest landscape.

The first step in restoring old growth forests within the Cortes landscape is to identify the old growth forests which currently remain on the island. However, this proved more challenging than first anticipated.

Among other impacts, such as loss of plant and animal species, excluding old growth forests will result in declining water quality and timber productivity over time.

The MoF forest cover type data is formulated primarily as a timber management and inventory tool. In many areas of the province, forests tend to be either logged or unlogged natural stands. In these landscapes, most remaining old growth forests can be easily identified based on stand age. However, on Cortes Island and in other areas with a long history of settlement and logging, most forest areas have been logged in the past and many stands were partially cut. As a result, areas which contain ecologically significant old growth structures are dominated, from a timber management point of view, by younger stands. On many sites, the MoF stand data listings reflect the makeup of the second growth forest, and may or may not include information about scattered old growth trees left on the site as a separate layer[5] of information.

The decision making process used by the MoF to identify the boundaries of forest types which contain old growth remnants is not clear. If one half of a uniform second growth type contains scattered old growth trees, and the other half contains none, does the MoF break the area into two types, or is it left as one type with a “scattered old growth” listing?

[5] The MoF breaks complex stands with more than one age of tree into separate layers. Thus, the data for a stand may indicate that it has a main layer of 50 year old Douglas-fir, with an additional layer of scattered 250 year old Douglas-fir veterans, or old growth trees.

These problems are not significant from a conventional timber management point of view, but are very significant when attempting to inventory remaining old growth forests, and to develop plans to maintain fully functioning forest ecosystems at all scales.

In response to these difficulties, the SFF and the CIFC embarked on a program to map remaining old growth forest patches and stands containing old growth structures on Cortes Island.

The first draft of mapping was carried out by the SFF using 1:17,000 black and white air photos. Mapping “old growth” form air photos is problematic: there is no way to measure the age of a tree on air photos. We used crown form, crown width, and tree height to identify what we believed were old forest areas. Old trees generally have wide, ragged crowns and are significantly taller than second growth forests. We identified two classes of old forests on the island:

- High Density Old Growth: Areas with more than 10 stems per hectare of old growth trees. Generally, these are intact stands which have not been logged. High density old growth is rare in the more settled portions on the island, but becomes more common moving onto the central spine and up onto Von Donop peninsula. These areas are proposed for protection.
- Low Density Old Growth: Areas with less than 10 stems per hectare of old growth trees. Generally, these are logged areas or rocky, sensitive sites with a few scattered old growth trees. Low density old growth forests on stable and moderately stable terrain remain in the potential timber landbase, with the caveat that any logging activity in the area must not impact the stems or roots of the large old trees. This will likely require buffer zones around all individual trees.

David Shipway of the CIFC then performed further photo interpretation and extensive field inspection of the photo interpreted old growth stands. As expected, he found several areas where young trees with large crowns had been mistakenly typed as old growth, and added many small areas of old growth trees which had been missed. The final map from this process is shown in the Figure 16. Table 14 summarizes the stratifications shown on the map.

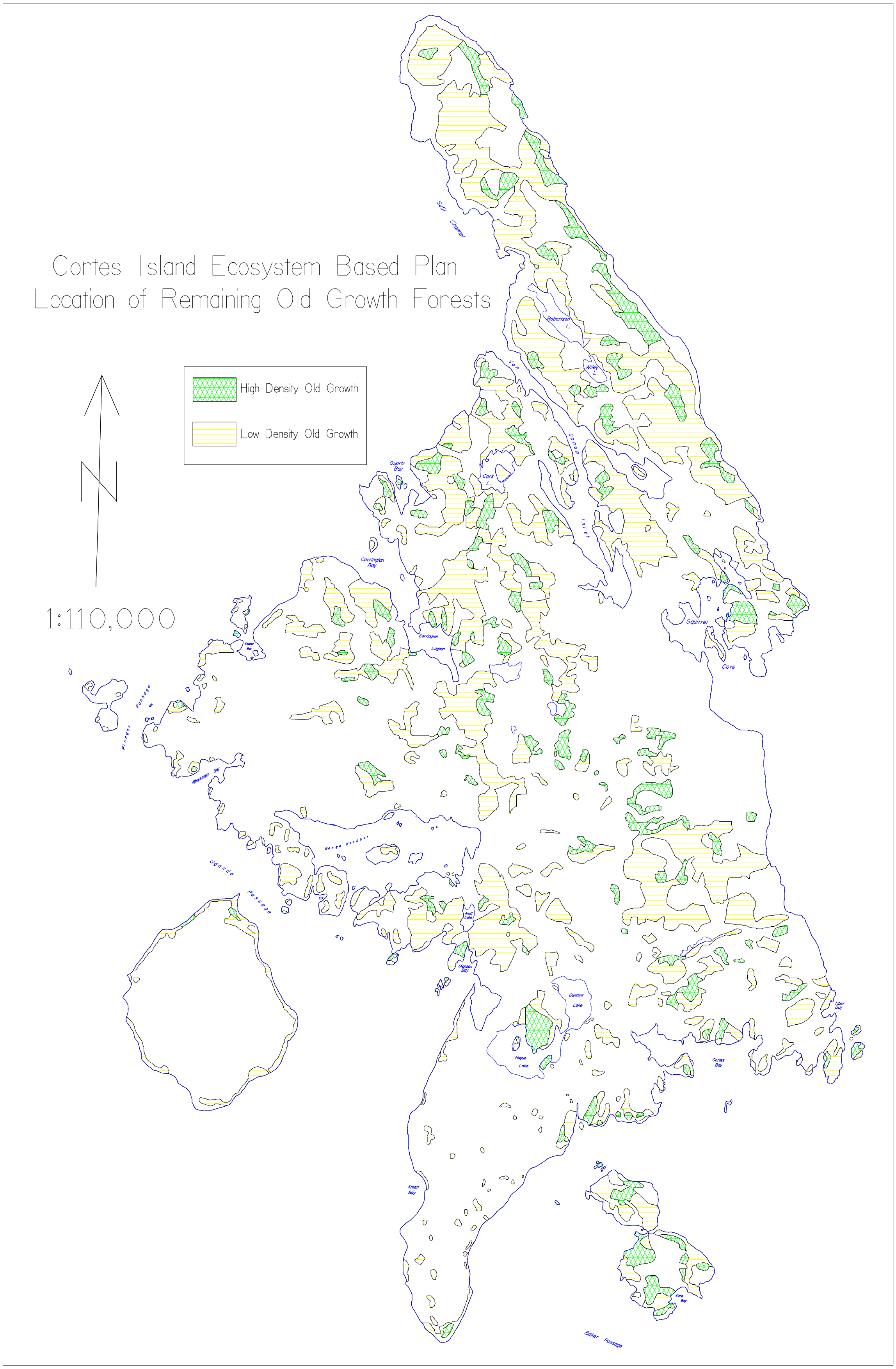

Figure 17: Map of Remaining Old Growth Forests on Cortes Island

Stratification	Area (ha)	Percent of Total
Low Density Old Growth (< 10 stems/ha)	3,239	23%
High Density Old Growth (> 10 stems/ha)	777	6%
Other Land Strata	9,682	71%
Total Area	13,698	100%

Table 15: Area of Old Growth Forest by Stratum

We believe that old growth forests once dominated the landscape of Cortes Island. However, extensive logging and resulting fires around 80 to 100 years ago have greatly reduced the area of remaining old growth. Currently, only 6% of Cortes Island is occupied by high density old growth forests, and a further 23% falls within the low density class. Remember that the low density old growth class is not "old growth forest", but is generally a natural open area or logged area which contains some large old growth structures. While ecologically valuable, low density old growth areas are not an ecological substitute for full canopied old growth forests on good growing sites. We believe that the current proportion of old growth forest in the Cortes landscape is well below the historical range of variation of old growth coverage prior to European settlement. Therefore, for purposes of this plan, we have decided that all remaining high density old growth forests on Cortes Island should be protected from timber extraction and other activities that significantly alter their composition, structure, and function. This decision affects only old growth on stable and moderately stable terrain, because old growth on unstable or ecologically sensitive terrain is always protected (i.e. is not a potential timber zone).

The current old growth forests will be supplemented over time by old growth stands which develop within the protected landscape network. This process will take at least another century, but there is no way to speed up the creation of old growth forests.

3.2.6 Cross Island Linkages

As part of the protected landscape network, the SFF identified a network of connecting corridors, or cross island linkages, throughout the Cortes landscape. These corridors have several purposes:

1. To provide movement paths for plants and animals which wish or need to migrate across the island.
2. To provide linear, connected areas of old forest habitat in readily accessible locations which extend throughout the island landscape.
3. To link specific ecological features, or ecological resources, with undisturbed forest habitat.

Questions are often raised about the concept of corridors or corridor design. The SFF is often asked why we have delineated corridors through areas where "the deer don't walk through," or other similar observations. We do not dispute these observations based upon local knowledge. However, the corridor networks we design are not based upon the habitat needs of a specific wildlife or game species, but are rather an attempt to preserve ecological connections throughout the landscape. Putting corridors "where the deer walk" is usually a good thing, but placing corridors "where the deer don't walk" is not necessarily a bad thing.

Corridors would be completely unnecessary if human forest use practices did not cause severe ecological impacts. No other species routinely removes many or all of the forest trees from large areas, while tearing up the ground and re-arranging the creeks. In a natural landscape without human disturbances, animals and plants can move through a variety of seral stages and old growth phases of forest ecosystems. However, human disturbances break natural movement corridors and create systematic patterns of disturbed areas on the landscape which do not mimic or reflect natural disturbance patterns. Human disturbances tend to break connectivity or fundamentally change the landscape in a variety of undesirable ways. Because of the impacts of human use, even of wholistic timber management, we believe it is required to maintain an undisturbed network of corridors or linkages throughout any landscape.

Corridors, or landscape linkages, are not a perfect solution to the problem of human disturbance. Ecologists and scientists are engaged in an ongoing debate about the effectiveness of corridors, and the possible negative impacts of designing corridors in the landscape. A review of the likely benefits and negative impacts of corridors is provided in Appendix 3. In brief, ecologists fear that corridors may increase predation or lure animals into less than suitable habitat resulting in population decline, not population maintenance. However, there is solid support for corridors on the basis that they are the best option available, barring complete protection. There is also consensus that managing the landscape to provide resources for biodiversity on all portions of the land (the matrix) is greatly preferable to severely impacting some areas and relying on a corridor system to maintain plant and animal population. Wholistic forest use seeks to achieve this goal by ensuring that forest structure and function remains intact on all areas, regardless of human use. However, we are not so arrogant as to believe that we have all the answers. We believe a corridor system is required in order to provide an insurance policy, or a refuge and movement system, for organisms that require resources not found in wholistic timber management zones, riparian zones, or protected ecologically sensitive terrain.

Corridors are located so as to take advantage of natural features such as:

- old growth forest patches,
- passes between hills or mountain ranges,
- wetland ecosystems,
- riparian ecosystems, and
- undisturbed areas of the landscape.

While corridors are not specifically designed to mimic large animal movement routes, they are designed to avoid barriers to movement. We also design corridors to link existing protected areas within the landscape. It is very important that animals and other organisms have an undisturbed movement corridor to access large protected areas.

The linkages delineated on Cortes Island are generally 200 to 400 m wide. In some special locations, the corridors swell to over 800 m in order to encompass and protect an ecological feature such as a wetland complex. Corridors take in a mix of stable and ecologically sensitive terrain. In many locations on Cortes Island, the designated corridors travel along the edge of a rocky upland. In these locations, we deliberately included a belt of stable forested terrain beneath the upland, and the area up to the crest of the rocky ridge. In this way, we provide a diversity of habitats within the corridor and hope to increase the options for plant and animal movement.

Corridor location at the landscape planning level is an inexact science. Further study or local knowledge may indicate that some corridors should be shifted from their proposed location to other nearby locations which have a greater habitat value. This is not unexpected and is part of the process of improving this initial plan to meet the final requirements of the Cortes community.

Figure 18 shows the cross island linkage network designed for Cortes Island by the SFF and with input from the CIFC. Tables 16 and 17 summarize the area and contents of the linkages by terrain type. Table 18 compares the area within linkages to the total landbase of Cortes Island by terrain class and ownership status. The following text describes the rationale for each corridor selected and highlights the important features that are linked by or protected within each corridor.

Corridor #1: This is the main east-west corridor across the central portion of Cortes Island. From the east, the corridor begins by linking a series of wetlands and alder stands in the valley bottom with some inclusions of upland forest. The corridor then turns north and takes in the west slope of Green Mountain, and then extends towards Plunger Passage, following a long valley with a series of wetland complexes. This corridor is severely compromised at the Squirrel Cove/Manson’s Landing road junction beside the end of Gorge Harbor. At this point, logging, residential development, and roads come together to pinch the corridor to an extremely narrow width. This is unfortunate, but not currently avoidable. There is no alternative location for this linkage except directly over Green Mountain, which is not a desirable location.

Corridor #1 connects a series of low density old growth patches on sensitive elevated terrain and includes several small patches of high density old growth.

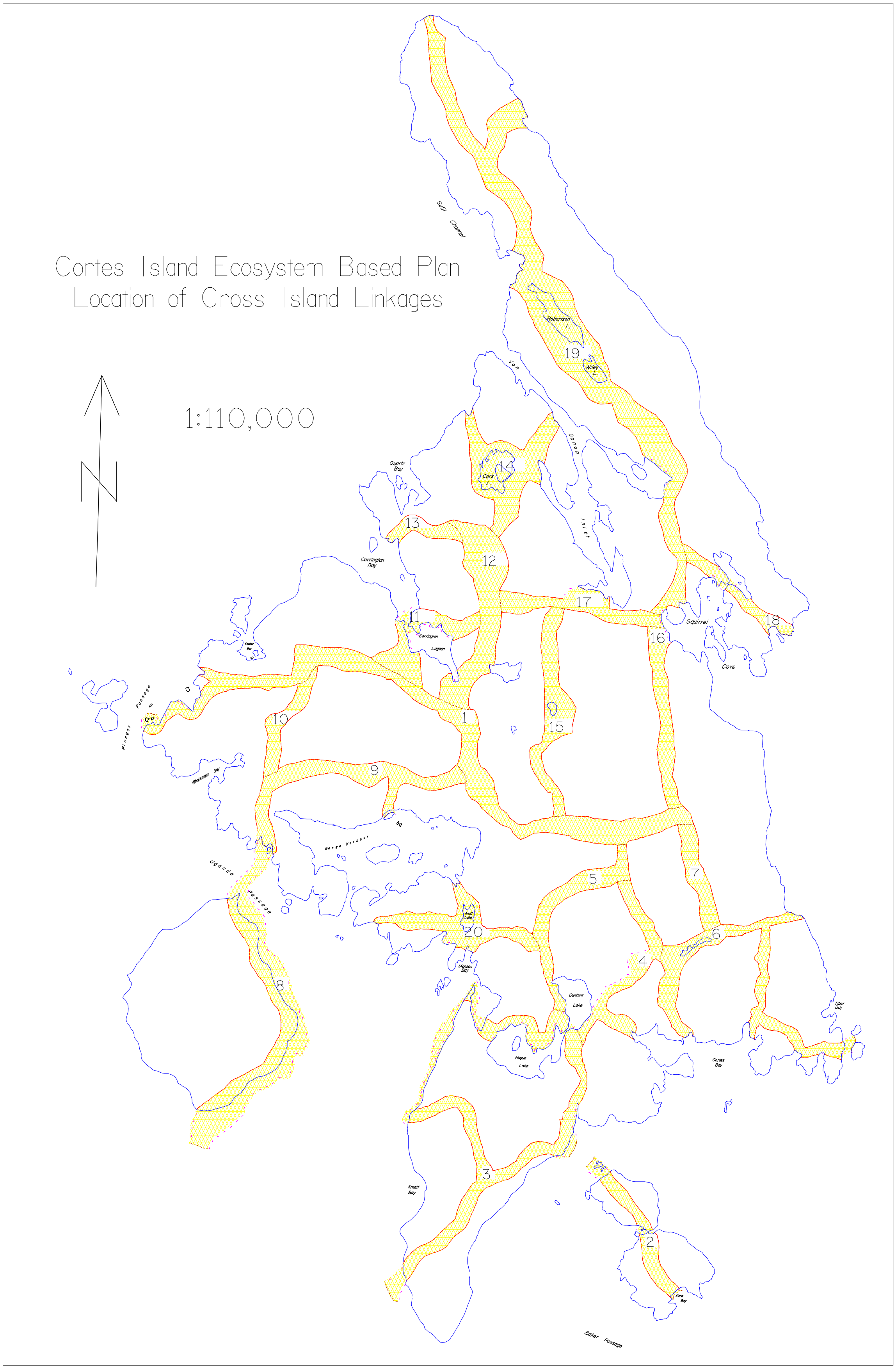

Figure 19: Map of Proposed Cross Island Linkages on Cortes Island

Land Classification	Area (ha)	% of Total	Area (ha)	% of Total
MoF Netdowns				
Not Forested	26	1%		
Non Productive Forest	72	2%		
Non-Merchantable Forest	35	1%		
ESA Class 1 Terrain	86	3%		
ESA Class 2 Terrain	49	2%		
Disturbed Areas from Logging	60	2%		
Subtotal			328	11%
SFF/CIFC Netdowns				
Additional CIFC Wetlands	131	4%		
Steep Terrain	990	32%		
Riparian Ecosystem	503	16%		
High Density Old Growth	161	5%		
Sensitive Terrain in Moderately Stable Zones	24	1%		
Subtotal			1809	59%
Potential Timber Landbase				
Low Density Old Growth	147	5%		
Moderately Stable and Stable Terrain	792	26%		
Subtotal			939	31%
TOTAL	3076	100%	3076	100%

Table 19: Contents of Cross Island Linkages by Netdown Strata

Corridor #2: Corridor 2 provides a linkage along the spine of the Twin Islands southeast of Cortes.

Corridor #3: Corridor 3 forms a loop which links many ecologically significant sites on the Sutil Peninsula. The Sutil Peninsula is almost completely privately owned and heavily impacted by human settlement and logging. This corridor seeks to find a way to join remaining ecologically intact second growth forest areas, wetlands, and intertidal zones to protect the ecological whole. The corridor also joins the planned regional park in the Gunflint Lake-Hague Lake area and the existing Manson’s Landing Provincial Park. A long arm extends from the southern portion of the corridor down to the extensive intertidal zone around the Sutil Peninsula and Sutil Reef itself.

Corridor #4: This short corridor provides a linkage from the east side of Gunflint Lake around the eastern border of the Linnaea Farm fields and up the Linnaea Farm road to a pass leading to Corridor 1. Corridor 4 also intersects with Corridors 3, 5, and 6. This corridor does not protect any particularly special ecological features, but does provide a required linkage in this area.

Corridor Number	Total Area (ha)	Area of MoF Netdowns (ha)	Percent of Total Area	Area of CIFC/SFF Netdowns (ha)	Percent of Total Area	Potential Wholistic Timber Landbase (ha)	Percent of Total Area
1	407	43	11%	189	46%	175	43%
2	67	7	10%	39	58%	21	32%
3	265	33	12%	97	36%	136	51%
4	104	23	22%	54	52%	27	26%
5	107	6	6%	56	52%	45	42%
6	183	8	4%	132	72%	43	23%
7	66	1	2%	53	80%	12	18%
8	119	5	4%	57	48%	57	48%
9	159	8	5%	64	40%	87	55%
10	57	4	8%	17	29%	36	63%
11	94	17	19%	53	56%	24	25%
12	196	23	12%	152	77%	21	11%
13	39	15	38%	22	57%	2	5%
14	154	20	13%	120	78%	15	9%
15	127	12	9%	71	56%	44	35%
16	97	2	2%	20	20%	75	77%
17	100	11	11%	62	62%	27	27%
18	56	3	6%	38	68%	15	27%
19	564	78	14%	422	75%	64	11%
20	115	9	8%	93	81%	13	11%
Total	3,075	328	11%	1,809	59%	939	31%

Table 20: Area of Individual Cross Island Linkages by Terrain Class

Corridor #5: Corridor 5 runs from west of Gunflint Lake north to join Corridor 4 at the pass at the upper end of Linnaea Road. It provides connecting linkages between the Linnaea Pass, a large wetland on the road between Gunflint Lake and Gorge Harbor, and Corridor 20, which extends along the spine of land to the south of Gorge Harbor. While Corridor 5 does not itself contain exceptional ecological resources, it does provide a necessary connecting link in the landscape to join the mentioned features.

Corridor #6: Corridor 6 is actually a complex of linkages through the rugged terrain between Cortes Bay and Tiber Bay. This corridor joins a variety of large intertidal zones at the heads of bays and an extensive wetland in the interior. The arms of the corridor pass through a variety of forest types in valleys between rocky uplands, including both high density and low density old growth types. The function of the corridor is to protect forested movement paths between the intertidal area of Cortes Bay and the wetland in the interior portion of the island.

Ownership Stratification	Total Area	Area in Corridors	Percent of Stratum Area in Corridors	Total Area of Non-Forested, Non-Productive, MoF ESA and Silva ESD (1)	Area of Non-Forested, Non-Productive, MoF ESA and Silva ESD in Corridors	Percent of Stratum Area in Corridors	Total Area of Stable and Moderatley Stable Terrain (1)	Area of Stable and Moderatley Stable Terrain in Corridors	Percent of Stratum Area in Corridors
Class "A" Provincial Parks	1,032	311	30%	849	253	30%	182	58	32%
Proposed Parks	219	46	21%	195	43	22%	24	4	15%
Other Govt Reserves	177	88	50%	102	54	53%	75	35	46%
Indian Reserves	376	91	24%	82	22	27%	294	69	24%
MacMillan Bloedel Holdings	1,876	534	28%	839	286	34%	1,037	249	24%
Other Private Land	4,714	759	16%	2,608	428	16%	2,106	331	16%
Crown Land	5,305	1,245	23%	3,552	867	24%	1,754	378	22%
Total	13,698	3,075	22%	8,228	1,952	24%	5,472	1,124	21%

Notes:
(1) Includes corridors.

Table 21 Proportion of Land within Corridors by Terrain Class and Ownership Status

Corridor #1: This short corridor provides a linkage between the wetland in Corridor 6 and the far eastern end of Corridor 1. Corridor 7 extends along a flat bench with wetlands, between the coast and an upland ridge. Much of Corridor 7 is occupied by low density old growth and the corridor joins a high density old growth patch. This corridor is set well in from the coast of Cortes to avoid human settlement and roads.

Corridor #2: Corridor 8 extends along the eastern coast of Marina Island from Shark Spit in the north, to the extensive intertidal zones along Marina Reef at the south end of the island. This corridor includes the intertidal zone surrounding Marina Island, a thin strip of old growth timber left along the steep shores of Marina Island, and a 200 meter wide buffer of recently logged area along the coast of the island. This corridor was created to provide a movement path and biodiversity resource for animals which may wish to cross Uganda Passage and utilize the habitat on Marina Island.

Corridor #3: This corridor extends from Corridor 1 in the east to Corridor 8 in the west, along the north shore of Gorge Harbor. This corridor basically duplicates the function of Corridor 1 to the north, but was felt to be required because of the extensive distance between Gorge Harbor and Carrington Bay—a single corridor (Corridor 1) was not sufficient to provide a linkage function to the entire western peninsula of Cortes Island. An arm of Corridor 9 links a patch of low and high density old growth to Gorge Harbor. Corridor 9 runs down to the sea directly north of Shark Spit to provide a linkage across Uganda Passage to Marina Island.

Corridor #4: This is a short corridor which provides a required north-south link between the portion of Corridor 9 which connects to Uganda Passage and Corridor 1. Corridor 10 travels through settled and heavily disturbed areas, and will require time and possibly restoration in order to begin to function more completely as a linkage and biodiversity refuge.

Corridor #5: Corridor 11 is a short but wide corridor which was identified by the CIFC to protect the land around the extensive riparian / wetland area to the southwest of Carrington Lagoon, and to maintain the linkage along the north shore of Carrington Lagoon to Corridor 1. This corridor encompasses many ecologically important areas including low density and high density old growth, wetlands, and the shoreline of the ecologically significant Carrington Lagoon area.

Corridor #6: This corridor runs north from Corridor 1 at Green Mountain, and links Green Mountain, Carrington Lagoon, and a series of small lakes and wetlands to the area around Cork Lake and Quartz Bay. The north end of Corridor 12 expands to include high density old growth stands, low density old growth stands, and a series of wetlands in a valley between rocky outcrops. Corridor 12 contains diverse habitats to protect biodiversity and provides an important north-south linkage in the central portion of the island.

Corridor #7: This is a short spur corridor which joins the sea coast south of Quartz Bay to Corridor 12. Corridor 13 encompasses several low density old growth areas.

Corridor #8: Corridor 14 completes the north-south linkage begun with Corridors 1 and 12, to extend up to the Von Donop Inlet and Von Donop Marine Park. Corridor 14 also expands to include the riparian zones and forests around Cork Lake, and links them to Von Donop Park. A small northerly arm of Corridor 14 extends along a valley with low density old growth forests to provide a linkage to the sea coast outside of Von Donop Park.

Corridor #9: Corridor 15 extends from the wetland complex in Corridor 1 north along the Bluejay Road, past Bluejay Farms, and ends at Corridor 17 at the south end of Von Donop Inlet. We considered removing this corridor out of the corridor network, because it basically duplicates the functions of Corridors 1 and 16. However, we felt that Corridors 1 and 16 were too far apart to stand on their own, although having a third corridor in this small area is rather a "tight fit." In the end, we decided to err on the side of conservation and include Corridor 15 in the landscape network. Corridor 15 joins a series of high and low density old growth patches with riparian zones and wetland complexes, as well as providing an important north-south linkage through the interior part of Cortes Island.

Corridor #10: This corridor provides a north-south link between the far eastern end of Corridor 1 and Corridor 17, south of Von Donop Inlet. Corridor 16 extends through nondescript second growth forest on MacMillan Bloedel land and IR. 7. The exact location of this corridor is negotiable—it does not pass through any specific features, but a corridor is necessary on this portion of the island to complete the north-south link along the east coast of Cortes Island.

Corridor #11: Corridor 17 is the central portion of the northernmost east-west linkage on the main portion of Cortes Island. This corridor runs from the area just east of Carrington Lagoon, south of Von Donop Inlet, to Squirrel Cove. This corridor includes a wide variety of very ecologically important land, including intertidal zones, old growth forests, and riparian ecosystems.

Corridor #12: Corridor 18 is the eastern end of the northernmost east-west linkage on the main portion of Cortes Island. This corridor runs along the northeast side of Squirrel Cove to Lewis Channel. This corridor includes a variety of ecologically important land, including coastline bluffs and old growth forests. The corridor crosses Squirrel Cove at the culturally and ecologically important narrows separating the inner portion of the cove from the main outer portion.

Corridor #13: Corridor 19 extends from the west end of Squirrel Cove to the northern tip of Cortes Island along the west side of Cliff Mountain, through the valley that includes Wily Lake and Robertson Lake. The southern portion of this corridor is largely within Von Donop Marine Park. North of Robertson Lake, the corridor climbs on to the rocky spine of the Von Donop Peninsula, and runs through the north end of the peninsula. A small easterly arm extends from the corridor to Lewis Channel to take in a patch of moderate terrain and high density old growth. This corridor provides a main terrestrial link to Von Donop Marine Park and a linkage between the main portion of Cortes Island and the Von Donop Peninsula.

Corridor #14: Corridor 20 extends the protected landscape network westward onto the peninsula which lies south of Gorge Harbour. Much of the corridor is located on ecologically sensitive, rocky terrain, containing many scattered old growth trees. A small area of level, moist valley bottom is included near the tip of the peninsula. The corridor also encompasses Anvil Lake and the riparian ecosystem north of the lake to protect biodiversity, and to provide a north/south link across the base of the peninsula.

3.2.7 Intertidal Zones

During the course of this project, the CIFC educated the SFF staff about the importance of intertidal zones in a coastal ecosystem. Cortes Island has many kilometers of gently sloping shoreline which forms important intertidal habitat. Intertidal zones at low tide provide the quickest and easiest way to move long distances along the shore, and are used extensively as movement corridors. Many of the corridors described in Section 3.2.6 join intertidal zones at their seaward end(s).

Intertidal flats are a also a critical, and threatened, transitional habitat type which is used by terrestrial and aquatic organisms. The CIFC provided a map of intertidal zones derived from air photo interpretation which we digitized into the GIS system. Figure 20 shows the location of the 1,191 ha of intertidal zone mapped by the CIFC.

Intertidal zones are not directly threatened by forestry activity. However, they can be negatively impacted by development of any kind which changes the vegetation cover, drainage patter, or ecology of the bordering terrestrial ecosystem. Therefore, the foreshore around all intertidal zones should be protected.

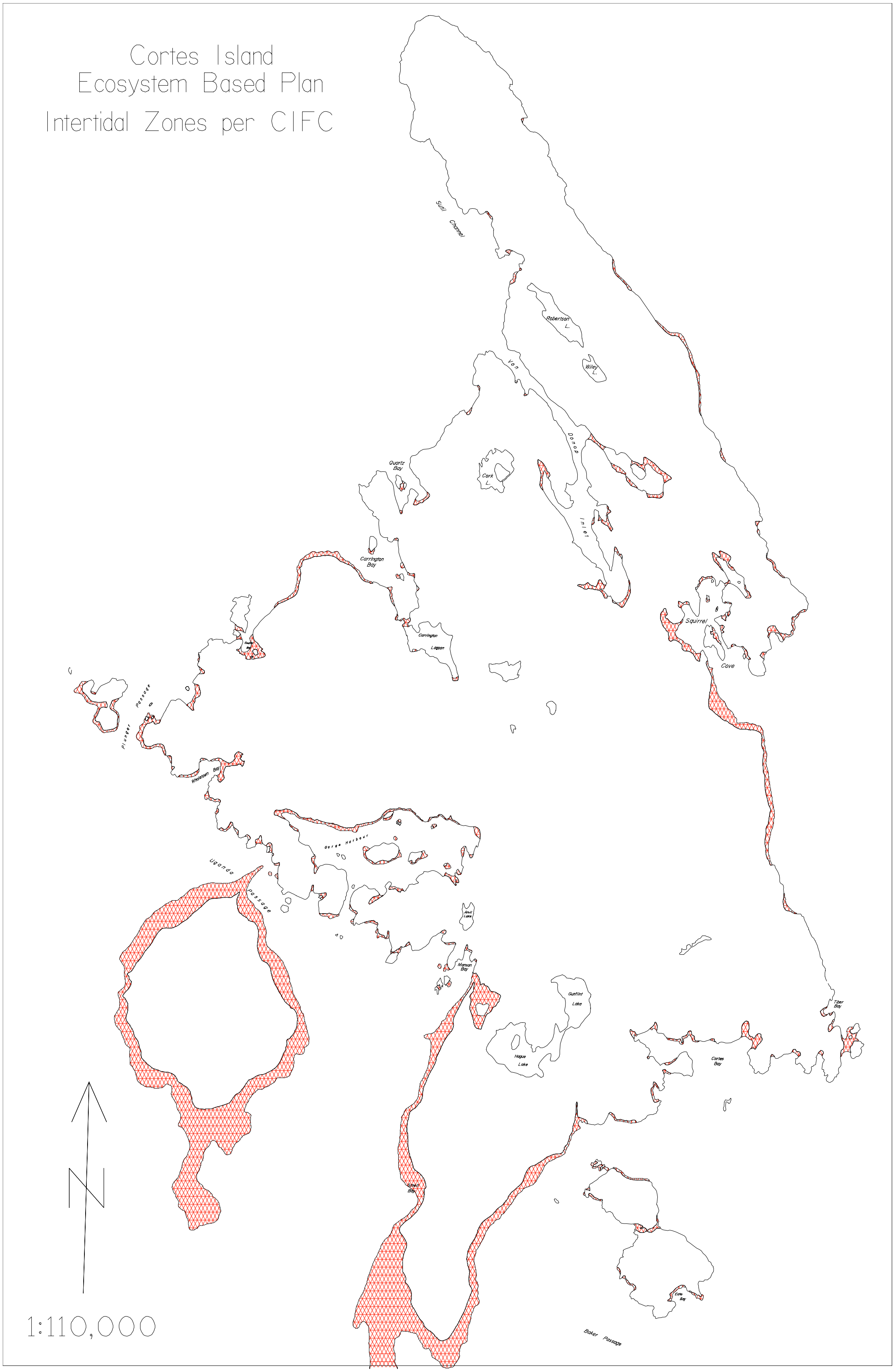

Figure 21: Map of Intertidal Zones

3.2.8 Land Ownership

Land ownership status is a critical parameter in this analysis, as ownership determines the responsibility for land and forest management decisions. Land ownership on Cortes Island rests with a variety of institutions and groups, including:

- The Provincial Government, as administered by the Ministry of Forests
- MacMillan Bloedel Limited
- Many smaller private landowners
- Other levels of government or other Ministries (in charge of various protected areas)

We used the land ownership information contained in the forest cover map data files as the base for land ownership mapping. The forest cover ownership data provided the following information:

- section and quarter section survey lines
- approximate identification of private land and crown land
- identification of U.R.E.P. (Use, Recreation and Enjoyment of Public) reserves and other miscellaneous government reserves
- identification of Indian Reserves
- outdated and partial mapping of parks and protected areas

We amended the forest cover data file as follows to improve the ownership mapping to required standards:

- MacMillan Bloedel holdings were mapped from a 1974 map provided by the CIFC titled *Managed Forest Land - MacMillan Bloedel*, which was drawn by the Regional District of Comox Strathcona Planning Department.
- The forest cover data mapping of other private land was updated in several locations per CIFC instructions.
- The boundaries of existing Class “A” Provincial Parks (Von Donop Marine Park and Manson’s Landing Park) were digitized from map and written information provided by Rik Simmons of the Ministry of Environment Lands and Parks, Strathcona District.
- The boundaries of the proposed Carrington Bay Park were digitized from a map provided by Alison Mewett of the Regional District of Comox Strathcona Planning Department.
- The boundaries of the Hague Lake / Gunflint Lake proposed park were digitized per the CIFC.

Figure 22 shows the resultant ownership mapping. Table 22 summarizes total area and potential wholistic timber management landbase by ownership status.

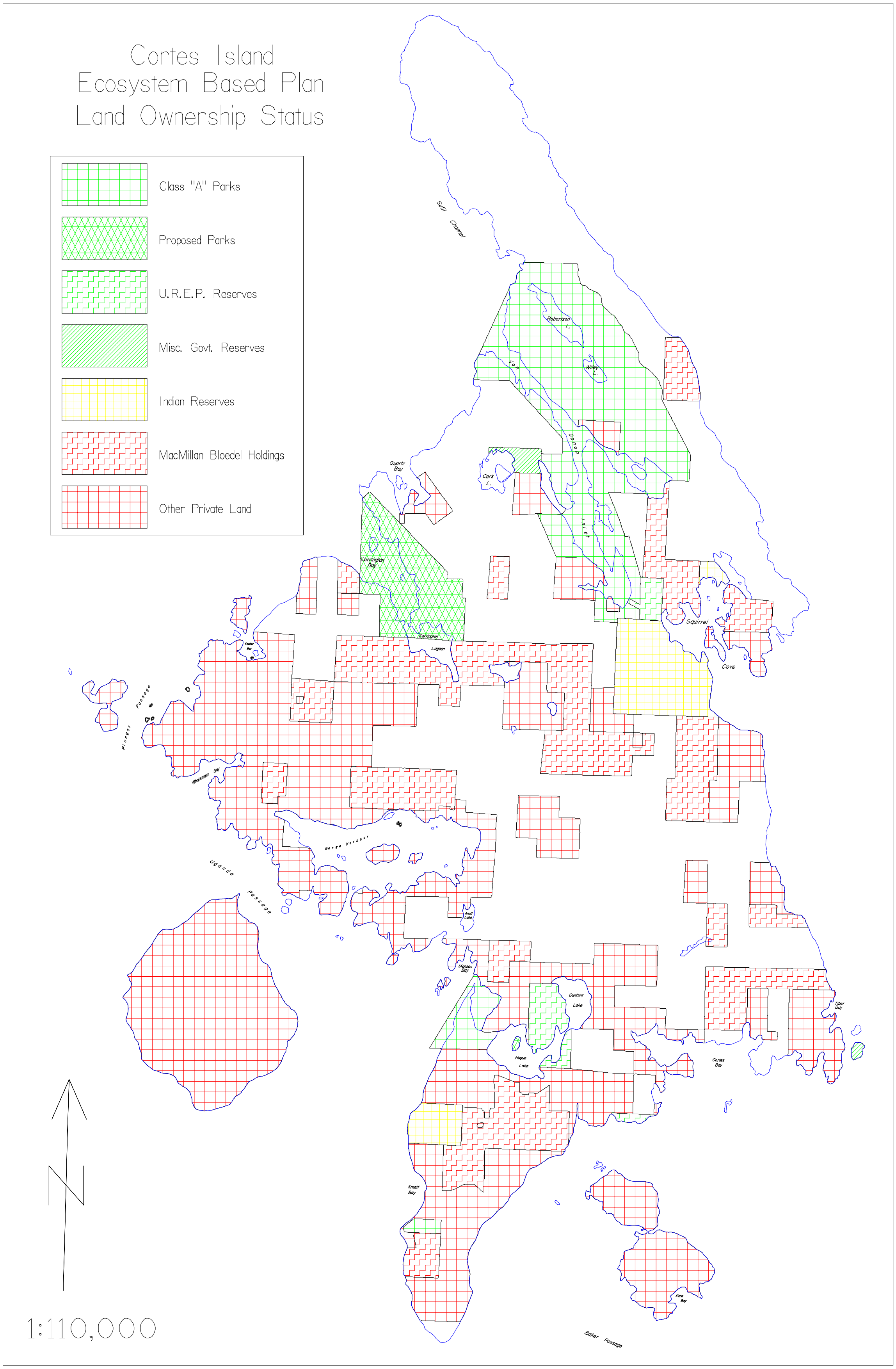

Figure 23: Map of Land Ownership Status on Cortes Island

3.3 Estimation of Timber Yield

The ecologically sustainable Annual Allowable Cutting rate, or AAC, is a critical output of this ecosystem-based landscape planning process. The estimated AAC is based on two factors:

1. The annual growth rate, or yield, in forest stands.
2. The area of forest stands which are ecologically and culturally suitable for timber management.

The area times the yield per hectare equals the AAC.

This section of the report outlines the processes and parameters used to estimate the annual growth rate. Previous sections of the report have documented the netdowns used to estimate the sustainable timber management landbase.

Hereafter in this discussion AAC mean the *ecologically sustainable AAC* as determined in this ecosystem-based planning process.

3.3.1 Timber Yield Estimation

The volume of wood which is grown each year on the timber management landbase is one of the two main variables needed to estimate the ecologically sustainable AAC in the study area. The average annual timber growth is often referred to as the yield or the mean annual increment (MAI) in forestry jargon. Average annual growth rate is generally expressed in cubic meters of timber produced per hectare per year (m^3/ha/yr). The annual allowable cut is related to the MAI, but is always lower due to factors such as timber waste, regeneration delays, and ecological protection measures.

We used Variable Density Yield Prediction Version (VDYP) software, Version 6.3c, published by the Ministry of Forests to estimate forest yield for this project. We used VDYP in the "batch" mode to estimate the yield for each forested polygon in the forest cover data file for each Landscape Unit. "Forested polygons" were identified as all polygons which had either an Inventory Type Group (ITG)[6] entry or were tagged as logged areas in the MoF data. This process included many areas which are not in the potential wholistic timber landbase, but SFF wished to determine the yield on all forested sites in order to know the timber yield on the land excluded from timber management in this plan, as well as yield on the land included.

[6] An Inventory Type Group is a grouping of stands with similar species composition, such as all Hemlock and Balsam forests, or all Douglas-fir forests. Each stand on a forest cover map is assigned to an ITG by the MoF inventory process.

VDYP requires a group of variables to run. Table 23 lists the information required by the software, and explains the source of data or assumptions used in each case.

Required Variable	Notes
Species Composition	The makeup of the stand on the site, listing tree species present and percentage of forest cover by species. No tree species are listed in the data files for logged areas which are not yet restocked. In these instances, SFF assumed 100% Douglas-fir stocking.
Forest Inventory Zone	Administrative designation, from forest cover data file.
Public Sustained Yield Unit (PSYU)	Administrative designation, from Ministry Of Forests.
Utilization Level	The minimum diameter at breast height of “merchantable trees”. Set to 17.5 cm for all stands.
Rotation Age	Age at which stand will be logged. This figure exerts a significant control on the predicted yield -- longer rotation ages result in lower annual yields. Table 24 shows the rotation ages used.
Site Index	A numeric measurement of the timber growing capacity of each forested site. This figure is provided by the MoF for each forested polygon.
Crown Closure	The percentage of the available growing space occupied by the crowns of the overstory trees in a stand. SFF used the VDYP defaults for each species group in the study area. SFF considered using the crown closure listed in the forest cover data file, but decided that basing long-term timber productivity on current crown closure, which in some cases may be more a function of past logging than site capability, and in other cases reflected young forest conditions, was not a suitable methodology.

Table 25: Variables Required by VDYP Software.

VDYP will calculate the stand yield at the culmination of mean annual increment or at a rotation age set by the user. SFF elected to set reasonably long rotation ages to match the ecosystem-based planning goals of maintaining biological diversity and growing large, high quality trees. The rotation ages used are still significantly less than ecological rotation ages, or the age at which old trees would begin dying. However, since significant areas of old growth reserves will be left throughout the landscape in the protected landscape network, and 25% of the trees in a timber zone will be left permanently to grow old and die, these rotations are a reasonable compromise between maintaining forest functioning and producing high quality timber in reasonable periods of time. Table 26 shows the rotation ages used.

Analysis Unit	Inventory Type Groups	Site Index	Rotation Age
Douglas-fir, Good Site	1 - 8, 28 - 31	>= 33	100
Douglas-fir, Medium Site	1 - 8, 28 - 31	26 - 32	120
Douglas-fir, poor site	1 - 8, 28 - 31	15 - 25	140
Hemlock , Good Site	12 - 17	>= 26	100
Hemlock, Medium Site	12 - 17	22 - 25	120
Hemlock, Poor Site	12 - 17	11 - 21	140
Cedar, Good/Medium Site	9 - 11	>= 18	120
Cedar, Poor Site	9 - 11	13 - 17	160
Alder, Good/Medium Site	37 - 39	>= 23	80
Alder, Poor Site	37 - 39	11 - 22	100

Table 27: Rotation Ages Used in Yield Prediction.

These rotation ages reflect the generally faster juvenile growth, shorter life spans, and more rapid development of old forest characteristics in deciduous forests.

The estimated yield, or MAI, calculated by VDYP is an estimate of net timber yield in cubic meters per hectare per year. That is, allowances have been made for losses to decay and for waste and breakage during logging, using standard MoF netdowns.

3.3.2 Netdown to Retain Ecological Structures

Managing for and retaining large ecological structures[7] within the timber management landbase is a requirement of ecologically responsible, ecologically sustainable timber management. Ecological structures are necessary to provide habitat for animals ranging in size from small mammals and birds to microscopic arthropods, to maintain organic inputs into soil, to maintain soil structure, to store and filter water, and to maintain ecosystem health and resiliency. SFF hypothesized that a minimum of 25% of the biological productivity of the site, or the timber yield in this case, must be left on the site for these purposes (remember, natural disturbances leave close to 100%). All timber yield predictions in wholistic timber zones are therefore reduced by 25% in the final summary tables.

4. Results

The tables on the following pages provide a basic summary of the timber management landbase and the timber yield for the three types of potential timber management land on Cortes Island:

- Crown land controlled by the Ministry of Forests
- Private land held by MacMillan Bloedel Ltd.

[7] Large, old standing trees, standing dead trees (snags), and fallen trees.

- Private land held by other owners

The tables compare conventional and wholistic timber management landbases and timber yield predictions.

Tables 28, 29 and 30 show the gross area in hectares within each of these ownership classes, and document the series of netdowns used to model the net potential wholistic timber management landbase for each. The nature and derivation of these netdowns was described in Section 3. Each of these tables contains a reference to MoF netdowns, even though two of the ownership strata are outside of MoF control. This is because we use the standard MoF netdowns to model the conventional forestry perspective on all strata.

Tables 31, 32 and 33 show the same type of information, but are expressed in cubic meters of timber growth per year.

The potential timber management landbase and annual yield described in this section are based on the principles of wholistic forest use. Appendix 5 contains SFF papers on the standards and guidelines applicable to ecologically responsible wholistic timber management. If aggressive and ecologically damaging forest practices are used instead, greater areas of completely protected land will be required to attempt to offset the ecological impacts of conventional timber cutting. In other words, the proportion of Cortes Island protected in this plan is low by ecological standards. Maintaining ecosystem functioning with a minimum of protected area depends on ecological contributions from "the commodity forest", which are not provided by the clearcut and plant paradigm of conventional forestry.

The results section of this report is incomplete at this time. In order to meet the August 15, 1996 delivery date requested by the CIFC, we have not been able to prepare a table, graph, and write-up showing/discussing the distribution of land per the stratifications used on each of the main report maps. This task will be accomplished as soon as possible and the results appended to a revised edition of this report.

Source of Netdown	Description	Percent Netdown	Area in Classification (ha)	Landbase Area (ha)
Stratification of Landbase within Crown Land Controlled by Ministry of Forests				
	Total Area of Crown Land Controlled by Ministry of Forests:			**5,305**
MoF	**Non Forest Areas:**			
	Open areas, rock and cleared areas.	100%	12	
	Disturbed Areas - netdown to existing logged areas to allow for roads, trails and landings.	10%	99	
	Forested Areas:			
	Environmentally Sensitive Class 1 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	90%	205	
	Environmentally Sensitive Class 2 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	40%	122	
	Non Merchantable Forest Types:			
	Non-Productive forest	100%	164	
	Non-Merchantable forest	100%	63	
	Sub Total: MoF Netdowns to Timber Landbase:		**664**	
	MoF Timber Landbase within Crown Land Controlled by Ministry of Forests:			**4,641**
SFF / CIFC	Wetlands	100%	123	
	Steep / Strongly Complex Terrain	100%	2,217	
	Shallow Soil / Dry Sites	100%	127	
	Riparian Zones	90%	422	
	Cross Island Linkages	100%	308	
	High Density Old Growth Forests on Stable and Moderately Stable Terrain	100%	353	
	Sensitive Terrain inclusions in Stable and Moderately Stable Zones	0 to 25%	43	
	Sub Total: SFF/ CIFC Netdowns:		**3,591**	
	Potential Timber Management Landbase in Low Density Old Growth Stands:			
	Moderately Stable Terrain			34
	Stable Terrain			165
	Potential Timber Management Landbase:			
	Moderately Stable Terrain			95
	Stable Terrain			756
	SFF Potential Wholistic Timber Management Landbase:			**1,050**

Note: The Ministry of Forests timber landbase shown above includes areas which the Ministry of Forests will remove from the timber landbase due to clearcut adjacency, and visual management considerations. We did not model these MoF netdowns. Therefore, the MoF landbase is somewhat larger than will occur after operational planning.

Table 34: Derivation of Potential Timber Management Landbase on Crown Land Controlled by MoF

Derivation of Sustainable Timber Yield for Crown Land Controlled by Ministry of Forests				
Source of Netdown	**Description**	**Percent Netdown**	**Timber Yield in Classification** (m3/year)	**Timber Yield** (m3/year)
	Gross Timber Yield from Crown Land Controlled by Ministry of Forests:			**23,856**
MoF	Disturbed Areas - netdown to allow for existing roads, trails and landings.	10%	484	
	Environmentally Sensitive Class 1 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	90%	785	
	Environmentally Sensitive Class 2 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	40%	604	
	Non Merchantable Forest Types:			
	Non-Productive forest	100%	308	
	Non-Merchantable forest	100%	58	
	Sub Total: MoF Netdowns:		**2,239**	
	MoF Timber Yield from Crown Land Controlled by Ministry of Forests:			**21,617**
SFF / CIFC	Wetlands	100%	209	
	Steep / Strongly Complex Terrain	100%	10,216	
	Shallow Soil / Dry Sites	100%	604	
	Riparian Zones	90%	2,067	
	Cross Island Linkages	100%	1,537	
	High Density Old Growth Forests on Stable and Moderately Stable Terrain	100%	1,644	
	Sensitive Terrain inclusions in Stable and Moderately Stable Zones	0 to 25%	228	
	Sub Total: SFF/ CIFC Netdowns:		**16,503**	
	Potential Timber Management Landbase in Low Density Old Growth:			
	Moderately Stable Terrain			169
	Stable Terrain			781
	Potential Timber Management Landbase:			
	Moderately Stable Terrain			513
	Stable Terrain			3,650
	Subtotal: Gross MAI on SFF Timber Management Landbase:			**5,114**
	Reduction to MAI to Allow for Retention of Ecologically Important Structures on Logged Areas	**25%**	**1,278**	
	MAI on SFF Timber Management Landbase:			**3,835**

Note: The MoF reduces timber harvesting <u>rates</u> in many areas in response to visual management concerns, wildife habitat needs, hydrological concerns, and to allow logged areas to regrow to a certain level before adjacent areas are logged. We were not able to model these netdowns within the scope of this project, but believe they could result in up to 30% of the indicated MoF MAI being unavailable for harvest at any time. These "additional netdowns" do not affect the Silva MAI, as these various factors are already considered in Wholistic Forest Use planning.

Table 35: Derivation of Timber Yield from Crown Land Controlled by MoF

Stratification of Landbase within MacMillan Bloedel Holdings				
Source of Netdown	**Description**	**Percent Netdown**	**Area in Classification (ha)**	**Landbase Area (ha)**
	Total Area of MacMillan Bloedel Holdings:			**1,876**
MoF	**Non Forest Areas:**			
	Open areas, rock and cleared areas.	100%	11	
	Disturbed Areas - netdown to existing logged areas to allow for roads, trails and landings.	10%	49	
	Forested Areas:			
	Environmentally Sensitive Class 1 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	90%	5	
	Environmentally Sensitive Class 2 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	40%	13	
	Non Merchantable Forest Types:			
	Non-Productive forest	100%	19	
	Non-Merchantable forest	100%	19	
	Sub Total: MoF Netdowns to Timber Landbase:		**116**	
	MoF Timber Landbase within MacMillan Bloedel Holdings:			**1,761**
SFF / CIFC	Wetlands	100%	50	
	Steep / Strongly Complex Terrain	100%	366	
	Shallow Soil / Dry Sites	100%	36	
	Riparian Zones	90%	272	
	Cross Island Linkages	100%	203	
	High Density Old Growth Forests on Stable and Moderately Stable Terrain	100%	95	
	Sensitive Terrain inclusions in Stable and Moderately Stable Zones	0 to 25%	7	
	Sub Total: SFF/ CIFC Netdowns:		**1,030**	
	Potential Timber Management Landbase in Low Density Old Growth Stands:			
	Moderately Stable Terrain			13
	Stable Terrain			67
	Potential Timber Management Landbase:			
	Moderately Stable Terrain			9
	Stable Terrain			642
	SFF Potential Wholistic Timber Management Landbase:			**731**

Note: The Ministry of Forests timber landbase shown above includes areas which the Ministry of Forests will remove from the timber landbase due to clearcut adjacency, and visual management considerations. We did not model these MoF netdowns. Therefore, the MoF landbase is somewhat larger than will occur after operational planning.

Table 36: Derivation of Potential Timber Management Landbase on MacMillan Bloedel holdings.

Derivation of Sustainable Timber Yield for MacMillan Bloedel Holdings				
Source of Netdown	**Description**	**Percent Netdown**	**Timber Yield in Classification** (m3/year)	**Timber Yield** (m3/year)
	Gross Timber Yield from MacMillan Bloedel Holdings:			**8,889**
MoF	Disturbed Areas - netdown to allow for existing roads, trails and landings.	10%	234	
	Environmentally Sensitive Class 1 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	90%	22	
	Environmentally Sensitive Class 2 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	40%	75	
	Non Merchantable Forest Types:			
	Non-Productive forest	100%	36	
	Non-Merchantable forest	100%	32	
	Sub Total: MoF Netdowns:		**398**	
	MoF Timber Yield from MacMillan Bloedel Holdings:			**8,491**
SFF / CIFC	Wetlands	100%	101	
	Steep / Strongly Complex Terrain	100%	1,825	
	Shallow Soil / Dry Sites	100%	190	
	Riparian Zones	90%	1,289	
	Cross Island Linkages	100%	1,008	
	High Density Old Growth Forests on Stable and Moderately Stable Terrain	100%	475	
	Sensitive Terrain inclusions in Stable and Moderately Stable Zones	0 to 25%	34	
	Sub Total: SFF/ CIFC Netdowns:		**4,922**	
	Potential Timber Management Landbase in Low Density Old Growth:			
	Moderately Stable Terrain			60
	Stable Terrain			320
	Potential Timber Management Landbase:			
	Moderately Stable Terrain			41
	Stable Terrain			3,148
	Subtotal: Gross MAI on SFF Timber Management Landbase:			**3,569**
	Reduction to MAI to Allow for Retention of Ecologically Important Structures on Logged Areas	**25%**	**892**	
	MAI on SFF Timber Management Landbase:			**2,677**

Note: The MoF reduces timber harvesting rates in many areas in response to visual management concerns, wildife habitat needs, hydrological concerns, and to allow logged areas to regrow to a certain level before adjacent areas are logged. We were not able to model these netdowns within the scope of this project, but believe they could result in up to 30% of the indicated MoF MAI being unavailable for harvest at any time. These "additional netdowns" do not affect the Silva MAI, as these various factors are already considered in Wholistic Forest Use planning.

Table 37: Derivation of Timber Yield from MacMillan Bloedel holdings.

Stratification of Landbase within Private Land outside MacMillan Bloedel Holdings				
Source of Netdown	**Description**	**Percent Netdown**	**Area in Classification (ha)**	**Landbase Area (ha)**
	Total Area of Private Land outside MacMillan Bloedel Holdings:			**4,714**
MoF	**Non Forest Areas:**			
	Open areas, rock and cleared areas.	100%	377	
	Disturbed Areas - netdown to existing logged areas to allow for roads, trails and landings.	10%	115	
	Forested Areas:			
	Environmentally Sensitive Class 1 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	90%	77	
	Environmentally Sensitive Class 2 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	40%	16	
	Non Merchantable Forest Types:			
	Non-Productive forest	100%	126	
	Non-Merchantable forest	100%	28	
	Sub Total: MoF Netdowns to Timber Landbase:		**739**	
	MoF Timber Landbase on Private Lands outside MacMillan Bloedel Holdings:			**3,975**
SFF / CIFC	Wetlands	100%	86	
	Steep / Strongly Complex Terrain	100%	1,116	
	Shallow Soil / Dry Sites	100%	137	
	Riparian Zones	90%	531	
	Cross Island Linkages	100%	287	
	High Density Old Growth Forests on Stable and Moderately Stable Terrain	100%	100	
	Sensitive Terrain inclusions in Stable and Moderately Stable Zones	0 to 25%	33	
	Sub Total: SFF/ CIFC Netdowns:		**2,289**	
	Potential Timber Management Landbase in Low Density Old Growth Stands:			
	Moderately Stable Terrain			8
	Stable Terrain			49
	Potential Timber Management Landbase:			
	Moderately Stable Terrain			90
	Stable Terrain			1,540
	SFF Potential Wholistic Timber Management Landbase on Private Land:			**1,686**

Note: The Ministry of Forests timber landbase shown above includes areas which the Ministry of Forests will remove from the timber landbase due to clearcut adjacency, and visual management considerations. We did not model these MoF netdowns. Therefore, the MoF landbase is somewhat larger than will occur after operational planning.

Table 38: Derivation of Potential Timber Management Landbase on Other Private Land

Derivation of Sustainable Timber Yield for Private Land outside MacMillan Bloedel Holdings				
Source of Netdown	**Description**	**Percent Netdown**	**Timber Yield in Classification (m3/year)**	**Timber Yield (m3/year)**
	Gross Timber Yield from other Private Land:			**20,060**
MoF	Disturbed Areas - netdown to allow for existing roads, trails and landings.	10%	523	
	Environmentally Sensitive Class 1 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	90%	300	
	Environmentally Sensitive Class 2 Areas:			
	Regeneration Problems	90%		
	Soil and steepness problems	40%	64	
	Non Merchantable Forest Types:			
	Non-Productive forest	100%	221	
	Non-Merchantable forest	100%	33	
	Sub Total: MoF Netdowns:		**1,141**	
	MoF Timber Yield from other Private Land:			**18,918**
SFF / CIFC	Wetlands	100%	197	
	Steep / Strongly Complex Terrain	100%	5,330	
	Shallow Soil / Dry Sites	100%	635	
	Riparian Zones	90%	2,659	
	Cross Island Linkages	100%	1,381	
	High Density Old Growth Forests on Stable and Moderately Stable Terrain	100%	452	
	Sensitive Terrain inclusions in Stable and Moderately Stable Zones	0 to 25%	159	
	Sub Total: SFF/ CIFC Netdowns:		**10,811**	
	Potential Timber Management Landbase in Low Density Old Growth:			
	Moderately Stable Terrain			40
	Stable Terrain			242
	Potential Timber Management Landbase:			
	Moderately Stable Terrain			438
	Stable Terrain			7,387
	Subtotal: Gross MAI on SFF Timber Management Landbase:			**8,107**
	Reduction to MAI to Allow for Retention of Ecologically Important Structures on Logged Areas	**25%**	**2,027**	
	MAI on SFF Timber Management Landbase:			**6,080**

Note: The MoF reduces timber harvesting <u>rates</u> in many areas in response to visual management concerns, wildife habitat needs, hydrological concerns, and to allow logged areas to regrow to a certain level before adjacent areas are logged. We were not able to model these netdowns within the scope of this project, but believe they could result in up to 30% of the indicated MoF MAI being unavailable for harvest at any time. These "additional netdowns" do not affect the Silva MAI, as these various factors are already considered in Wholistic Forest Use planning.

Table 39: Derivation of Timber Yield from Other Private Land

5. Recommendations

The following recommendation for additional analysis work are based on insights we gained while carrying out this project. These tasks could be accomplished in additional joint endeavors between the SFF and the CIFC, or by the skilled volunteers of the CIFC.

We recommend that future ecosystem based analysis and planning work on Cortes Island:

- Incorporate the information, recommendations and land use designations in and arising form the *Cortes Official Community Plan* in the SFF Ecosystem Based Plan.
- Complete the documentation of past logging activity on Cortes Island. The CIFC completed the first step of this process during this plan, but time and budget constraints prevented the SFF from incorporating their information. An iterative process would be required to digitize, review and improve the existing CIFC data. However, an improved map of past logging on Cortes Island would be a valuable planning asset.
- Identify and map wholistic timber use zones. The SFF Ecosystem Based Plan identified areas which are ecologically suitable for wholistic timber management, but makes no assessment of whether these areas are socially suitable for timber management. This is in accordance with our instructions from the CIFC. Developing a map of wholistic timber management zones would be an iterative process like those used to develop the rest of the custom data layers in this project in order to reflect the needs and wishes of the Cortes community.

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