AN ECOSYSTEM-BASED PLANNING FRAMEWORK
FOR THE TLELL RIVER WATERSHED, QUEEN CHARLOTTE ISLANDS

By

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We accept this thesis as conforming
to the required standard

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Queen Charlotte Islands

Table of Contents

1.0 INTRODUCTION

1.1 The place: Tlell River watershed

The Tlell River watershed is located on the Queen Charlotte Islands, British Columbia. The Tlell River drains approximately 34,400 ha of central and eastern Graham Island, the largest and northern island in the Queen Charlotte Islands archipelago. To date, this watershed is in a predominantly natural state, with very little resource extraction having occurred.

The Tlell River watershed is one of the 14 Haida-declared areas-of-interest on the Queen Charlotte Islands that the Council of the Haida Nation (CHN) have requested be left in their natural condition, pending completion of land title treaties. Harvesting has been deferred for more than 10 years in the Tlell area-of-interest. The Tlell area-of-interest represents approximately 22 % of the Queen Charlotte Islands Timber Supply Area (TSA) operable landbase[1], and approximately 28% of the operable landbase within the Haida-declared areas-of-interest. The Tlell River watershed is considered by many on the Queen Charlotte Islands to be a very special place with many attributes worthy of protection. These are discussed further on in the analysis.

1.2 The context

A Local Resource Use Planning (LRUP) process for the Tlell Watershed was underway for a number of years (January 1997 – March 2001, with some interruptions related to the staffing

[1] Operable landbase: that part of the provincial forest landbase that contributes to the productive forest (in the commercial sense).

capability of the Ministry of Forests to sponsor the planning table). The LRUP is part of a commitment by the Ministry of Forests (MOF) with the (then) Islands Community Stability Initiative (ICSI)[2]. The planning process was established to determine the extent, location, and distribution of all resource values and uses within the watershed, and to specify how resource use will take place through the development of a zoning scheme and area-specific management objectives and strategies. The intent was for the zones, management objectives and strategies to be developed through a consensus-building process that involved a representative group of stakeholders in the preparation of recommendations to government. The planning group's aim was to accommodate the interests of all parties at the planning table (Tlell Local Resource Use Planning Table Terms of Reference, unpublished document, 1998).

The planning group has gathered a considerable volume of resource information for the watershed, including information on the following:

- fish and fish habitat,
- marbled murrelet habitat capability and suitability mapping,
- hydrological studies, including areas prone to flooding,
- identification of rare plant communities,
- areas of high recreational value (sport fishing, hunting and hiking),
- identification of habitat for Rocky Mountain elk,
- identification of areas of historical interest (settlers' trails, homesteads),

[2] Since mid-2000, ICSI has been disbanded, and the task of the Community Forest Pilot Agreement was turned over to a Community Forest Board that is composed of representatives from the various communities (mayors and regional district representatives).

- scenic resources,
- wildlife species at risk in the watershed,
- critical aspects for ecological functioning,
- areas of important old growth forest,
- areas of high Haida archaeological and cultural value,
- economic factors, and
- ecosystems that have potential for the production of non-timber forest resources (such as mushrooms, and wild berries).

ICSI had been granted a Community Forest Pilot Agreement for the Tlell River Watershed that encompasses the Tlell Haida-declared area-of-interest. ICSI was established to address social, economic and environmental issues resulting from resource extraction, and to participate in designing a future that will support a healthy environment and create a self-sustaining Islands economy. It will be critical for the Community Forest Board to develop a forest resource use plan for their community forest that is seen to address these issues. The Community Forest Pilot Agreement is seen by government as an important vehicle to address the communities' interest of creating jobs. This includes primary and secondary processing on the island, and accessing resources from the Tlell River watershed in one of the largest deferred Haida-declared areas-of-interest on the Islands.

The next step for the Islands community forest is to develop a framework for a resource use plan that identifies management objectives based on the science-based information collected by the LRUP, and the interests of the Islands communities. The communities, as represented initially by ICSI, and now the Community Forest Board, will need to be very careful to ensure that all planning for the watershed will maintain the integrity of the watershed's ecosystems. Ecosystem-based management planning[3] has been used in other parts of the province to achieve this aim, and is also an appropriate vehicle for resource use planning for the Tlell River watershed.

Ecosystem-based management plans typically have the strategic goal of maintaining or restoring ecological integrity within the planning area. Many experts in the field agree on the key steps that should be included in an ecosystem-based management planning framework. However, there are discrepancies as to how the broad goals and principles of ecosystem-based management should be operationalised.

1.3 The Tlell Local Resource Use Plan (LRUP) process and the players

The Local Resource Use Planning process for the Tlell River watershed consisted of more than three years (1997-2001) of effort by concerned citizens, community stakeholders, government agencies, and resource stakeholders[4]. This group of people is referred to as the Tlell River watershed Local Resource Use Plan (LRUP) working group (WG), or LRUP WG.

[3] The terms ecosystem-based management plan(ning), ecosystem-based plan(ning), ecosystem-based management are used interchangeably throughout this document.
[4] As the planning officer for the Queen Charlotte Islands Forest District, the author of this thesis chaired and managed the LRUP WG and the technical committee from July 1998 to March 2000.

The need for the completion of a Tlell River watershed LRUP arose from the Memorandum of Understand signed by the Minister of Forests and ICSI in 1996 that stated that "prior to the issuance of cutting permits, an integrated watershed planning process must be completed (for the Tlell watershed)".

The Tlell LRUP process has involved:

- attending meetings, up to 20 hours per month at times, since the planning process began in 1996;
- completing information requirements of the WG including 40 reference maps and analysis;
- seeking expert input on specific topics, such as socio-economic analysis, marbled murrelet habitat, identification of riparian features, and ecosystem-based forest planning;
- securing funds to address specific information needs of the WG, including northern goshawk and marbled murrelet habitat suitability studies, hydrological assessment and fisheries inventory; and
- informing the public of LRUP WG progress through newsletters, press releases and a public workshop.

Refer to Appendix A for further details regarding the Tlell LRUP process and players.

1.4 The problem

In the Tlell River, harvesting has been deferred since 1989 and 1993 in the Timber Supply Area (TSA) portion and Tree Farm Licence (TFL) portion of the Tlell watershed, respectively. Since the current allowable annual cut (AAC) does not reflect the deferral of harvesting in the 14 Haida-declared areas-of-interest, the result is an overcut situation in other areas throughout the TSA, which is not sound forest management, and is definitely not sustainable[5].

The need for a resolution to the Tlell River watershed resource use issues, and to land use issues, in general, on the Queen Charlotte Islands, is very high. An Islands-wide land use plan, such as Queen Charlotte Islands/Haida Gwaii (QCI/HG) land and resource management plan (LRMP), was initiated in 1997, but no progress had been made until February 2003 when the Council of the Haida Nation and the province agreed to co-manage a land-use planning process for the Queen Charlotte Islands/Haida Gwaii. The goal of the Queen Charlotte Islands/Haida Gwaii land use planning process is to develop a balanced plan that:

- protects environmental integrity,
- maintains spiritual and cultural values,
- enhances sustainable economic opportunity, and
- fosters community well-being (Ministry of Sustainable Resource Management backgrounder, 2003).

[5] The last AAC determination for TFL 39 Block 6 identified a partition cut for the Haida-declared areas-of-interest (including the Tlell Haida-declared area-of-interest) in order to aid in addressing the over-harvest situation in the remainder of TFL 39 Block 6.

The Queen Charlotte Islands/Haida Gwaii land use plan will provide management direction at the regional level for a wide range of resources on the Islands rather than at the landscape level. This will be required for the Community Forest Pilot Agreement in the Tlell River watershed. As of November 2003, three two-day QCI land-use planning meetings have been held on the Islands that have focussed predominantly on establishing the planning process. The target date for completion of a recommended Islands-wide land use plan agreement is, optimistically, July 2004.

1.5 The opportunity

A framework for an ecosystem-based management plan for the Tlell River watershed community forest that is based on the principles of sustainability, and acknowledges and addresses the concerns of the local communities and stakeholders, is needed to provide a base from which the planning for the community forest can be put into action. The Queen Charlotte Islands/Haida Gwaii land use plan will provide some management direction for resource use in the Tlell River watershed, albeit not to the level of detail that will be required for the Community Forest Agreement to succeed. Since considerable information, both scientific and anecdotal, has been gathered regarding the Tlell River watershed, there is an excellent opportunity to propose a framework for an ecosystem-based management plan that can be used to address the communities' needs for sustainable resource use in the Tlell.

The Tlell LRUP table has not only collected a considerable amount of information (see Appendix A) in the form of specialist's reports, maps, inventories, scientific papers, and field sessions with specialists; but also the various interests represented by those at the table have been discussed in depth. There is a need to bring all of this information and expressed interests together in order to propose a possible solution, based on the principles of sustainability, for resource management in the Tlell River watershed.

The research question is: how can this science-based information for the Tlell River watershed best be brought together in order to prepare a resource management plan that is consistent with the philosophy of the Islands communities, and is based on the principles of sustainability? Ecosystem-based management was initiated and has evolved because of a concern that 'traditional forest management practices', that typically have emphasized the economic values of the forest, were resulting in the 'biodiversity crisis'(Yaffee, 1999), as a result of the harvest of predominantly old-growth forests. This most definitely mirrors the sentiments of the Haida and many others on the Queen Charlotte Islands.

The Community Forest Pilot Agreement in the Tlell could provide opportunities for harvesting operations in one of the largest Haida-declared areas-of-interest on the Islands, which would alleviate some of the pressure in other areas of the Islands. A community forest endeavour locally managed by the Islands communities will have the additional benefit of providing the opportunity for a sense of local stewardship of the land, which has not been the case on the Islands in recent history.

1.5.1 Significance of the problem/opportunity

The Tlell River watershed provides an excellent opportunity to propose a framework for an ecosystem-based management plan that can be used to address the communities' needs for sustainable resource use in the Tlell.

Sustainability depends on maintaining ecosystem productivity and integrity, while at the same time maintaining economic and social stability. An ecosystem-based planning framework is required that integrates scientific knowledge of ecological relationships within a complex socio-political and values framework for the sustainable use of resources in the Tlell River watershed. Current forest practices in the watershed may not be ecologically sound, operationally achievable, economically viable, publicly acceptable, nor safe. If forest practices are implemented that have not been grounded in the principles of ecosystem-based management, the end result could be degradation of the forest resource (and possibly other resources and biodiversity) in the Tlell River Watershed.

An ecosystem-based planning framework for the Tlell River watershed that identifies the key concepts and steps that will be necessary to successfully operationalize an ecosystem-based plan for the watershed will be the first step in the development of a plan to maintain the integrity of the forest and river ecosystem in the watershed. This will also contribute to a strong local economy and social stability, now and for future generations.

1.6 Goal and objectives

The goal of this thesis is to develop and propose an ecosystem-based planning framework to highlight the key issues, information and decisions that need to be considered in order to operationalize, successfully, an ecosystem-based management plan for the Tlell River watershed. In doing so, this project will provide clarity around some of the key concepts of ecosystem-based management, and highlight some others that are controversial. This thesis will summarize goals, broad principles and key steps of an ecosystem-based planning framework, as suggested by the literature on the subject.

Key ecological components of an ecosystem-based management plan will also be summarized. This project will identify and describe the science-based information that is already known about the Tlell River watershed, and will identify the means in which this information can be used in ecosystem-based management planning for the Tlell River watershed.

2.0 METHODOLOGY

Phase 1: Literature Review

Phase 1 involved a literature review of ecosystem-based planning, forest ecosystem integrity, and case studies; specifically:

- key concepts of ecosystem-based planning,
- key steps in an ecosystem-based planning framework,
- ecosystem integrity – elements that are critical for the maintenance of forested ecosystem integrity,
- key ecological components of an ecosystem-based plan, and
- approaches that can be used in ecosystem-based planning.

Key concepts relating to ecosystem-based planning (see section 3.1.1), and key ecological concepts (section 3.1.2) and approaches (see section 3.1.2.1) are summarized in the following chapter. The main steps involved in an ecosystem-based planning framework can be found in section 4.1.1.

Phase 2: Historical summary

During Phase 2, the planning process for the Tlell LRUP was summarized. The source of this information is the LRUP working group files kept by the Queen Charlotte Islands Forest District, Ministry of Forests.

A summary of the planning process to date for the Tlell River watershed has been outlined in Section 1.3 (with further details in Appendix A).

Phase 3: Science-based information

Phase 3 involved identifying and describing science-based and other information that is already known about the Tlell River watershed, and that will be necessary for ecosystem-based planning to succeed in the watershed. The source of this information regarding the Tlell watershed is the LRUP working group files maintained by the Queen Charlotte Islands Forest District, Ministry of Forests.

A summary of the science-based and other information that is known about the Tlell River watershed can be found in section 3.2.

Phase 4: Ecosystem-based planning framework

Phase 4 involved the proposal of a potential planning framework to highlight the key issues, information and decisions that need to be considered in order to successfully operationalize an ecosystem-based plan for the Tlell River watershed.

An ecosystem-based planning framework that highlights the key issues and decisions that need to be considered in the order to operationalize, successfully, an ecosystem-based plan for the Tlell is developed and proposed in section 4.1.1.

Phase 5: Possible barriers to success

Phase 5 identified possible barriers to successful ecosystem-based planning in the Tlell River watershed.

Challenges to implementing ecosystem-based management planning in the Tlell, such as the question of human development versus ecological integrity, and the challenges to integrating social and economic considerations in ecosystem-based management are summarized in sections 4.1.2.1 and 4.1.2.2, respectively. Concerns surrounding the information base and the process are identified in section 4.1.2.3.

3.0 RESULTS

3.1 Ecosystem-based management and planning

3.1.1 Definition of ecosystem-based management planning

Ecologists began to identify key components of what would become 'ecosystem management' as early as the 1930's in North America (Grumbine, 1994). By the late 1980s, many scientists had advocated a general 'ecosystem management' approach to land management. Since that time there have been a number of papers written on the subject, but there is still no consensus as to what constitutes ecosystem management. Ecosystem-based management plans typically have the strategic goal of maintaining or restoring ecological integrity within the planning area. Many experts in the field agree on the key steps that should be included in an ecosystem-based management planning framework. However, there are discrepancies as to how the broad goals and principles of ecosystem-based management should be operationalized. Since ecosystem-based management includes science and values, it is likely to be interpreted differently by people with different values (Holt, 2001).

After reviewing considerable literature on ecosystem-based management, Grumbine (1994) suggested a definition of ecosystem management that is now widely accepted by others: "*Ecosystem management integrates scientific knowledge of ecological relationships within a complex socio-political and values framework toward the general goal of protecting native ecosystem integrity over the long term*" (p. 28).

LRMP participants in the Central Coast adopted the following definition for ecosystem-based management to guide their decision-making (Ministry of Sustainable Resource Management – Skeena Region, 2001):

> *a strategic approach to managing human activities that seeks to ensure the coexistence of healthy, fully functioning ecosystems and human communities. The intent is to maintain those spatial and temporal characteristics and processes of whole ecosystems such that component species and human, economic and cultural activities can be sustained* (p.7).

The Silva Forest Foundation (1997) describes an ecosystem-based approach to forest use as:

> *protecting forest functioning at all spatial scales through time as the first priority, and then seeks to sustain, within ecological limits, a diversity of human and non-human uses across the forest landscape. In other words, an ecosystem-based approach focuses first on what to leave and then on what can be taken without damage to ecosystem functioning* (p.1).

Other authors have identified land management approaches other than ecosystem-based management. Yaffee (1994) discussed three different approaches to land management that lie along a continuum:

i) environmentally sensitive multiple use, where the environment is a constraint (traditional forest management);

ii) an ecosystem approach to management in which the ecosystem is not a constraint, but a goal; and

iii) eco-regional management which is very similar to ii) but rather than thinking of ecosystems purely on a conceptual level, identifies ecosystems as specific locations on the ground and tends to manage for processes rather than biota.

Options ii) and iii) differ from environmentally sensitive multiple use in terms of the goals: i) maximises production for human use – anthropocentric approach, whereas the latter two options aim to maximise ecological integrity and allows production within the ecological constraints – ecocentric approach (Holt, 2001). Social and economic objectives are still a key part of the ecosystem approaches, but they are addressed within the overall goal of maintaining ecological integrity (Yaffee, 1999). The maintenance of ecological integrity as the key goal of ecosystem-based management has been critical to almost all of the recent scientific literature on the subject (Grumbine, 1994; Jensen and Bourgeron, 1994; Clayquot Sound Scientific Panel, 1995; Yaffee, 1999).

3.1.2 Key concepts in ecosystem-based management

There are some key concepts that form the basis for an ecosystem-based management plan. According to Grumbine (1994), who provided a summary of 33 papers on ecosystem-based management, and Yaffee (1999), the overarching goal of ecosystem-based management is to maintain and/or restore ecological integrity. Social and economic objectives are also a key component in an ecosystem-based management approach.

The ecosystem-based management approach to resource management is currently being implemented in several areas in British Columbia, such as the North Coast Land and Resource Management Plan (NCLRMP) and the Central Coast Land and Resource Management Plan (CCLRMP). For these two processes, ecosystem-based management is aimed at ensuring that the long-term co-existence of healthy, functioning ecosystems and human communities. The aim is to avoid the unsustainable "boom and bust" cycles that have been associated with resource-based economies of the past century (Ministry of Sustainable Resource Management – Skeena Region, 2001).

The CCLRMP has identified some key principles of ecosystem-based management for their process (Ministry of Sustainable Resource Management – Skeena Region, November 2001):

- healthy, functioning ecosystems provide the basis for sustaining communities, economies, cultures and quality of human life; therefore, ecological sustainability is fundamental to land and marine management;
- empowered and healthy communities play a leadership role in sustaining healthy ecosystems, cultures and economies;
- focus planning on the needs of the ecosystems and the values that you want to maintain;
- planning should be done over ecologically and economically relevant time-frames and involve regional, landscape and site scale planning;
- incorporate the best of existing knowledge (e.g., traditional, local and western science) into planning and decision-making;

- knowledge of natural processes and human interactions is incomplete, and decisions made in the present can pose unacceptable risks for the future. Apply the precautionary principle and adaptive management in decision-making. Monitor the consequences of decisions and adopt a learning approach to planning;
- maintain natural, social and economic capital in the region and preserve the full range of options for future generations; and
- respect individuals, communities of interest, including businesses, and cultures.

Many of the CCLRMP concepts closely follow Grumbine (1994) and Yaffee (1999), but these authors also emphasize the following:

- use ecologically-derived boundaries for decision-making rather than administrative ones;
- use scientific data to inform decision-making such as the composition, structure, processes, and functions of ecosystems. The best information available should be used in ecosystem-based planning while acknowledging information gaps and uncertainty around our knowledge of how ecosystems function;
- monitor the implementation and the effectiveness of the plan; and
- use active experimentation in adaptive management and incorporate the flexibility to change management as necessary.

Franklin (2000) uses the following description of ecological integrity: *"the system's wholeness, including presence of all appropriate elements and occurrences of all processes at appropriate rates"*. Noss (1999) states that ecosystems remain healthy only when their natural processes such as, nutrient cycling, energy flow, hydrology, succession, and disturbance regimes, remain intact. Holt (2001) notes that these definitions of ecosystem integrity do not intend that management maintains all species on all areas at all times; nor do they suggest that ecosystems are static. The key to these definitions is that at the appropriate scale, all elements, populations and processes are maintained (Holt, 2001).

Maintaining ecosystem integrity is the goal of ecosystem-based planning because it protects biodiversity within the bounds of the natural range of variability of the ecosystem (Noss, 1999), and it maintains ecosystem and social resiliency against catastrophes in biological, economic or political systems (Haynes et al., 1996). By fostering the development of diversified economic systems, unsustainable boom and bust cycles should be avoidable.

Various authors on the topic of ecosystem-based management have suggested specific goals that increase the probability of maintaining ecological integrity. The set of goals outlined and recommended by Grumbine (1994) are as follows:

- maintain viable populations of all native species;
- represent, within protected areas, all native ecosystem types across their natural range of variation;
- maintain evolutionary and ecological processes (e.g. disturbance regimes, hydrological processes, etc.);
- manage over periods of time long enough to maintain the evolutionary potential of species and ecosystems; and

- accommodate human use and occupancy within these constraints.

3.1.2.1 Ecological planning approaches

Ecosystem-based planning is based on a number of key ecological components and approaches that can be used to maintain ecological integrity. These include:

- use of coarse and fine filters,
- single species management,
- emulation of natural disturbance regimes, and
- identification of reserve areas based on ecosystem representation.

Some authors have suggested that the concept of reserves is fundamentally at odds to an approach that acknowledges the dynamic nature of ecosystems (Quigley and Arbelbide, 1997). However, each of these approaches has positive features that reduce the probability that important elements in the ecosystem have been missed, and therefore increase the likelihood that the plan maintains ecological integrity (Holt, 2001).

3.1.2.1.1 Coarse and fine filters

Coarse filter approaches to maintaining ecological integrity acknowledge that there are thousands of species that we know little or nothing about, and that our ability to predict ecological dynamics is very limited (Province of British Columbia, 1995). Maintaining key ecosystem elements in suitable abundance and distribution at a landscape level is therefore a likely way to maintain this diversity (Franklin, 2000). The existing mapped vegetation classification for the Tlell River watershed can be analyzed pragmatically for use in the coarse filter approach.

Coarse filter strategies include (Province of British Columbia, 1995; Holt, 2001):

- a system of protected reserves outside of the managed forest,
- protected reserves within the managed forest representing the various seral stages,
- management zones with specific objectives, and
- stand level retention targets within the working forest.

However, some species will not be adequately protected using a coarse filter approach. Species that must be managed through a fine filter approach are those species with specific habitat requirements and those that are already rare or have limited ranges.

Fine filter strategies include identifying (Province of British Columbia, 1995; Holt, 2001):

- sensitive species, or species that have habitat requirements that are not likely to be covered in the coarse filter, and
- rare habitats not adequately covered by the coarse filter.

3.1.2.1.2 Single species management

In addition to using the coarse and fine filter approaches to management, single species management should also be implemented within the planning framework (Noss, 1996b). Considering the following groups of species will increase the likelihood that the plan will maintain ecological integrity (Noss, 1996b):

- Keystone species or species group: It is particularly important that these species are adequately managed since removing them from the ecosystem likely will have greater impacts than removing other species. For example, the Clayquot Scientific Panel (1995) identified bears and salmon as likely being such a species group in the Clayquot Sound area.
- Umbrella species: Umbrella species are those species with large and broad habitat requirements. Retention of sufficient habitat to maintain these species is believed to provide a coarse filter approach to maintaining other species. Identifying the habitat requirements for umbrella species will provide guidance as to the positioning of zoning and amount of reserve area to maintain ecological integrity.
- Indicator species: Indicator species are species that are highly sensitive to changes to the ecosystem and, as a result, quite often require special attention. Indicator species are useful for monitoring the impacts of changes to ecosystems.
- Sensitive species: Sensitive species are species that are already rare, endangered or threatened.

3.1.2.1.3 Reserves or protected areas

The importance of protected areas as a central element of an ecosystem-based management plan is a well-accepted (Noss, 1996a), but not uncontroversial concept. The main purposes for maintaining reserves or protected areas are:

- to provide refuges for natural processes;
- to provide core habitat for sensitive species; and

- to retain representative samples of ecosystems.

The ad hoc selection of reserves has been demonstrated to be an ineffective method of maintaining ecological integrity (Pressey et al., 1996) since invariably, ad hoc selection results in over-representation of some ecosystems that do not require as much protection, and conversely, under-representation of ecosystems that require additional protection. Three approaches have been suggested to avoid ad hoc selection (the first two of which are commonly used in resource management planning in British Columbia): gap analysis for representation (Holt, 2001); protection of special elements (Noss, 1999); and reserve selection algorithms (Pressey et al., 1996).

Gap analysis is a technique that uses existing reserves as a central focus and identifies ecosystems, land formations or habitat types that are not currently included in the existing reserves (Holt, 2001). It is relatively straightforward and uses readily available information. This process was completed for each forest district in the province in the late 1990's. Gap analysis is often used within the coarse filter approach in order to identify under-represented habitats and vegetation types.

The following guidelines regarding gap analysis have been reported in the literature (Peters et al., 1997):

- the potential need for over-representation of rare features since there needs to be adequate representation to increase the probability of maintaining ecological integrity around these features;

- consider increasing representation of widely impacted ecosystems; and
- assess not only whether ecosystems are present, but also whether appropriate structural and seral stages are present.

The protection of special elements is akin to the fine filter approach as the elements of the landscape that are rare or special and require additional protection are identified and reserved. These areas are reserved independently from larger protected areas that are often selected for purposes of adequate representation of ecosystem types found across the landscape.

Reserve selection algorithms have most often been designed for use where there are no existing reserves, with their aim being to select the combination of reserves that provides the best opportunity for maintaining ecological integrity. Usually the first reserve chosen has the highest diversity (number of species) and further reserves are added based on the maximum additional number of species added (Holt, 1998, 2000, 2001). Other elements such as species richness, rare ecosystems, and critical habitat can also be used in the algorithm (Holt, 2001).

3.1.2.1.4 Retention: How much is enough?

Maintaining ecological integrity includes retaining habitat for the purposes of maintaining populations of species across their natural ranges, and maintaining natural processes across the landscape (Holt, 2001). When attempting to make this concept work in an operational context, the issue becomes the determination of how much retention is enough in order to meet these broad goals.

The following provides some broad guidance to meet these goals (Holt, 2001):

- Although science cannot provide a generic answer to the question of retention, it can provide some guidance with regard to the range of percentages that are more likely to maintain ecological integrity within a specific geographic area. This process involves risk assessments and assumptions regarding the natural variability of the various ecosystems in the area.
- How much retention is sufficient to meet these broad goals will vary with respect to the natural disturbance regimes and the natural range of variability of the specific components within the landscape. For example, the percentage of old seral forest required to maintain ecological integrity will increase as the natural levels of old seral forest typically found in that ecosystem increase. The probability of not maintaining ecological integrity increases as the difference in the landscape conditions from the natural state increase.
- Even high levels of retention may not be sufficient to maintain ecological integrity if critical areas are not reserved. As a result, the question of how much retention is enough depends also on the specific location of the reserved areas.
- Ecosystem-based landscape planning requires consideration of habitat connectivity and sometimes population viability to determine the appropriate levels of retention.

- Scientific literature has suggested ranges of retention necessary to maintain ecological integrity. Depending on the numerous factors within the ecosystem in question, these ranges have varied widely, but the lowest of the ranges noted is 8% of any given ecosystem-type to be reserved or protected (Jeo et al., 1999). Generally, the suggested retention is in the order to 12-20% reserved or protected.
- Addressing the question 'how much is enough' will involve a number of different approaches to provide guidance. When combined with information from risk analyses, society can be well informed in order to make the decision as to how certain it wishes to be that ecological integrity is being maintained in the planning area.

3.1.2.1.5 Natural disturbances and the range of natural variability

Ecosystems are dynamic, spatially heterogeneous systems at all scales (Sousa, as cited in Parminter, 1998, p.3). Ecosystems vary in response to both changes in the abiotic environment and the history of natural disturbances. Forested ecosystems experience natural disturbances at different scales; these disturbances are of varying intensities and have varying effects (Parminter, 1998). White and Pickett (as cited in Parminter, 1998, p.4) define disturbance as *"any relatively discrete event in time that disrupts ecosystem, community, or population structure, and changes resources, substrate availability, or the physical environment"*.

The characteristics of natural disturbance agents (such as fire, wind, pathogens, insects) combine to define a natural disturbance regime based on the area affected, the return interval, and the magnitude of the disturbances (Parminter, 1998)

Different natural disturbance regimes have created forests with greatly differing seral stage distributions. Portions of the province with less frequent stand-initiating disturbance have more older forest types, and a greater abundance of species adapted to landscapes of older forests, than do areas with more frequent disturbance (Province of British Columbia, 1995).

Forest harvesting generally increases the amount of young forest and decreases the amount of older forest, because commercial forest rotations are generally shorter than natural disturbance return periods (Province of British Columbia, 1995). This effect is most pronounced in forest types that have the lowest frequency of natural stand-initiating disturbance. The more that managed forests in these forest types diverge from natural disturbance regimes, the greater the risk of loss of biodiversity (Province of British Columbia, 1995).

According to the Biodiversity Guidebook (Province of British Columbia, 1995) designations, the Coastal Western Hemlock (CWH) Biogeoclimatic zone (which is the classification for the Tlell River watershed) is within natural disturbance type (NDT) 1, i.e., ecosystems with rare stand-initiating events.

Historically, these forest ecosystems are usually uneven-aged or multi-storied even-aged, with regeneration occurring in gaps created by the death of individual trees or small patches of trees (Province of British Columbia, 1995). When disturbances such as wind, fire, and landslides occur, they are generally small and result in irregular edge configurations and landscape patterns (Province of British Columbia, 1995).

The mean return interval for these disturbances is generally 250 years for the CWH biogeoclimatic zone. To maintain important landscape characteristics in this disturbance type, a relatively high proportion of forests with mature and old seral stage forest attributes is required (Province of British Columbia, 1995). Maintaining a variety of canopy layers (vertical structure) and spatial patchiness (horizontal structure) is important for maintaining biodiversity in this NDT (Province of British Columbia, 1995).

All ecosystems change over time. The range of natural variability is the amount of variation exhibited by ecosystem characteristics (or components) over an appropriate timeframe. For example, the percentage of a given landscape (such as a watershed or a group of watersheds) covered by old growth at a given time may vary between 35% and 90% depending on the disturbances (such as fire or large windstorm events) that have occurred on this landscape in the past (Holt, 2001).

Use of the "range of natural variability" concept assumes that recent and ecologically relevant conditions provide guidance for current and future land management. This concept is well accepted (Province of British Columbia, 1995; Morgan et al., 1994; Haynes et al., 1996) and is often expressed as the closer the current landscapes are to the range of natural variability, the higher the probability of maintaining ecological integrity (Swanson et al., 1994; Parminter, 1998). The general rationale is that species have adapted to the range of habitat patterns resulting from historical disturbance events, and so the probability of population survival is reduced if the habitat is maintained outside of this natural range (Holt, 2001). The range of natural variability is also used as a benchmark or baseline for monitoring purposes. When historic data is lacking, 'untouched' landscapes are used as surrogate ecosystems to set benchmarks.

Where current conditions are outside the range of natural variability, restoration may be the appropriate management tool for the landscape. When current conditions and desired future conditions are within the range of natural variability, management can likely be maintained (Landres et al., 1999). It should be noted that future conditions may be difficult to predict in practice, in which case a certain degree of adaptive management may be in order.

3.1.2.2 Risk assessment

Another necessary phase of the ecosystem-based plan is the risk assessment phase. This involves the evaluation of ecological risks that are associated with alternative land or resource use plan scenarios (Ministry of Sustainable Resource Management – Skeena Region, 2001). Risk assessment provides methodology for evaluating the likelihood of a negative outcome resulting from human-caused changes to environmental conditions (Ministry of Environment, Land and Parks, 2000). The need for formal risk assessment arises due to our inability to fully comprehend the causes and effects in complex ecological, social and economic systems that are part of land and resource use planning (Ministry of Sustainable Resource Management – Skeena Region, 2001). The best that can be done in these complex systems is to understand the risks that are inherent in various courses of action (such as foreclosing on ecological, economic or social options) and to take steps to manage the risks (Ministry of Environment, Land and Parks, 2000).

In order to be successful in an ecosystem-based, management-planning context, the risk assessment must address a wide range of options, and consider how the precautionary principle (see section 3.1.2.4) overlaps with the ecological objectives (Holt, 2001). O'Brien (1997) provides a useful analogy: *there is no point examining in detail the risks of crossing an icy river on foot when a wider viewpoint would identify that there is a bridge just downstream.*

Risk assessment requires the evaluation of two separate components: likelihood and consequence. For example, what is the projected likelihood of loss or damage to an ecological or economic value as a result of a particular action? Secondly, what is the projected magnitude of the consequence? When the likelihood and the consequence are both predicted to be high, the risk is similarly high and the option would be considered to be high risk, regardless of the benefits (Ministry of Sustainable Resource Management – Skeena Region, 2001).

Key steps in implementing risk assessment in ecosystem-based management planning (Ministry of Sustainable Resource Management – Skeena Region, 2001) include the following:

1. assemble the baseline ecological information,
2. identify the environmental values affected by land management strategies,

3. identify indicators for use in evaluating risk,
4. define low risk benchmarks or thresholds for the indicators (e.g. historical range of natural variability, habitat requirements for selected species),
5. define classes of risk[6] (e.g. what defines medium risk versus high risk),
6. assess environmental risk of resource management alternatives by comparing to the low risk benchmark or threshold, and
7. identify risk reduction strategies (risk management) in the form of iterative land and resource use scenarios.

Risk assessment for social or economic values can be approached in a similar manner as the steps noted above, although predicting on the major socio-economic implications of various plan scenarios using multiple accounts analysis[7] may be a more concise and better understood method (Ministry of Sustainable Resource Management – Skeena Region, 2001).

3.1.2.3 Adaptive management versus the precautionary approach

Adaptive management is an approach to management where uncertainty about the consequences of resource management strategies is acknowledged and experimental learning is valued (Taylor, 2000). The precautionary principle is another alternative for dealing with uncertainty. The precautionary principle usually assumes the worst and recommends a strategy that errs on the side of caution, through which the likelihood of

[6] Identifying risk classes can be highly value-laden and subjective.
[7] Multiple accounts analysis: a type of economic impact analysis that can be used to illustrate the impacts of land use decisions. It's purpose it to help to understand the trade-offs associated with lands use alternatives, so that the impacts can be understood before a given land use decision is made. Multiple accounts analysis is a form of cost/benefit analysis that brings values other than economic values into the equation.

undesirable impacts is minimized (Taylor, 2000). Adaptive management and the precautionary principle should be used in different situations.

The precautionary principle makes sense when (Taylor, 2000; Ministry of Sustainable Resource Management – Skeena Region, 2001):

- the consequences of a particular outcome are irreversible and unacceptable, and/or
- it is impractical to design a data-gathering strategy that will resolve key uncertainties, such as when we are dealing with a unique system, systems with very long response times, or indicators with higher levels of natural variability.

A disadvantage of the precautionary principle may be that it is unnecessarily restrictive (and as a result, costly), and it does nothing to resolve the outstanding uncertainties.

Adaptive management makes sense when (Taylor, 2000; Ministry of Sustainable Resource Management – Skeena Region, 2001):

- there is substantial indecision or disagreement over the best way to reach a specified goal,
- the uncertainty falls outside the scope of the ecosystem-based plan (e.g. the impacts of global warming are not within the scope of the planning process),
- the uncertainty can't be resolved by other more cost effective means (e.g. upgrading a resource inventory),

- it is too risky or impractical to postpone management decisions until formal research has addressed the question,
- it is possible to design a good experiment given the circumstances, and/or
- the risk of an undesirable outcome from the management strategy is acceptable.

Adaptive management should be used when managing resources uncertainty is unavoidable. Ignoring the uncertainty can have large social, economic and ecological costs. Learning through trial and error can also have large costs associated with it, however, and can also be a very inefficient method of managing resources (Taylor, 2000; Ministry of Sustainable Resource Management – Skeena Region, 2001). The results are easily misinterpreted because there are a number of possible reasons for an observed change (e.g. decline in salmon runs – is it due to over-fishing? Increase in habitat loss? Changing oceanic conditions? Or possibly some combination of all three?).

Adaptive management is a much more efficient way of learning since a carefully designed experiment will yield more reliable information, and adaptive learning can help us to learn why a certain management strategy worked or did not work.

3.1.2.4 Socio-economic component of the ecosystem-based management plan

Humans and their social and economic systems are very important components of ecosystem management (Grumbine, 1994). Understanding and accommodating societal values is integral to implementing a successful and sustainable ecosystem-based management plan. Yaffee (1999) states that an ecosystem-based management plan aids in the development of diversified economic systems designed to avoid unsustainable boom and bust cycles. Human communities are part of ecosystems and depend heavily on the environment for their physical, economic and social well-being (Wilson, 2002). According to the USDA (1999), it is important to recognize that strong communities and economies must protect ecosystems.

Land use planning in British Columbia has typically integrated the socio-economic information specific to the area in various ways. The most common method is to describe the 'base case' of existing social and economic conditions and then to forecast what these conditions will be like in the future with and without any change to the resource management direction (Ministry of Sustainable Resource Management – Skeena Region, 2001; Wilson, 2002). This method can help in understanding the implications of various land use scenarios that are being considered in the planning.

In planning for ecosystem-based management, the social well-being and economic health in the plan area are key considerations (Wilson, 2002). Social well-being refers to a community's social resiliency, quality of life, community capacity, and level of local responsibility for local issues (empowerment) (Wilson, 2002).

A community is economically healthy when it has a variety of sources of economic wealth that are all environmentally sound and financially viable (Kline, 1997). The equitable distribution of the benefits and costs is also a key aspect to economic health and social well-being (Kline, 1997). Economic resiliency, self-reliance, and equity are all indicators of economic health.

Ecosystem-based management should involve sustaining natural ecosystems for the benefit of future generations, while providing goods and services for each generation. This supports the concept that the needs of future generations are as important as those of the current generation (USDA, 1999).

Refer to Appendix B for further details regarding the socio-economic component of an ecosystem-based plan; including a suggested framework for the inclusion of social and economic considerations in an ecosystem-based plan.

3.1.2.5 Indicators for social, economic and ecological goals in an ecosystem-based management plan

Appropriate social, economic, and ecological indicators are required to assess a management plan's progress towards the community's goals and objectives. Short-term impacts of natural resource management decisions are usually felt most strongly at the community level. However, a range of indicators should be selected to reflect conditions at various levels such as the individual, family, community, and regional levels (Wilson, 2002).

When selecting indicators to monitor the success of the management plan that is implemented, it is important that they reflect the diverse range of goals and objectives in the ecosystem-based management plan. As a result, indicators are best chosen by a representative group of stakeholders to reflect the diverse values and interests in the plan area (Beckley and Burkowski, 1999). Refer to Appendix C for selection criteria for indicators for social, economic and ecological goals in an ecosystem-based plan.

3.2 Science-based and other information on the Tlell River watershed

This section reviews the pure science-based biophysical data available for the Tlell watershed. In addition, the local and regional social science information on the economy and society is reviewed.

3.2.1 Biophysical environment

The majority of the Tlell River watershed is located in the Queen Charlotte Lowlands (QCL) ecosection, while the western fringes of the watershed fall in the Skidegate Plateau (SKP) ecosection (Ministry of Forests Research Branch, map of biogeoclimatic units of the Vancouver Forest Region, 1994). The Tlell River drains approximately 34,400 ha of central and eastern Graham Island, Haida Gwaii/Queen Charlotte Islands. The Tlell River flows east and northeast from low mountains at its headwaters, into a large wetland complex known as the "Pontoons". Four major sub-basins drain into the Pontoons area from low mountains: Lella Creek, Survey/Three-Mile Creek, Upper Tlell, and Feather Creek sub-basins. The Pontoons have been described as "a shallow inland depression with wetlands that are periodically flooded by the Tlell River adjacent to very gentle slopes with forest and bogs" (Roemer and Moore, 1981). From the Pontoons flowing north, the Tlell River mainstem (Lower Tlell River) drains through a single, well-incised channel, with several large cross-stream logjams throughout its length (M.

Milne, personal communication, 2000). One major sub-basin, Geikie Creek drains into the Lower Tlell River close to its mouth. The mouth of the Tlell River has been moving north in recent history due to deposition of sediment along the shoreline through long-shore drift (M. Milne, personal communication, 2000).

The maximum elevation of the watershed is approximately 580 m on Skowkona Mountain at the headwaters of the Upper Tlell River (from 1:20,000 TRIM maps). The maximum elevation of the majority of the watershed is less that 500 m. The Tlell watershed is located within the Coastal Western Hemlock (CWH) biogeoclimatic zone.

In the 1860s, a forest fire swept through a large portion of the central and eastern Graham Island, encompassing the Tlell River watershed from the mouth (Tlell LRUP working group, personal communication, 1999). As a result, the majority of the Tlell watershed is a mature forest approximately 120 - 140 years old, with small stands of old growth alluvial spruce stands along the river banks and wetlands where the trees were not burned (Ministry of Forests forest cover maps, inventory update 1998) – referred to as legacy stands.

The Working Group developed a 1:40,000 base map that indicates the watershed boundary, various drainages in the watershed, location of roads, and tenure boundaries. This map is based on the Ministry of Forests inventory update from 1998 for the TSA portion of the watershed, and management plan #8 forest cover information for the TFL portion of the watershed (Tlell LRUP technical committee, unpublished base map, 2000).

Further details regarding the general biophysical environment of the Tlell River watershed can be found in Appendix D.

3.2.1.1 Climate and hydrology

Average annual precipitation over the watershed can be estimated using Government of Canada Atmospheric Environment Service (AES) data for Tlell, short-term B.C. Environment Research Analysis Branch (RAB) data for Survey Creek and Tlell, and precipitation and runoff research completed by the Ministry of Forests (Hogan and Schwab, 1990). According to available information, Tlell receives approximately 1 050 mm yr^{-1} and Upper Survey Creek receives between 2 225 and 2 247 mm yr^{-1} (Hogan and Schwab, 1990).

The following is a summary of the available hydrological information for the Tlell River watershed.

- Although hydrologic data is not available for the Tlell River, trends in discharge can be examined using data from the Yakoun River[8] (36 year record - WSC station 080A002) (Dobson Engineering Ltd., unpublished report, February 2000). Over the last eight years, flood levels have been low with no flows in excess of five-year return period magnitudes. Similar flow trends should have been realized on the Tlell River (Dobson Engineering Ltd., unpublished report, February 2000).

[8] Yakoun River is the watershed directly to the west of the Tlell River, which flows into Massett Inlet.

- Using Survey Creek precipitation, the mean annual maximum flow has been estimated to be 235.7 $m^3 sec^{-1}$. Using an average precipitation between the Tlell and Survey data sites, a mean annual maximum flow of 165.7 $m^3 sec^{-1}$ was calculated (Dobson Engineering Ltd., unpublished report, February 2000). More reliable projections for the watershed could only be made with long-term (30 to 50 year) hydrometric records for the Tlell River (Dobson Engineering Ltd., unpublished report, February 2000).

- BC Environment return period calculations for the Yakoun River predict unit area flows with a 10-year return period of 138 $m^3 sec^{-1}$ /100 km^2. By applying this runoff estimate per unit area to the Tlell system, ten-year return period flows at the mouth could be approximately 440 $m^3 sec^{-1}$ (Dobson Engineering Ltd., unpublished report, February 2000). It is important to note that flow estimates projected from the Yakoun River data present a worst-case scenario for Tlell discharge, since average annual precipitation in the upper Yakoun River watershed can exceed 3 665 mm yr^{-1} (Dobson Engineering Ltd., unpublished report, February 2000). Based on the variability of calculated discharges, low confidence levels should be applied when using the Yakoun data set for 100-year return interval calculations on the Tlell.

- The size of the Tlell River watershed and the distribution of small and large wetland complexes are thought to increase the lag time between storm events and peak discharge, and decrease flood magnitudes (peak flows). Flood maps derived from anecdotal information show vast areas surrounding the Pontoons and other large wetlands that are inundated during high flows (T. Husband, personal communication, 1999). Local residents have observed a two-day lag period between rainfall (L. Lee, personal communication, 1999) and peak flows, which agrees with precipitation and runoff research conducted by the Ministry of Forests (Hogan and Schwab, 1990).

- The stability of the lower sub-basin mainstem channels, Pontoons and lower Tlell River system, indicates that past forest development has had a very limited effect on overall watershed condition (Dobson Engineering Ltd., unpublished report, February 2000).

The following table summarizes the current watershed hazards with respect to peak flows, surface erosion, landslides, and riparian function and channel stability (Dobson Engineering Ltd., unpublished report, February 2000):

Watershed/ Sub-basin	HAZARD RATINGS FOR THE TLELL RIVER*				
	Peak Flows	Surface Erosion	Landslides	Riparian	Channel Disturbance
Feather Creek	N/A**	N/A	N/A	N/A	N/A
Three Mile Creek	Low	Low	Low	Moderate	Moderate
Upper Survey Creek	Low	Low	Moderate	Moderate	Moderate
Survey Total	Low	Low	Low	Moderate	Moderate
Lella Creek	N/A	N/A	N/A	N/A	N/A
Upper Tlell River	Low	Low	Low	Low	Low
Upper Tlell including Pontoons	Low	Low	Low	Low	Moderate
Tlell Watershed	Low	Low	Low	Low	Low

*Hazard ratings are derived through a professional interpretation of the realized effects on the water resource from past forest development in the watershed with consideration of implications for future forest development planning.
** N/A – hazard ratings have not been applied to unlogged sub-basins
(Dobson Engineering Ltd., unpublished report, 2000)

Despite current hazard levels due to past forest development in the watershed being low to moderate, future forest harvesting and road construction could affect hillslope and channel stability, stream sedimentation, riparian conditions and discharge in the Tlell River watershed (Dobson Engineering Ltd., unpublished report, February 2000).

Dobson Engineering Ltd. (unpublished report, February 2000) states the following:

> *In general terms, the Tlell watershed consists of both upland and lowland landscape types each with different forest management concerns. The lowlands*

area, which includes the Tlell residual, Pontoons area, and broad alluvial floodplains in several sub-basins, is poorly drained and susceptible to disturbance with road construction and harvesting. The uplands consist of well-drained soils where minimal disturbance would be expected with application of standard Forest Practices Code requirements. To date, forest development in lowland areas has been minimal, and the watershed is considered to be in good condition.

In the Upper Survey and Three-Mile sub-basins, the effects of past forest development have manifested themselves in the form of landslides, channel sedimentation, windthrow in riparian areas, and floodplain inundation by beaver dams in low-lying areas. Windthrow and surface erosion effects have been minimal and are not a current concern. Most of the landslides that have occurred did not reach stream channels, and where sediment delivery did occur slide tracks are now partially vegetated. Additional landslides remain a concern for one section of the Survey mainline between 4.6 and 4.9 km.

Channel morphology has been significantly altered in Survey and Upper Survey Creeks where beavers have dammed mainstem and tributaries following harvest in the riparian zone. Controls on beaver populations are the only possible restoration strategy in these areas.

Dobson Engineering Ltd. (unpublished report, February 2000) also provides a discussion on watershed sensitivity:

- *Natural peak flows are effectively buffered through temporary runoff storage in the extensive wetland complexes and broad alluvial floodplains in the Feather, Survey and Lella sub-basins. The peak flow effect of large debris jams on the lower Tlell River was not clear. On one hand, their ability to partially block flow and store runoff may reduce peak flow magnitude, but on the other hand, discharge surges observed on the lower channel may be effectively increasing maximum instantaneous discharge and channel erosion at points along the mainstem.*

This observation is substantiated by D.L. Hogan of the B.C. Ministry of Forests (1991), (unpublished report, entitled "Yakoun River: Rate-of-cut evaluation"), where it is stated that even though there has been considerable logging history in the Yakoun River watershed (part of TFL 39), *"there has been very little change in the form of the hydrograph over the period of record"*, and the *"channel was probably stressed far more by the historical removal of log jams, as a result of mining activities in the 1910's, than by sediment derived from spatially diffuse logging related sources*" (D.L. Hogan, unpublished report, 1991, p.i).

Further climate and hydrology information relating to the Tlell River watershed can be found in Appendix E.

3.2.1.2 Hydroriparian areas

The hydroriparian zone is very important in an ecosystem-based approach to watershed-level planning (J. Pojar, personal communication - Tlell LRUP ecosystem function workshop, May 1999), as it is the interface between water and land. Riparian plants stabilize banks, reduce sedimentation and moderate water temperature (D. Daust, personal communication, 1999) and they provide stream structure in the form of woody debris and provide nutrients from fallen leaves, twigs, lichens, and other small organisms (J. Pojar, personal communication, 1999).

Recent research in fish biology and observation of natural disturbance regimes suggest that riparian buffers should be variable in width, and sometimes even absent (P. Burton, unpublished article "Designing riparian buffers", 1999). Burton (unpublished article, 1999) suggests that there should be greater diversity in riparian management practices while still protecting riparian resources and function. In general, he also states that the denser and wider the strip of retained streamside vegetation, the more it can intercept overland runoff and the sediment it may be carrying from upslope. He also argues that it is not necessary to exclude active forest management and commercial forestry from hydroriparian zones as long as the scale and intensity of harvesting activities is kept at levels comparable to the historic range of natural variability for the given ecosystem. There will always be constraints on certain stand management practices near streams and floodplains.

A review of recommended riparian buffer widths (R. Fuerstenberg[9], unpublished report, 1992) notes that except for grazing, the results of the various studies from across the United States and from Europe consistently ranged from 15 m to 50 m riparian buffers, depending on the function that the buffer was intended to fulfil. This includes the following:

- for the maintenance of benthic communities, three studies recommended 30 m buffer widths;
- for the recruitment of woody debris and system stability, a minimum of 20 m – 30 m was recommended by two independent studies;
- for the purposes of sediment removal, seven studies recommended between 3 m – 46 m for a buffer depending on the slope and the soil texture (steep terrain and clay require larger buffers); and
- in order to control water temperatures by shading, six independent studies recommended between 12 m – 43 m for buffer width.

Three key points regarding the hydroriparian ecosystem follow (Clayquot Sound Scientific Panel, 1995):

- The hydroriparian ecosystem is the focus of activity for a large portion of all animals, and the site of the most diverse plants in a watershed. The hydroriparian ecosystem is the major travel corridor for many terrestrial and all aquatic organisms.

[9] Robert R. Fuerstenberg is a senior ecologist with the watershed co-ordination unit in the Water and Land Resources Division of the Department of Natural Resources in Washington State, US. Unpublished report entitled: "A literature review of recommended buffer widths to maintain various functions of stream riparian areas", prepared for King County Water Management Division, 1992.

- Changes in the environment that modify physical processes influence the invertebrate faunas and this, in turn, may alter fish species composition or shift fish species zones within a watershed.
- The maintenance of natural paths and regimes of subsurface waterflow is important to plant and animal biological diversity, as well as to slope stability. This is particularly true for wetlands and steep slopes.

For further information relating to the hydroriparian zone, please refer to Appendix F.

A map of the sensitive hydrological features within the watershed has been produced, and agreed to by the WG as part of the map folio that illustrates the sensitivities within the watershed (Tlell LRUP Working Group, unpublished hydroriparian features map, 2000). This map is based on the anecdotal, and science-based hydrological information collected to date.

3.2.1.3 Soils and slope stability

On the relatively few steep slopes in the Skidegate Plateau ecosection within the Tlell - in the watershed headwaters - there are some soils that are inherently unstable and are prone to slides (A. Banner, unpublished paper, 1989). Road construction and clearcut logging can increase the frequency of slides if these activities are undertaken on unstable soils. Slides initially destroy most vegetation along the slide path leaving an accumulation of trees, rocks, and soil of varying depths in the deposition zone. Scouring to bedrock or to compact material generally occurs over the top third to two-thirds of the slide path (A.

Banner, unpublished paper, 1989). Vegetation recovery is typically rapid, especially on lower slope positions where soils are still present.

Soil classification mapping based on the terrestrial ecosystem mapping database is available for the watershed. A map identifying the location of sensitive sandy soils within the watershed has been prepared (Tlell LRUP WG, unpublished sandy soils map, 2000) and agreed to by the WG as part of the map folio that illustrates the sensitivities within the watershed.

Reconnaissance level terrain stability mapping (intensity level 'D') has been completed for the Tlell watershed by a professional geoscientist (Tom Millard, research geomorphologist, Vancouver Forest Region, 1998). This mapping has identified stable, potentially unstable, and unstable terrain areas throughout the watershed. There are very few potentially unstable or unstable terrain areas identified in the Tlell watershed and the majority of these areas occur in the headwaters of the watershed - predominantly in the Upper Tlell sub-basin. Assessing slope stability through a detailed field assessment (where reconnaissance level mapping indicates potential instability), avoiding activities on unstable slopes, and carefully prescribing appropriate harvesting practices on steep and marginally stable slopes are essential to avoid increasing erosion rates above natural levels (T. Millard, personal communication, 1999).

Terrain stability mapping (level 'D') is available for the watershed, along with a slope class map based on TRIM, which identifies seven different slope classes. The map identifying unstable and potentially unstable terrain within the watershed has been agreed to by the WG as part of the map folio that illustrates the sensitivities within the watershed (Tlell LRUP working group, unpublished unstable terrain map, 2000).

Refer to Appendix G for further details relating to soils and slope stability in the Tlell River watershed.

3.2.1.4 Fish and fish habitat

There are 306 marine species of fish known to occur in the waters surrounding the Islands (Prince Rupert Interagency Management Committee (PRIAMC), unpublished draft report[10], 1999). Northcote et al. identified (as cited in PRIAMC, 1999, p.63) fourteen freshwater species for the Islands. The species known to be found in freshwater on the islands include: coastal cutthroat trout, pink salmon, chum salmon, coho salmon, rainbow trout (steelhead), sockeye salmon, Chinook salmon, dolly varden, eulachon, three-spine stickleback, pacific lamprey, western brook lamprey, coastrange sculpin, and the prickly sculpin. All of the freshwater species are salt-tolerant and probably reached the Islands by dispersing through the sea (Northcote et al., as cited in PRIAMC, 1999, p.63).

Most of the information known about the fisheries resource on the Islands focuses on conditions and status of the commercial species. In an assessment undertaken by BC Environment (PRIAMC, unpublished report, 1999) on the river systems on the Islands,

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[10] PRIAMC unpublished draft report entitled "Queen Charlotte Islands/Haida Gwaii - Background report: An overview of natural, cultural, and soci-economic features, land uses and resources management".

the Ain, Yakoun, Naden, Skedans, Mathers, and Copper waterways ranked highest according to the variety of salmon species and the size of the populations. Not far behind in ranking were the Tlell, Honna, Mamin, Awun rivers and Pallant Creek (PRIAMC, unpublished report, 1999). Fisheries managers remain concerned about fish habitat impacts since minor streamside impacts due to logging are believed to be cumulative over time (PRIAMC, unpublished report, 1999). The Tlell river is one of few rivers on the BC coast where pink salmon spawn every autumn in the Tlell River — rather than odd or even years, as on the south and north coasts of BC, respectively (Thompson, 2003). Fish and fish habitat details are presented in Appendix H.

Fish and fish habitat inventory maps produced for the Tlell Watershed Society by the Haida Fisheries Program are available for the watershed.

3.2.1.5 Wildlife

The Queen Charlotte Islands are home to a number of endemic species that are distinct from continental forms, many of which are assumed to be present in the Tlell River watershed. Numerous introduced species are also present in the watershed and some of these are causing serious problems for the endemic species.

Eight species or sub-species of land mammals found on the Islands are believed to be endemic and may differ from their counterparts on the mainland in colouring, size, and use of different habitats (Prince Rupert Interagency Management Committee (PRIAMC), unpublished report[11], 1999). The Dawson caribou was the only distinct species on the Islands, but the last one was shot in 1908. The remaining endemic mammal sub-species include: the short-tailed or Haida weasel (ermine), *Mustela ermineas haidarum*; the pine marten, *Martes americana nesophilla*; the black bear, *Ursus americanus charlottae*; two sub-species of shrew, *Sorex obscurus elassodon* and *Sorex obscurus prevontensis*; and two species of deer mouse, Peromyscus *maniclatus keeni* and *Peromyscus sitkensis prevostensis* (PRIAMC, unpublished report, 1999).

The Queen Charlotte Islands are among the richest bird islands in Canada. Although there are fewer numbers of species found here than on the adjacent mainland (remote islands typically have fewer species), millions of birds visit or nest in the archipelago every year (PRIAMC, unpublished report, 1999). Of the 243 species and subspecies of birds that live or visit the Islands, 71 species are known to nest on the Islands (PRIAMC, unpublished report, 1999). There are no known endemic species, but there are four well-defined sub-species that are endemic: the Northern (Queen Charlotte) Saw-whet owl, Queen Charlotte Hairy Woodpecker, Queen Charlotte Steller's Jay and Pine Grosbeak (PRIAMC, unpublished report, 1999). The pine grosbeak is found only on the Queen Charlottes and Vancouver Island. Over 70% of the bird species found on the Islands are non-perching, and many are associated with aquatic habitats and the outer coastal islands of the Queen Charlotte Islands (PRIAMC, unpublished report, 1999).

[11] PRIAMC, unpublished report entitled "Queen Charlotte Islands – Haida Gwaii - Background report: An overview of natural, cultural, and socio-economic features, land uses and resources management (draft)", 1999.

3.2.1.5.1 Species at risk

There are a number of endemic species on the islands that are considered to be at risk, either because of conflicts with human activities, alterations or loss to their habitats. There are currently five birds and one mammal for this area that are listed as 'identified wildlife' species under the *Forest Practices Code of British Columbia Act.* This means that these species can be managed under a set of required prescriptions. The species include: Keen's long-eared myotis (bat), Northern (Queen Charlotte) goshawk, Sandhill crane, Marbled murrelet, Ancient murrelet, and the Cassin's auklet (PRIAMC, unpublished report, 1999). The Cassin's auklet and Ancient murrelet are offshore birds that use the outer coastal islands for breeding and are not of concern in the Tlell watershed. Refer to Appendix I for details regarding the species at risk in the Tlell River watershed.

3.2.1.5.2 Introduced species

At least nine species of land mammals, one amphibian and three domestic animals have been introduced to the islands through human settlement patterns and active introductions (PRIAMC, unpublished report, 1999). Research to date indicates that these species are causing a significant negative impact on the ecological integrity of the islands. The potential remains high for continued expansion of these species, which is likely to result in further displacement and possible eradication of rare or endemic flora and fauna (PRIAMC, unpublished report, 1999).

Many of the introduced species, including deer, squirrels, beavers, elk, rats, house mice, and racoons, have altered the Islands (PRIAMC, unpublished report, 1999). Sitka deer are foraging extensively on young cedar and devil's club, racoons are raiding seabird-breeding grounds, and particularly in the Tlell River watershed, beavers are altering the natural hydrology in the area (PRIAMC, unpublished report, 1999). Refer to Appendix J for further details regarding introduced species in the Tlell River watershed.

3.2.1.6 Vegetation

The majority of the watershed has stands of mature forest of approximately 120 – 140 years old due to a large forest fire that went through the area in the 1860s. The upper portions of the watershed have old growth stands greater than 250 years old, as well as recent clearcut areas that have been harvested within the last 18 years (Ministry of Forests forest cover maps, 1998). The lower portion of the watershed also has recently cleared areas around the community of Tlell and surrounding farmland.

The Tlell River watershed is found within the Coastal Western Hemlock Submontane Wet Hypermaritime (CWH wh1) and Coastal Western Hemlock Montane Wet Hypermaritime (CWH wh2) biogeoclimatic subzones (Biogeoclimatic units of the Vancouver Forest Region map, Ministry of Forests Research Branch, 1994).

The CWH wh1 is restricted to the Queen Charlotte Islands where it occurs at lower elevations on the leeward side of the Queen Charlotte Ranges. The elevational limits range from sea level to approximately 350 m (PRIAMC, unpublished report, 1999). The

CWH wh1 climate has mild, wet winters with little snowfall, and cool moist summers (MOF, 1994). Forests on zonal sites are dominated by western hemlock (Hw), western redcedar (Cw), and Sitka spruce (Ss) (Pojar et al., 1991). Mosses dominate the understory with *Hylocomium splendens* (step moss), *Rhytidiadelphus loreus* (lanky moss), and *Rhizomnium glabrescens* (large leafy moss) occurring most commonly (MOF, 1994). The herb and shrub layers are sparse, mostly due to heavy deer browsing. Very old successional stages are increasingly dominated by cedar. Subdued terrain on the Queen Charlotte Lowlands and eastern Skidegate Plateau has extensive bogs and nutrient- poor to very poor, western redcedar, western hemlock and salal-dominated stands, such as the forest surrounding the Pontoons area.

The CWH wh2 is also restricted to the Queen Charlotte Islands where it occurs above the CWH wh1 throughout the eastern Skidegate Plateau and eastern Queen Charlotte Ranges. Elevational limits range from approximately 350 m to 600 m (PRIAMC, unpublished report, 1999). The CWH wh2 is cooler and wetter than the CWH wh1 below it, and has greater snowfall and a more persistent snowpack (PRIAMC, unpublished report, 1999). Forests in zonal sites are dominated by western hemlock, western redcedar, and yellow-cedar, with Sitka spruce occurring less commonly. Minor amounts of mountain hemlock may occur, but vigour is poor. The understory is dominated by mosses and liverworts, including *Hylocomium splendens* (step moss), *Rhytidiadelphus loreus* (lanky moss), and *Scapania bolanderi* (scapania) (MOF – Vancouver Forest Region, 1994). The herb and shrub layers are sparse, also probably due to heavy deer browsing.

The following maps have been produced in order to characterize the vegetation in the watershed:

- leading tree species,
- forest cover age class,
- forest height class, and
- wetlands.

These four maps are based on 1998 forest cover information for the TSA and management plan #8 information for the TFL 39 portion of the watershed. The map identifying the location of the wetlands within the watershed has been agreed to by the WG as part of the map folio that illustrates the sensitivities within the watershed (Tlell LRUP WG, unpublished wetlands map, 2000).

A soil nutrient and moisture regime map of the watershed was produced using TEM information with the aim of identifying wet and rich sites in the watershed (Tlell LRUP technical committee, unpublished soil nutrient and moisture map, 2000).

Using the TEM information, mapping of the various biogeoclimatic ecosystem types (down to the site series level) in the watershed has been completed. Also using the TEM information, a map has been produced which identifies the critical ecosystems (Tlell LRUP technical committee, unpublished critical ecosystems map, 2000) as identified during the Jim Pojar (Prince Rupert Forest Region (PRFR) – Ministry of Forests regional ecologist) / Phil LePage (PRFR regional silviculturist) ecosystem function workshop held in May, 1999. Red- and blue-listed rare plant associations (as identified by the

Conservation Data Centre in 1999) have also been identified on mapping based on the TEM database. The red- and blue-listed rare plant associations map is part of the map folio that illustrates the sensitivities within the watershed (Tlell LRUP working group, unpublished red- and blue-listed rare plant associations map, 2000).

3.2.1.7 Ecological function, old growth and fire legacy stands

Knowledge of how ecosystems maintain and renew themselves is a necessary prerequisite to ecosystem-based management, to selecting silvicultural systems, and in determining harvesting and transportation systems (Clayquot Sound Scientific Panel, 1995; Pojar, personal communication, 1999). Forest trees are long-lived, but are also subject to disturbances. Tree mortality is most often due to natural changes such as landslides, windthrow, fire, disease or insects. Because forest cover is naturally renewed by events that may dramatically alter or disturb existing cover, the common pattern of these events is called the 'natural disturbance regime' (Clayquot Sound Scientific Panel, 1995). The regional climate and physiography govern the natural disturbance regime of any given ecosystem (Clayquot Sound Scientific Panel, 1995). For example, in the wet climate of a coastal temperate rainforest, such as the southern portion of the Tlell River watershed that falls within the Skidegate Plateau, fires are smaller on average, and less frequent than in other areas in the province. Windthrow is the principal agent of disturbance, whereas in the interior of the province, fire often dominates (Pojar, personal communication, 1999). In the Hecate Lowlands ecosection portion of the Tlell watershed, where precipitation levels are lower, fire incidence as part of the natural disturbance regime is likely more frequent and on a larger scale, as evidenced by the Skidegate fire of the 1860s (Pojar, personal communication, 1999).

Wild forests renew themselves naturally in a manner that depends on the natural disturbance regime. Logging is disturbance that alters the pattern of renewal. Ecological knowledge can be used to ensure that the changes caused by logging, and the forests that regenerate after logging, are not dramatically different from those created by the natural disturbance regimes (Clayquot Sound Scientific Panel, 1995; Pojar, personal communication, 1999). Forest practices that approximate natural disturbance regimes help to retain ecosystem processes and maintain ecosystem productivity and integrity (Clayquot Sound Scientific Panel, 1995; Pojar, personal communication, 1999).

Windstorms cause major natural disturbances to forests in the Tlell watershed, and are the most common natural agent of forest disruption and renewal. This disturbance ranges from single-tree blowndown to large patches of trees. Blowdown provides space for the growth of young trees (advanced regeneration) that were previously shaded by the windthrown trees. Low mounds of soil produced by the upturned root wads of the blowdown trees provide seedbeds for western hemlock and red alder, in particular (Pojar, personal communication, 1999).

The stands of large, old trees on the Islands contain examples of some the largest biomass accumulations in the world (Pojar, personal communication, 1999). Some of the old growth stands within the Skidegate Plateau portion of the Tlell River watershed are examples of these stands.

Researchers are in agreement that most of the distinctive attributes of old-growth forests relate to their structural features: large, old, living trees; large snags; and large, downed trunks or snags on the ground (Clayquot Sound Scientific Panel, 1995). These features are interrelated over time and take a long time to develop: approximately 175 to 250 years are required in coastal environments (Clayquot Sound Scientific Panel, 1995). The Working Group defined old growth as stands that are over 250 years old, although they also recognized that old growth characteristics may exist in stands that are younger than 250 years old. These old growth characteristics are particularly apparent in the 'legacy stands' or fire-skipped stands within the lower watershed.

According to preliminary findings in a study investigating the ecological role of old-forest remnants conducted by (B. Marcot, Pacific Northwest Research Station, US Forest Service, personal communication, 1999), on a per hectare basis within younger forests, old growth stands are more ecologically significant than plantation forests.

A map based on management plan #8 data for the TFL and TSR II data for the TSA identifies the location of the fire legacy stands within the watershed. This map has been agreed to by the WG as part of the map folio that illustrates the sensitivities within the watershed (Tlell LRUP working group, unpublished fire legacy map, 2000).

Refer to Appendix K for further details relating to ecological functioning, old growth and the fire legacy stands within the Tlell River watershed.

3.2.2 Economy

3.2.2.1 Background and local economic trends

The economy of the Islands is currently largely based on resource extraction (logging and fishing), government and tourism. Forestry employment has declined somewhat over recent years, but is still the single largest private sector employer (G. Holman, unpublished report[12], 1997). The economic benefits of timber harvesting to date have been limited by the transport of most of the raw logs for processing. The contribution of government to the local economy has declined due to the closure of the Canadian Forces Station (CFS) at Massett, although this has been somewhat offset by the increase in Parks Canada employment after the creation of Gwaii Hanaas National Park Reserve (Holman, unpublished report, 1997). Tourism appears to be the Islands most promising growth sector, although benefits to the economy have been limited due to non-local ownership of operations and facilities (Holman, unpublished report, 1997).

The resolution of the Haida land claim, the possible continuation of economic development funding provided as a result of Gwaii Hanaas (South Moresby Forest Replacement Account - SMFRA), initiatives to increase the availability of timber for local processing, and the take-over of CFS Masset by the local community will have significant long term implications for the economy of the Islands (Holman, unpublished report, 1997).

[12] G. Holman, unpublished report entitled "Queen Charlotte Islands Land and Resource Management Plan: Socio-economic base case", prepared for the Land Use Co-ordination Office, Province of British Columbia, June 1997.

The Tlell watershed is in the commercially significant Coastal Western Hemlock (CWH) Biogeoclimatic zone and is recognized as the most productive forest zone in Canada (Pojar et al, 1991), with coniferous forests of western hemlock, western redcedar, Sitka spruce and yellow-cedar being the commercial species on the Islands, in general, and in the Tlell River watershed. Shore pine, western yew and mountain hemlock are also present, but have less potential economically under the present timber tenure system. Yellow-cedar becomes an important component of the climax forests at higher elevations and is also a very valuable wood (Mullins and Tedder, 1994).

The most productive forest communities occur on recently deposited alluvial materials adjacent to streams and rivers. Large, tall, widely-spaced Sitka spruce dominate in these alluvial forests (Mullins and Tedder, 1994). Less vigorous spruce stands also occur on the stabilized sand dunes behind the marine beaches and also on the rocky headlands exposed to sea spray. Low productivity forest develop mainly on poorly drained, flat terrain, and are found within the eastern portions of the Skidegate Plateau and the Queen Charlotte Lowlands ecosections within the Tlell watershed. Scrubby western redcedar, western hemlock and shore pine are common within this area.

Land-use in the watershed has included historic mining exploration in the Survey sub-basin; commercial harvesting and road construction in the upper Survey sub-basin, Three-Mile sub-basin and Survey residual; cattle ranching on two quarter sections at the mouth of the Tlell River; rural and urban settlement; and the Naikoon Provincial Park.

Ecological reserves have been proposed for the Pontoons and a unique Sitka spruce-devil's club ecosystem in the lower Survey Creek. These areas are now proposed as Goal 2 areas under the Protected Areas Strategy, and may be formally designated as protected areas during the islands-wide land use planning process recently initiated (QCI LRMP). Small scale timber harvesting has also occurred on private land in the Upper Tlell sub-basin and lower Tlell residual near Hecate Strait.

The small amount of logging that has occurred in the upper portion of the Tlell watershed within TFL 39, now operated by Weyerhaeuser Company, has all been done using clearcut logging as the silviculture system (D. Trim, Weyerhaeuser Co. Ltd., personal communication, 1999).

The forestry industry in the Queen Charlotte TSA is heavily weighted toward harvesting activities. Approximately 70 % of all direct forestry jobs associated with the TSA are in logging and silviculture (Mullins and Tedder, 1994). Most of this is carried out by two major licensees – Husby Forest Products Ltd. and Timber West Forest Ltd., and by the forest district's Small Business Forest Enterprise Program (SBFEP – now the B.C. Timber Sales program). The SBFEP had proposed 9 blocks within the TSA portion of the Tlell watershed for harvesting from 1998-2003 (R. Johnson, MOF, personal communication, 1999).

In 1999, ICSI was tentatively awarded a Community Forest Pilot Agreement (CFPA) (now managed by the Community Forest Board) that has been proposed for the Tlell watershed. The details of the license (e.g. allowable annual cut, specific location of the area-based license within the Tlell) are still to be negotiated prior to the signing of the license documents between the Minister of Forests and the Community Forest Board. This license, once signed, would displace the SBFEP operations within the watershed (assuming that the CFPA encompasses all of the TSA land within the watershed).

As stated in the *Islands Community Stability Initiative Consensus Document* [13](January 1996), a number of people on the Islands feel that for too long, decisions that affect the well-being of the Islands communities have been made by people who do not live on the Islands and who have little or no personal interest in the future of the Islands. The concept of an area-based community forest that is managed by local communities would help to address many of the concerns regarding local stewardship over local resources. Once the CFPA licence document has been signed, communities will have an opportunity to implement more local control over the management of the landbase under the CFPA, on a pilot basis. Use of this tenure in the long term will depend on the success of the pilot.

Refer to Appendix L for more details regarding general Islands economic trends.

[13] Islands Community Stability Initiative Consensus Document is an unpublished "living" document that was signed in January 1996 that represents the Island Community Stability Initiative's best effort to address forest management and timber supply issues on the Islands. The Island Community Stability Initiative (ICSI) was formed in November 1995 by elected representatives, and their designated alternates, from every community and rural electoral area on the archipelago known as Haida Gwaii and as the Queen Charlotte Islands. ICSI was replaced by the Community Forest Board (CFB) in 2001.

A tenure and ownership map of the watershed identifies the location of private land, the boundaries for the TFL, TSA and Naikoon Provincial Park boundaries (Tlell LRUP technical committee, unpublished tenure and ownership map, 2000).

3.2.2.2 Forestry

3.2.2.2.1 Economic underpinning

In the forest industry, there is growing interest in enterprises that increase timber utilization or value-added to primary products, although there are economic factors that will constrain growth in these activities (Holman, unpublished report, 1997). Another important economic development initiative is the ICSI (now Community Forest Board) award of a Community Forest Pilot Agreement (CFPA) that, once signed by the Minister of Forests and ICSI, intends to increase local harvesting and processing of timber and other forest resources.

As noted above, the single most important sector of the Islands economy is forestry, including harvesting, processing, transportation, road building and silviculture. Timber from the Islands supports an even greater number of harvesting and processing jobs for workers elsewhere in BC (Holman, unpublished report, 1997).

The current annual harvest levels as reflected in the AACs (allowable annual cuts) for the TSA and the three TFLs in the islands in various decisions is approximately 1.9 million m^3 as established by the Chief Forester (Holman, unpublished report, 1997). However, actual harvest levels of Crown regulated timber have been lower than the AAC over the past several years. Annual harvest on private lands is approximately 70,000 m^3 (Holman, unpublished report, 1997). The TSA AAC[14] of 475,000 m^3 represents about 25% of the total harvest level on the Islands. The current cumulative AAC for the Islands is 19% over the estimated long-term harvest level (Holman, unpublished report, 1997). The TSA portion of the Tlell River watershed represents approximately 8.6% of the timber harvesting land base (6 895 ha) as it is defined in the Timber Supply Review II (TSR II) data package for the Queen Charlotte TSA.

There are a number of areas that have been identified by the Haida, local communities or the Regional Protected Areas Team (RPAT) as areas of interest that potentially conflict with timber harvesting. Although these areas remain within the timber harvesting landbase, in the past they have been temporarily deferred from harvesting in the hopes that land use decisions would be made through an Islands-wide land use planning process. The past deferral of these areas and the resultant increased pressure on the remaining timber harvesting landbase on the Islands has created pressing concerns regarding short-term timber supply shortages on the Islands. It is becoming increasingly urgent to make final decisions regarding land use on the Islands.

3.2.2.2.2 Tlell watershed timber supply estimate

The following is based on a September 1997 summary provided by Myles Mana, Timber Supply Forester for the Vancouver Forest Region. The forest inventory information and

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[14] The AAC for the TSA has been temporarily reduced from 475,000 m^3 by 24% to 361,000 m^3 until April 1, 2003 or until the Duu Guusd (one of the Haida-declared areas-of-interest) ceases to be a designated area.

resulting rates of harvest in this section are only based on the portion of the Tlell watershed that is part of the Queen Charlotte Timber Supply Area. The timber harvesting landbase remaining in the Tlell TSA area, net of all of the above exclusions, is 5 638 ha (based on TSR 1 assumptions). The total timber volume on the harvesting landbase is estimated at 2,353,000 m^3. The mature timber volume estimate (stands older than 100 years) is 2,324,000 m^3.

The current mature timber inventory of 2.3 million m^3 (based on TSR I information) in the TSA portion of the Tlell area (i.e., excluding the portion within TFL 39) is sufficient to sustain an annual harvest of 25,000 m^3 for 93 years or 30,000 m^3 for 77 years (M. Mana, Ministry of Forests, unpublished data, 1997). Since almost the entire standing timber inventory in the THLB is mature, harvesting at these levels imply forest rotation periods of 93 years and 77 years, respectively (M. Mana, Ministry of Forests, unpublished data, 1997). This is assuming the forest management regime described in the TSR 1 with Forest Practices Code constraints. Refer to Appendix M for further details on the assumptions that lead to estimates of the timber harvesting landbase and timber inventory for the TSA portion of the Tlell watershed.

A timber volume map of the watershed has been produced using the TSR II TSA data, and TFL management plan #8 data (Tlell LRUP technical committee, unpublished timber volume map, 2000). This map identifies timber volumes in four categories.

3.2.2.2.2 Silvicultural systems

Silvicultural systems describe the series of treatments by which a stand is harvested, regenerated, and tended to produce timber and other forest products.

Selecting a silvicultural system is a separate decision from the rate at which a forest is harvested – the 'rate-of-cut'. The choice of the silvicultural system is based on site-specific characteristics and management objectives for a specific area of land. The determination of allowable annual cut, while considering these factors amongst others, typically employs larger planning units called management units (i.e., TFLs or TSAs). The rate of cut and the allowable annual cut (AAC) are also distinct. Rate-of-cut is based on area and is an input to the planning process, constrained by hydrological, fisheries, biodiversity, and other environmental considerations.

The dominating objective of classical silvicultural systems has been to create appropriate conditions for regenerating selected tree species. Recent thinking regarding silvicultural systems focuses more on desired stand conditions for attributes other than regeneration (Clayquot Sound Scientific Panel, 1995).

Clearcutting, seed tree, and shelterwood are even-aged systems because they create stands in which trees are predominantly one age class (Clayquot Sound Scientific Panel, 1995). The selection system is an uneven-aged system because it maintains or creates forests with trees of many ages. These silvicultural systems are considered to be discrete;

each is suited to a particular trees species, specific sites, and specific management objectives (Clayquot Sound Scientific Panel, 1995).

In the short term, the environmental effects of many small openings may be greater than the effects of fewer, larger ones. Numerous small, dispersed cutblocks affect a larger proportion of the watershed by (Clayquot Sound Scientific Panel, 1995):

- requiring more kilometres of active road which increases the potential for sediment production for the running road surface;
- producing more forest edge effect (which is a benefit to some species, but harmful to others);
- increasing fragmentation of the forest which can harm species requiring more continuous forest cover (although old-growth dependent species may benefit from micro-fragmentation); and
- encouraging deer populations which will damage regeneration.

If sustainable ecosystem management is to be one of the key management objectives for the Tlell River watershed, of prime consideration should be how much of the forest cover is retained post-harvest. A retention silvicultural system retains trees and patches of forest to protect a variety of values and ecosystem components. The retained trees and forest patches should create forest characteristics similar to patterns and remnant structures left after natural disturbances (Clayquot Sound Scientific Panel, 1995). In order to maintain the ecological integrity of the watershed, it will be necessary to ensure that ecosystem processes do not depart from the range of natural variability exhibited before logging. It is clear that there is no single silvicultural system ideal for the whole Tlell watershed.

Refer to Appendix N for a summary of silvicultural systems, and harvesting and road transportation systems.

3.2.2.3 Islands tourism and recreation

In the 1990's, tourism was one of the most significant growth sectors and sources of economic diversification on the Islands (Holman, unpublished report, 1997). Tourism numbers were down fairly significantly for 1999 (B. Eccles, personal communication, 1999). Wilderness or eco-tourism is one of the fastest growing components of the tourism industry world-wide and in British Columbia. The demand for quality freshwater and saltwater angling in the Islands is expected to grow, as is the use of Naikoon Provincial Park. However, opportunities for growth in recreation use may be constrained in the longer term as existing recreation sites and parks on the Islands become saturated (Holman, unpublished report, 1997). Refer to Appendix O for additional information.

3.2.2.4 Trapping and non-timber forest products

Other nature-based consumptive activities that make an economic contribution to residents of the Islands include trapping and harvesting non-timber forest products. There are a number of active traplines in the Tlell watershed used particularly for trapping ermine and beaver. Elk and deer are also hunted in the watershed. A Recreation Opportunity Spectrum map for the location of potential areas for hunting has been produced for the Tlell watershed, based on the Ministry of Forests recreation database updated in 1998.

The term 'non-timber forest products' (NTFPs) refers to a broad range of resources in the forest, and generally describes any product in the forest, other than the trees used for the production of lumber and solid wood products or pulp (Tedder et al., 2000). While there are many hundreds of such products in the forest, approximately 200 products are currently commercially harvested in British Columbia (Tedder et al., 2000).

The non-timber forest product industry is comprised of two segments: special forest products and botanical forest products. Special forest products are derived directly from trees, usually salvage timber, and are regulated under the *Forest Act* and *Special Forest Product Regulation*. Botanical forest products, primarily edible mushrooms and floral greenery, but also nutraceuticals and potential bioproducts, are not derived from trees, but are harvested from forest ecosystems. Currently, botanical forest products are not regulated by the Province, but there is provision for such regulation under the *Forest Practices Code of British Columbia Act*.

A map of the watershed has been produced identifying the location of ecosystems that have berry-producing potential. This map is based on the TEM data and identifies the location of potential red huckleberry, Alaskan blueberry, salal, oval-leafed blueberry, and wetland berry-producing sites (Tlell LRUP working group, unpublished berry potential map, 2000). The berry potential map has been agreed to by the WG as part of the map folio that illustrates the sensitivities within the watershed.

Refer to Appendix P for further details on non-timber forest products.

3.2.2.5 Mining, oil and gas on the Islands

Significant exploration activity has occurred on a number of properties over the last decade with most of this focused on gold. Improved mapping and a more extensive network of logging roads have facilitated exploration. Mineral exploration expenditures were estimated at $6 million in 1996 (Holman, unpublished report, 1997).

There is significant oil and gas potential off the east cost of the Islands, in the Queen Charlotte Sound, along eastern Graham Island and northeastern Moresby Island. There is currently a moratorium on offshore oil and gas exploration on the west coast of British Columbia due to the potential environmental concerns. The excellent potential for oil and gas in the Queen Charlotte Islands areas would almost certainly result in further exploration and development activity if the offshore moratorium were to be lifted and environmental concerns could be resolved (Holman, unpublished report, 1997). Such developments would generate significant income and employment impacts, although only a portion of these impacts would accrue to the Islands (Holman, unpublished report, 1997). Currently, there is considerable resistance from many of the Haida and non-Haida residents to the recent suggestion that the government will lift the moratorium on off-shore oil and gas exploration in the Hecate Strait.

3.2.3 Society

3.2.3.1 Islands residents

Many aspects of the Tlell River watershed are important to people – both Haida and others - for spiritual, cultural, and scenic values, and for recreational and tourism use. The forest resources in the Tlell also provide economic benefits for residents of the Queen Charlotte Islands and off-island residents.

In addition to the Haida , the Tlell River watershed is enjoyed and used by non-Haida Islands people who live primarily in Tlell, Queen Charlotte City, Port Clements, Masset, and Sandspit. A large proportion of these people depend on local forest and marine resources that form the basis for timber, fisheries, and tourism industries. The economic importance of these resources also extends to people on Vancouver Island and in the lower mainland where jobs are supported by forests on the Queen Charlotte Islands.

Besides the economic benefits, residents value many aspects of the environment and scenery of the Tlell watershed. Some people choose to live on the Queen Charlotte Islands for other than financial reasons. The environment contributes to their quality of life and is important for their social and spiritual well-being. The long-term viability of the communities on the Queen Charlotte Islands depends upon sustaining the resources of watersheds like the Tlell. Over the long-term, the ecological integrity of the forest ecosystem is essential to meet their economic, spiritual, and social needs.

3.2.3.2 Aboriginal peoples

Although it is appropriate to discuss the importance of the natural resources within the Tlell River watershed to the Haida Nation, this discussion should come from Haida knowledgeable in these subjects. As it stands, this document provides a very brief overview of generally accepted information. It is hoped that in time, this section can be expanded with the assistance of knowledgeable Haida.

Haida culture has been linked to the land and the natural resources for a long time. Haida people have rights that are protected under section 35 of the Canadian constitution. As examples, the Haida have rights to harvest fish, to gather plants, to have access to trees for ceremonial and social needs, and to hunt and trap animals.

Cultural evidence of past uses such as test holes for canoe-building in large cedar trees, and evidence of bark harvesting from cedar trees are sites that the Haida want to maintain free from industrial change. Culturally modified trees (CMTs) that pre-date 1846 are noted as archaeological features and are protected under the *Heritage Conservation Act.*

The Haida have concerns about current and proposed industrial activity on the Islands, in general, and how it affects their access to resources needed to maintain their culture, traditional knowledge, and current lifestyle. The key concerns relate to jurisdiction over land, the forest tenure system, the methods used for timber harvesting, proposed harvesting within the Haida-declared protected areas, and the current rate of harvest.

Culturally modified trees, places of spiritual significance, and areas used for traditional activities are believed to be scattered throughout the Tlell watershed, and the Islands as a whole. The Haida assert that these places and the watershed's forests and water resources are essential for Haida economic, cultural, and spiritual well-being.

Refer to Appendix Q: Society, for further information regarding the Haida Nation, and the status of their land claim, and their lawsuit in the B.C. Supreme Court.

3.2.3.2.1 Traditional uses

The Haida have likely used the natural resources in the Tlell River watershed for a number of traditional purposes other than the selective harvesting of bark from cedar trees. Other traditional uses might include harvesting berries, fishing, hunting, and the collection of medicinal plants. The specific location of the practice of these aboriginal rights within the watershed had not been made known to the Tlell LRUP WG. Refer to Appendix Q for more details regarding the Haida Nation's traditional use of resources in Tlell watershed.

Archaeological overview assessment (AOA) mapping has been completed for the majority of the Queen Charlotte Islands (excluding Gwaii Haanas National Park Reserve). The AOA mapping indicates either a high, moderate, low, or unproven potential for finding archaeological artefacts in a given area. The distribution of known archaeological sites along the coasts of the Queen Charlotte Islands reflects the level of investigation that has occurred rather than the extent of the use of any particular area.

Due to the harvesting history on the Queen Charlotte Islands, there is particular concern over the future supply of monumental cedar (>1.5 m in diameter) for the purposes of making canoes and poles. Refer to Appendix Q for more information regarding the cedar strategy on the Queen Charlotte Islands/Haida Gwaii.

Based on TEM and forest cover databases, a map identifying the potential locations of monumental cedar stands has been produced (Tlell LRUP working group, unpublished potential monumental cedar stands map, 2000). This map has been agreed to by the WG as part of the map folio that illustrates the sensitivities within the watershed.

3.2.3.3 Recreation – historical trails and scenic resources

The Queen Charlotte Islands have strong international appeal for tourism particularly due to its isolation, dramatic coastline, scenery, old growth forests, and the national and provincial parks. The Tlell watershed, in particular, has some potential to expand tourism activities, particularly in the area of ecotourism. Improved road access and/or trail systems into the watershed could facilitate this expansion. Ecotourism is a highly vulnerable activity in relation to the scenic values and other types of activities that occur in the watershed. Uncontrolled tourism can also significantly damage land and marine resources, as well as local communities, if growth and use occurs unchecked. The impacts of any expansion to tourism in the watershed would need to be closely monitored.

Currently, the Tlell River watershed is used for a number of recreational uses, including hiking into Naikoon Provincial Park along the Tlell River, along East Beach up to the Pesuta shipwreck, and into Pretty John's and the Pontoons; fishing; kayaking and canoeing along the lower sections of the river and further upstream; and hunting for deer and elk. The limited access to the interior of the watershed does limit the recreational opportunities within the watershed for most visitors and residents. Refer to Appendix R for further details regarding recreation and historical trails in the Tlell watershed.

A recreational/historical sites and trails map of the watershed has been produced base on Ministry of Forests database (1998) and supplemented with anecdotal information (Tlell LRUP working group, unpublished recreation/historical trails map, 2000). This map has been agreed to by the WG as part of the map folio that illustrates the sensitivities within the watershed.

Scenic resources have been assessed by a landscape expert (B. Eccles, Recreation Officer, Ministry of Forests) within the Tlell River watershed, and recommended visual quality objectives have been defined for the watershed. Due to the gentle terrain, particularly in the Queen Charlotte Lowlands ecosection of the watershed, the ability of the Tlell landscape to absorb human changes without a reduction in visual quality is quite high. The main scenic corridor on the east coast of the Queen Charlotte Islands is the marine travel corridor close to the shore along which the BC Ferry travels. Highway 16 between Lawn Hill and Geikie Creek is also a sensitive travel scenic corridor that has the potential to be visually impacted by forestry activities within the Tlell watershed. Refer to Appendix R for further details regarding scenic resources in the Tlell watershed.

Maps identifying the location of the known scenic areas, and the recommended visual quality objectives classes (RVQO) within the watershed have been produced based on the Ministry of Forests visual resources database (1998 update) (Tlell LRUP technical committee, unpublished known scenic areas and recommended visual quality objectives maps, 2000).

3.2.3.4 19th and 20th century settlers

Farmsteads were first established in the Tlell watershed (on the south and east side of the Tlell River) in the early 1900's. With the Tlell area being the part of the Islands that receives the least amount of annual precipitation, it was considered to be the area with the best potential for agriculture on the Islands.

The economic boom in British Columbia during the 1950's and 1960's affected the Islands to a lesser degree. By 1956 there were 3,082 residents, about half of these residents being Haida (PRIAMC, unpublished draft report, 1999). Through the 1960's and 1970's, forestry, fishing and mining becoming more active and the Islands communities grew. Refer to Appendix S for further information regarding the early settlers to the Tlell area, and access to the watershed.

4.0 DISCUSSION

4.1 Ecosystem-based management framework for the Tlell River watershed

4.1.1 Implementing ecosystem-based management

Since ecosystems are not fully understood, implementing ecosystem-based management involves analyzing environmental information to assess the threats to ecological integrity, performing risk assessment of alternative management actions, and undertaking adaptive management strategies in order to address the issue of uncertainty. Within this framework, the resulting potential for the production of forest resources can then be determined.

The literature suggests that there are some important steps that must be taken to implement successfully ecosystem-based planning (Clayquot Sound Scientific Panel, 1995; Ministry of Sustainable Resource Management – Skeena Region 2001; Holt 2001). In short, they are as follows (each of these steps will be described in more detail):

1. Collect ecological information.
2. Collection information on regional / local economy and structure.
3. Identify threats to ecological integrity (e.g., rare and endangered species, ecosystems that are underrepresented in protected areas, etc.).
4. Identify factors that contribute to social and economic health in communities.
5. Define ecological baselines and limitations (e.g., historic range of variability, habitat requirements for certain species).
6. Analysis.

7. Formulation of the management plan - develop resource management alternatives that address the identified pressures and threats to ecological integrity.
8. Evaluate ecological risk of alternative management strategies – environmental risk/impact assessment.
9. Determination of sustainable harvest levels.
10. Operational-level planning and implementation.
11. Monitor approved plan and adaptive management trials.

Elements in Steps 1-6 have been addressed in Chapter 3 and detailed in the appendices, with specific information regarding the Tlell watershed. These elements are summarized below in Table 4.1 (Types and examples of inventories for ecosystem-based management); Table 4.2 (Threats to ecological integrity); and Table 4.3 (Analysis of baseline data).

Step 1 (ecological inventory (see Table 4.1)) requires that enough ecological information must be collected in order to understand the critical ecosystem components, such as:

- biogeoclimatic sub-zones and variants,
- forest cover (forest age, patch sizes, forest type),
- populations and distributions of selected species,
- habitat mapping for these selected species,
- quality and distribution of key fish and wildlife habitats,
- areas of known ecological sensitivity,
- historic patterns of natural disturbances (fire legacy stands), and

- ecological pressures in the area such as potential cumulative impacts for different land use sectors.

Social and economic information must be collected (Step 2) in order to understand the local social components (see Table 4.1 for examples).

Table 4.1: Types and examples of inventories for ecosystem-based management
(adapted from Holt (2001))

Type of inventory	Examples
Physical data	Climate, geology, hydrologic features, terrain, soils, topography, areas prone to flooding and spillways
Ecosystems and habitats	Forest cover; TEM mapping; ecosystem types; wetland habitats; species present; connectivity; patch size distribution; plant associations; areas of known ecological sensitivity; rare, threatened or endangered species and ecosystems
Current state of the land	Identify: ecological components that are thought to have changed significantly as a result of past and present management practices; areas where a shift in species may have occurred as a result of invasive species (beaver, deer, broom); other potentially degraded areas
Social and economic	Cultural and archaeological sites, and other areas important to local communities for recreation or other purposes; hunting areas; berry-collecting areas; employment levels; harvest levels; diversity of local employment base; local income levels; community infrastructure; percentage of companies locally owned; distribution of resources among community members and groups; availability of meaningful and satisfying work
Describe natural disturbance regimes and range of natural variability for baselines	Ecosystem processes and functions, and their historic range of variability; seral stage distribution; patch size distribution

The next step (Step 3) is the identification and characterization of significant current and future threats to biodiversity and ecological integrity within the watershed (see Table

4.2). This process aims to focus the discussions on the main ecological issues to ensure that limited resources (time and money) are allocated appropriately to achieve ecosystem-based management goals and objectives.

Table 4.2: Threats to ecological integrity
(adapted from Holt (2001))

Type of pressure	Examples
Currently under threat/pressures	Species, populations, ecosystems, or habitats that are currently rare, threatened or endangered
Potential future threat	Ecosystem components (species, populations, ecosystems, or habitat) that may be rare, threatened or under pressure with current management practices
Sensitive sites (easily degraded or perturbed as a result of disturbance)	Terrain stability, sensitive soils, soil erosion, ecological limitations to growth (such as shallow soils, very dry or very wet sites, broken slopes, riparian ecosystems)
Regional context	Use regional information to provide guidance and context to threats to ecological integrity (e.g. identification of under-represented ecosystems in protected areas)
External impacts	Climate change, and potential cumulative impacts for different land uses

Identification of factors that contribute to social well-being and economic health in communities is the next step (Step 4), (see Table 4.1 for examples).

Step 5 requires the definition of ecological baselines and limitations (e.g., historic range of variability, habitat requirements for certain species) (see Tables 4.1 and 4.2).

The analysis stage (in Step 6) requires that once the ecological information has been collected it must be analyzed to focus the discussions on the main ecological issues (see Table 4.3). This involves interpretation and evaluation of the inventory information collected predominantly in Step 1, but also in Step 2 in order to develop an understanding of the composition and structure of the ecosystems present. The threats to ecological integrity (Step 3) (exemplified in Table 4.2) should be used to focus this analysis since resources (time and money) are limited. At this stage, risk assessment indicators are also developed. The various habitat requirements for indicator, keystone, umbrella or sensitive species are also determined along with the compatibility of the above with the different silviculture system options. Assumptions that are used during the analysis must be explicitly stated. Knowledge gaps are identified through the analysis process, as is the approach by which these gaps will be addressed.

Table 4.3: Analysis of baseline data
(adapted from Holt (2001))

Type of analysis	Examples
Establish ecological baseline	Develop the baseline for the environmental risk assessment based on the range of natural variability (RONV) (e.g. RONV for seral stage distribution, level of connectivity, patch size distribution, level of structure remaining after natural disturbance))
Identify ecologically significant changes in ecosystem components	Identify changes in disturbance regimes, species distributions and ecosystems; compare natural range with current and future trends
Identify key species of concern	Umbrella, keystone, sensitive, indicator, and currently rare species
Identify habitat requirements for key species	For key species, identify habitat requirements, and critical habitat elements
Identify critical ecosystem types	Such as hydroriparian areas that link various ecosystems and landscapes
Capability and suitability	Determine the specific geographic areas for habitat supply, population viability, resource production, and Haida and social values
Knowledge gaps and assumptions	Document knowledge gaps and uncertainties; document the assumptions used in the above analyses.

It is not the purpose of this thesis to formulate a management plan for the Tlell River watershed: to do so would be counter to the central drive of stakeholder development of an appropriate community-negotiated management plan. As stated at the outset, rather the purpose here is to develop a framework for achieving an ecosystem-based management plan for the Tlell watershed. These remaining steps are part of that framework.

Step 7 sees the formulation of the management plan. Resource management alternatives that address the identified pressures and threats must be developed. The information compiled in Steps 1-6 provides the basis for setting objectives, defining management zones and management regimes by identifying the key issues at the appropriate scale. These elements are described in more detail below:

- **Setting objectives**: Objectives are the definition of the future desired conditions for the watershed, including objectives that span all of the spatial scales (e.g. site, stand, and watershed) and an ecological timeframe. All of the assumptions for each objective should be documented to allow testing through adaptive management. An example of an objective would be to maintain important Queen Charlotte black bear habitat features in areas of known high density as shown on Map X.
- **Defining management zones**: through a sequence of spatially locating a network of reserves (large reserves/protected areas for maintaining natural ecological processes, smaller reserves/protected areas for maintaining rare ecosystems); low intensity managed areas; balanced multiple-use managed forest areas; and plantation areas in an effort to minimize the risk to ecological integrity. Identify specific objectives for each of these zones.

- **Management regimes**: definition of management practices for each of the management zones that are consistent with the overall objectives, and the specific objectives for each zone. An example of a management regime or management strategy would be to provide for a 100 m no development buffer that will be maintained around the following black bear attributes (as determined through future inventory): denning sites, concentrated feeding/foraging sites, and primary travel corridors.

The key decisions required to formulate a management plan, and the information needed to guide those decisions are outlined in Table 4.4.

Table 4.4: Developing environmental, social and economic objectives
(adapted from Holt (2001))

Type of protection	Objective	Decision guidance
Large, fully protected reserve	Maintain natural ecological processes. Maintain a collection of functioning ecosystems. Maintain 'baseline' ecosystems.	To determine location of reserve, consider: ➢ Gap analysis of representativeness at the regional level. Consider structural / seral stage in this analysis ➢ Unimpacted 'baseline' ecosystems ➢ Habitats for rare, endangered, vulnerable species ➢ Habitats for key species (umbrella, keystone, indicator) To determine percent protected: ➢ Use RONV[15] to assess the extent of change from natural at the sub-regional scale; consider appropriate risk levels ➢ Use population viability estimates in combination with key habitat requirements for rare, endangered, or vulnerable species; or key species (umbrella, keystone, indicator)
Small, fully	Maintain rare or	To determine location of reserve, consider:

[15] RONV: range of natural variation

Type of protection	Objective	Decision guidance
protected reserve	critical ecosystems or habitats.	➢ Critical or rare habitat components ➢ Critical or rare ecosystems ➢ Areas that provide key connectivity To determine percent protected: ➢ Use extent of rare/critical habitat with risk assessment for each ecosystem or habitat in question.
Full protection with managed landscape	Maintain sufficient key areas to maintain ecological integrity (e.g. to maintain populations throughout their natural range)	To determine location of reserve, consider: ➢ Gap analysis of representativeness at landscape level ➢ Habitats for rare, endangered, or vulnerable species; or for key species ➢ Other resource values such as elk winter range ➢ Critical or rare habitat components ➢ Critical or rare ecosystems ➢ Key ecosystem components such as hydroriparian ➢ Areas that provide connectivity between watersheds To determine percent protected: ➢ Use RONV to assess the extent of change from natural at the sub-regional scale; consider appropriate risk levels ➢ Use population viability estimates in combination with key habitat requirements for rare, endangered, or vulnerable species; or key species (umbrella, keystone, indicator)
Partial protection within the managed landscape	Maintain key elements at the stand level (e.g. wildlife trees, coarse woody debris, bear denning habitat)	To determine location of reserve, consider: ➢ Biologically significant attributes at the stand level (e.g. snags) ➢ Critical or rare habitat components (e.g. bear dens) ➢ Key ecosystem components (e.g. hydroriparian) To determine percent protected, consider: ➢ Natural disturbance patterns ➢ Rates of decay for woody debris ➢ Adequate distances between retained attributes.
Management objectives	Maintain coarse and fine filter	➢ Identify zones to meet overall objectives ➢ Identify conflicts and opportunities using

Type of protection	**Objective**	**Decision guidance**
w/in managed forest	values identified plus connectivity	management regimes
Cultural objectives	Protection of Haida/cultural values	To determine location and percent protected: ➢ As necessary to preserve archaeological sites ➢ Consider overlap with other reserve areas in order to address other cultural values
Economic objectives	Maintain long-term diverse economic values	➢ Diversify the local forest industry for resilience (timber, non-timber forest products, value-added) ➢ Undertake full-cost accounting of alternative values (recreation and tourism) ➢ Make assumptions about trade-offs and risks explicit

In Step 8, the ecological risk must be evaluated and the plan finalised. Through the use of risk assessment, the potential impacts of proceeding with the preliminary management plans are determined as outlined in Step 7. Once the risks that are inherent in alternative management strategies have been identified, they must be assessed for how well they address the threats in the planning area. Similar risk-assessment approaches for socio-economic objectives should also be undertaken. Risk indicators for socio-economic objectives may include harvest or employment levels. Certain strategies may be incorporated into ecosystem-based management in order to minimize the socio-economic risks.

Determination of the production levels based on the management objectives, zones and management regimes from Step 7 determines the sustainable harvest levels (Step 9).

Operational level planning (Step 10) will likely require operational-level field assessments to be completed prior to the development of operational plans.

Implementation typically involves the establishment of various legal land use designations for larger regional ecosystem-based plans. On the watershed level, legal land use designations may not be the most effective method of implementing a more localized ecosystem-based plan.

It is possible to determine if the plan's ecosystem-based management objectives are being achieved by monitoring the ecological integrity and socio-economic indicators (Step 11). Monitoring also facilitates learning through any adaptive management strategies that may have been implemented. Results of the monitoring are used to re-evaluate, and where appropriate, revise inventory and data analysis, assumptions, management objectives, management plans and implementation procedures.

4.1.2 Challenges to implementing ecosystem-based management

4.1.2.1 Human development versus ecological integrity

As with any land or resource use planning process, the challenge in implementing ecosystem-based management is determining how much emphasis will be placed on resource management strategies to maintain and remove threats to ecological integrity, relative to strategies for achieving shorter term social and economic objectives in the short run. This challenge might be over-come by using a systems approach i.e., recognizing the inter-relatedness of all the management elements (social, economic, ecological, and governance) and inter-dependency over both short- and long-term scales to determine the appropriate balance.

What is also important for ecosystem-based management is to ensure that the right kinds of information on ecosystem attributes and functions, and critical thresholds of ecosystem integrity are brought to the planning process. Chapter 3 brings the available information to the table for the Tlell watershed. Similarly, the right kinds of analysis must be conducted so that complete information is available on options for achieving regional level ecological integrity while maintaining social and economic stability, and so that the risks are understood (Ministry of Sustainable Resource Management – Skeena Region, 2001). Section 4.1.1 identifies the essential steps in this process.

Maintaining ecological integrity is the common goal that is shared by all ecosystem-based management approaches from a whole range of value positions and agencies (Holt 2001). However, operationalizing this broad goal is the crux of the planning process, and has been the focus of criticism for a number of plans that have claimed to meet ecosystem-based management goals (Holt, 2001). In Holt's view, in order to be successful, the framework needs to be approached with the intent of maintaining ecological integrity, and to use risk assessments, the precautionary principle and adaptive management to increase the probability that integrity is maintained.

Some critics of ecosystem-based management planning have argued that ecological integrity seems to 'trump' other human goals. A number of authors (Grumbine, 1997; Haynes et al,. 1996; Franklin, 2000; Noss, 1999) agree that over time there is no way to sustain humans on this earth without sustaining nature, particularly because at present we don't know enough to decide what is, or is not, important to maintain. Apart from this, the notion of ethically doing the minimum to modify natural environments and processes that shape them is sound stewardship.

Amongst the scientific community, there appears to be little disagreement that moving further along the continuum from environmentally sensitive multiple-use towards ecosystem-based management is a positive step. Many also agree that making the change from the traditional product-oriented management to a new goal of maintaining ecological integrity, in which sustainability is a precondition rather than an afterthought, requires a fairly major shift in thought and approach to land management (Grumbine, 1997).

Grumbine (1994) notes that many authors neglect to identify some key process-related features of a successful ecosystem-based management plan. For instance, he stresses that the key to a successful plan is ensuring that all parties affected by the plan decision have equal and adequate representation, and that any power imbalances between parties are addressed upfront.

4.1.2.2 Challenges to integrating social and economic considerations in ecosystem-based management

Societal expectations of ecosystems must be integrated within the capabilities of ecosystems (USDA, 1999). There are two fundamental challenges of ecosystem-based management: increasing society's awareness of the limits of ecosystems, and identifying what those limits imply for the management of social well-being and economic health (Grumbine, 1994).

It can be very challenging to define the community's goals and objectives when the stakeholders hold quite often such diverse viewpoints and values. It is important to identify the common interests amongst the stakeholders, rather than the special interests advanced by individuals or groups that may want to address their own needs at the expense of the broader community (Yaffee, 1996). Rather than looking at their differences, stakeholders should focus on the common ground and shared values in a collaborative decision-making process. Stakeholders generally are identified as those operating locally or regionally. Nevertheless, how wide a net should be cast to consider stakeholder identity has never been resolved. Distant shareholders interests are presumably identified through companies operating 'locally'. Consumers' concerns are seldom represented at stakeholder tables other than very indirectly through market assessment by the locally operating companies.

The focus of ecosystem-based management plans should be on attaining long-term sustainable development and community health, rather than short-term financial benefits. Economic health is important for sustainability, but must be considered within ecological limits (Yaffee, 1999). Full cost accounting methods should be used in economic analyses to ensure that environmental and social costs are accounted for (Lee, 2001).

Since social, economic and environmental systems are dynamic, ongoing monitoring and adaptive management are critical to the success of ecosystem-based management. The collection of reliable data for these systems over the long-term is very costly and sufficient resources must be allocated to ensure that ecosystem-based management is implemented properly (Wilson, 2002).

Since humans play a vital role in ecosystem-based management (Lee, 2001), it is important not to ignore the needs of humans, their communities, and their diverse value systems. Wilson (2002) warns that if the human aspect of ecosystem-based management is not given sufficient attention, it can easily undermine ecosystem-based management and impede its implementation.

Clearly articulated and carefully targeted sustainable goals and objectives are required for ecosystem-based management. These goals, which have been developed and supported by the communities, can drive the process towards achieving the social and economic health within the ecosystem's natural limits. There is a considerable amount of uncertainty in measuring social and economic factors that, in turn, makes it difficult to assign appropriate targets for these factors (Maclaren, 1996). It must be decided which key indicators adequately represent the social and economic conditions in the area in question.

For these reasons, the Tlell LRUP WG suggestion is to rely on the concept of adaptive management and, to some extent, the precautionary principle: act cautiously and make subsequent adjustments based on the application of methods tested and found successful in similar environments. We do not know everything that there is to know about the ecosystems in the Tlell River watershed. Diligent monitoring and evaluation of practices will be necessary for the successful implementation of these concepts.

4.1.2.3 Tlell LRUP working group concerns

Through the Tlell LRUP process, the LRUP WG (WG) was seeking to define forest practices that are ecologically sound, operationally achievable, economically viable, publicly acceptable, and safe.

The WG recognized the important influence of human values and interests (of both Haida and non-Haida people) on the management of resources in the Tlell. The WG had spent considerably more effort and resources on attempting to understand the biophysical aspects and values in the watershed rather than on the economic, scenic, recreational, spiritual, cultural, and tourism values in the watershed. As a result, the physical environment of the Tlell watershed is described in depth, whereas the descriptions of the economic and community values are brief. Also, given that this is a Masters of Science thesis, a greater emphasis has been placed in the natural sciences, with the aim that this framework can be used, in part, to inform management decision-making.

The overall approach of an ecosystem-based plan is to ensure long-term economic viability and community benefits by recommending forest practices that maintain ecosystem integrity, while allowing for economic activities and other community benefits. The WG recognized that in order for economic viability and community stability to be a reality, there will be impacts to ecosystems in the Tlell River watershed.

An ecosystem-based plan for the Tlell must aim to balance the three critical 'pillars' of sustainability: the need to ensure the economic viability of development in the watershed; the necessity for the Tlell watershed to contribute to community stability and quality of life for the Islands; and the necessity to maintain functioning ecosystems. The WG recognized that this balance would be challenging to achieve. In recognition of this challenge, the WG recommended the close monitoring of biophysical, economic and social performance indicators during the implementation of an ecosystem-based plan, and stresses the importance of learning from experiences during implementation. A 5-year term was also being considered for an ecosystem-based plan. After 5 years of implementation of the plan, an independent assessment should be made to determine the effectiveness of the plan's ability to meet its goal of sustainability.

It is clear that from the current forest and non-forest knowledge base regarding the Tlell watershed, operational inventories must be expanded to include the status, abundance, and distribution of resources and values in the Tlell watershed, and the critical factors that affect timber harvesting and other uses of resources in the watershed.

An effective monitoring program and adaptive management practices must be implemented to potentially improve forest practices and procedures as experience and knowledge are gained. Equally, resource management policies that reflect human values, understanding, and knowledge at a particular point and time, must be reviewed and revised to keep pace with changes in these considerations. Furthermore; information and education are essential for successful implementation of new forest practices standards.

The Tlell LRUP WG was amongst those at the forefront of ecosystem-based planning in British Columbia – but built on significant process development garnered through work at the watershed level undertaken by the Silva Forest Foundation (particularly the Cortes Island, the Harrop-Proctor watershed, and the Slocan Valley plans). Ecosystem-based planning is now being undertaken at the regional level with the North Coast LRMP after initial attempts were made with the Central Coast LRMP. Full implementation of what some members of the LRUP WG envisioned may not be achievable, but the Community Forest Board has inherited a leading-edge ecosystem-based planning framework tailored to the Tlell River watershed along with a phenomenal information base.

5.0 CONCLUSION

The thesis project has delivered a report addressing the following items:

- a literature review of ecosystem-based planning including key ecological concepts, and forest ecosystem integrity;
- a brief summary of the planning and planning processes that have occurred to date in the Tlell River watershed;
- summarization of the science-based and other information that is already known about the Tlell River watershed;
- a planning framework has been put forward to highlight the key issues and decisions that need to be considered in order to operationalize successfully an ecosystem-based plan for the Tlell River watershed. The planning framework will also identify how the science-based information can best be used in an ecosystem-based plan for the Tlell River watershed; and
- identification of possible barriers to successful ecosystem-based planning in the Tlell River watershed.

In summary, this document (and the Tlell LRUP WG) recommends that an ecosystem-based approach be used to manage the forest resources of the Tlell River watershed. The main objective of sustainable ecosystem management relies on good forest management based on the following themes:

- Maintain watershed integrity:
    - maintain waterflows and critical elements of water quality within the range of natural variability; and

- maintain the stability and productivity of soils.

- Maintain biological diversity:
  - create managed forests that retain near-natural levels of biological diversity, and ecological function (recognizing that natural systems are dynamic);
  - maintain viable populations of indigenous species; and
  - maintain the species, populations and processes associated with late-successional forests (to the extent that they are within the range of natural variability).
- Maintain cultural values
  - maintain areas and sites significant to the Haida and other Islanders.
- Maintain scenic, recreational, and potential tourism values
  - maintain areas of significant scenic, recreational and tourism values.
- Be sustainable
  - provide a sustainable flow of timber products (and potentially non-timber products) from the managed forests of the Tlell watershed.

In this document, reference is made to "functioning" ecosystems or ecosystem "integrity". These terms are meant to signify functioning, self-sustaining systems, which, despite changes as the result of unnatural (i.e. human-induced) manipulations, remain within the limits and capabilities of the ecosystem to return to a state within their range of natural variability. These are concepts that connect a scientific understanding about the state or properties of a system with a social value about the desired state. However, it is difficult to define a normal state for ecosystems that are also subject to natural disturbances. Scientific methods can describe changes to a system in response to disturbances in terms of magnitude and frequency, and can determine causal mechanisms for most major disturbances, but the question of whether the system has maintained its "integrity" remains a question of value and interpretation. Managing forests requires the recognition and incorporation of human objectives for the system, even when a conscious attempt is made to ground management firmly in ecological principles.

It is expected that the development of an ecosystem-based plan will form the basis of a mutually productive working relationship between concerned citizens, resource stakeholders, community stakeholders, and government agencies for both forest and non-forest interests.

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7.0 APPENDICES

Appendix A: The Tlell Local Resource Use Plan (LRUP) process and the players

The Tlell LRUP process has allowed the formation of constructive relationships between members with different interests and values. Given these relationships, this community-based planning process has helped to pave the way for any future Islands land-use planning processes.

The LRUP WG has completed a substantive body of work:

I. Map folio:

Over 40 reference maps for features in the Tlell watershed have been generated by the technical committee (a sub-committee of the working group consisting of LRUP WG members), based on specifications approved by the LRUP WG. These maps will be used to identify zoning requirements and management objectives by the LRUP WG. The LRUP WG has also developed a map folio of the sensitivities in the watershed that will further aid with negotiations regarding management objectives. The following is a list of the mapped sensitivities that have been agreed to by the LRUP WG:

- sensitive hydrological features including the spillway and floodzone,
- fire legacy stands (stands that survived the fire that went through the Tlell watershed in the 1840s),
- bear spring forage,
- unstable and potentially unstable terrain,

- berry potential,
- wetlands,
- monumental cedar,
- sandy soils,
- red- and blue-listed plant communities, and
- recreational trails.

II. Interim Development Plan:

An interim development plan for Tree Farm Licence (TFL) 39 was developed by the LRUP WG to alleviate immediate pressure for employment for MacMillan Bloedel Ltd. employees (now Weyerhaeuser Co. Ltd.).

III. Key documents:

The following key documents have been developed:

- terms of reference: describes the mandate for the Tlell River LRUP; and
- summary of interests: summarizes the LRUP WG members collected interests for the Tlell River watershed.

The following is a list of participant stakeholder groups that were part of the identification of interests and resource information-collecting phases through the Tlell LRUP WG:

- Ministry of Forests, Queen Charlotte Islands (QCI) Forest District,
- Ministry of Environment, Lands and Parks, QCI Forest District,

- Department of Fisheries and Oceans,
- Council of the Haida Nation,
- MacMillan Bloedel Ltd. (now Weyerhaeuser),
- Small Business Loggers Association,
- Ministry of Forests QCI Forest District Small Business Forest Enterprise Program,
- Local government (representatives from the Regional District and Islands town councils),
- Islands Community Stability Initiative Board (elected board with 50% Haida and 50% non-Haida with representation from every community and rural electoral area on the Queen Charlotte Islands/ Haida Gwaii),
- Islands Forest Council (technical staff of the ICSI Board charged with involvement in strategic level planning on the Queen Charlotte Islands),
- Tlell Watershed Society (non-profit environmental non-government organization (ENGO)),
- Gowgaia Institute (ENGO),
- QCI Steelhead Society (ENGO)
- International Woodworkers Association (IWA) Local, and
- Interested public.

Appendix B: Socio-economic component of the ecosystem-based plan

Wilson (2002) suggests the following framework for the inclusion of social and economic considerations into an ecosystem-based management plan. These steps will ensure a plan that aims at building social well-being and economic health within safe ecosystem limits.

1. Interaction with all stakeholders and decision makers to develop their awareness of the key components of, and relationships between, economic, social and ecological systems;
2. Analysis of current levels of social well-being, economic health and ecological integrity within the plan area;
3. Development of a set of social and economic goals which reflect the values held by all stakeholders and are directed towards social well-being, economic wealth, and ecological integrity;
4. Identification of any discrepancies between the stakeholders goals and the current social, economic, and ecological conditions;
5. Development of a plan to address any discrepancies noted above;
6. Development of social, economic, and ecological indicators to measure progress towards the goals and objectives; and
7. Implementation, monitoring and adaptation, as necessary, of the ecosystem-based plan during the ongoing learning process.

Appendix C: Indicators for social, economic and ecological goals in an ecosystem-based plan

Maclaren (1996) proposes some indicator selection criteria. Indicators should be:

- representative (monitor and measure progress over a broad range of conditions),
- responsive (must signal only changes which measure movement away from historical patterns),
- relevant to the users,
- based on sound and objective data,
- understandable by all users,
- comparable to targets,
- comparable with indicators in other jurisdictions,
- cost-effective, and
- unambiguous.

Refer to the next page for examples of social well-being and economic health indicators.

Examples of social well-being indicators

Social resiliency	**Community capacity**	**Quality of life**	**Empowerment with responsibility**
Education attainment levels	Number of community volunteers	Divorce rates	Number of public meetings held
Unemployment rate	Availability of community information	Crime rates	Voter participation
Population size	Number of volunteer, non-profit organizations	Literacy rates	Percentage of local planning processes that require public participation
Population growth rates	Youth involvement in community service	Average housing prices	Resident involvement in civic activities
Population age structure	Community infrastructure (schools, libraries, hospitals)	Substance abuse rates	# of communities with co-management or stewardship responsibilities
Cultural characteristics of the population		Access to health care	
Percentage population in professional occupations		Hospital beds per capita	

(Adapted from: Wilson, 2002)

Examples of economic health indicators

Economic resiliency	**Self-reliance**	**Equity**
Diversity of local employment base	Number of home businesses	Income levels
Dominant manufacturing or extractive industry	Percentage of companies locally owned	Incidence of low income
Community balance of imports and exports	Real estate values	Average family income
Retraining opportunities	Percentage of population self-employed	Median income levels
Unemployment rate	Personal debt levels	Unemployment rate by gender
Employment programs	Public debt	Percentage of families without independent dwellings
Skill development	Ratio of full-time to seasonal workers	
	Bankruptcy rates	

(Adapted from: Wilson, 2002)

Appendix D: Biophysical environment of the Tlell River watershed

North of highway 16, the eastern side of the watershed is mainly located within the Naikoon Provincial Park boundary with a few small parcels of private land (Ministry of Forests, forest tenure and ownership maps, inventory update 1998). Limited logging of the private land areas has occurred to date. The western side, north of Highway 16 is mainly private land with rural development: Beitush Road runs parallel to the Tlell within the riparian zone. Private land within the community of Tlell also extends immediately south of Highway 16, extending approximately 3 km south of the bridge crossing, including rural and agricultural development along Richardson and Wiggins Roads.

South of Highway 16, the majority of the Tlell watershed is Crown land that is part of the Timber Supply Area (TSA) for the Queen Charlotte Islands with the exception of clearing for ranching and rural development (Ministry of Forests forest cover maps, inventory update 1998). The upper portion of the Tlell watershed is located within the adjacent Tree Farm License (TFL) 39, owned by Weyerhaeuser, formerly MacMillan Bloedel. A series of old settlers' trails are located to the east of the lower end of the Upper Tlell River and several parcels of private land are present in this area (T. Husband, personal communication, 1999).

To date, little logging has occurred in the Tlell watershed. Logging activities have not taken place in the TSA portion of the watershed (Ministry of Forests forest cover maps, 1998). Some private lands adjacent to Highway 16 have been logged for urban, agricultural and forestry development, and one parcel of private land in the Upper Tlell was selectively logged by helicopter in 1998.

Appendix E: Climate and hydrology

The weather and climate of the Tlell River watershed are strongly influenced by the watershed's proximity to the Pacific Ocean, in particular the Hecate Strait, and by the rainshadow effect from the Queen Charlotte Range to the west.

The Tlell River system has a rainfall-dominated hydrologic regime with peak flows occurring from mid-September to late March (M. Milne, Hydrologic assessment of the Tlell River Watershed, submitted to Tlell Watershed Society, February 2000 draft). Snow accumulation can occur at elevations above 250 to 300 m (B. Eccles, personal communication, 1999).

In the winter, a succession of frontal storms moves onto the west coast of the Queen Charlotte Islands, resulting in prolonged and heavy precipitation. Although the Tlell River watershed is somewhat in the lee of the Queen Charlotte Range, areas of the Tlell watershed that are within the Skidegate Plateau receive considerable precipitation during the winter months. Storms from the southeast also impact the watershed and bring high wind events that can cause windthrow in less windfirm stands.

Throughout the year, the ocean moderates temperatures so that winters are relatively mild and summers are relatively cool. Prolonged periods of subzero weather are unusual. Intense winter rain generates the highest stream discharges, particularly when it falls on melting snow ("rain-on-snow events") (B. Eccles, personal communication, 1999).

While there is no dry season, the summer months are relatively dry due to prevailing high-pressure systems and the decreased frequency of storms.

Heavy rainfall delivers large volumes of water onto slopes in the headwaters of the Tlell watershed. The extent of forest cover influences the total annual runoff of water, and, in many instances, the timing and peak of storm runoff (M. Milne, personal communication, 2000).

A summary of the hydrologic cycle and possible land-use effects on components of the cycle follows in order to form a basis for the discussion of the current Tlell River watershed condition and sensitivity to future forest development.

The following four processes and allocations by which water moves through the watershed to become streamflow are based on information provided in the unpublished report entitled "Hydrologic assessment of the Tlell River Watershed", authored by Dobson Engineering Ltd. and submitted to the Tlell Watershed Society, February 2000:

- channel interception – precipitation that falls directly on the channel surface comprising only a small part of a storm hydrograph (typically less than 2% of annual runoff);
- overland flow -water that flows directly over the land surface. In well-vegetated areas overland flow is rare (typically less than 10% of annual runoff), as soil infiltration rates are usually higher than maximum rainfall intensities;

- subsurface flow - water that infiltrates the soil and is intercepted by a relatively impervious layer forcing it to flow laterally downslope (represents the majority of the storm flow); and
- baseflow - portion of precipitation that infiltrates deep into the soil or bedrock that sustains streamflow during dry periods (low flows) (typically less than 5% of annual runoff).

Timber harvesting and road construction can affect water yield (quantity), peak flow duration, magnitude and timing, erosion rates, lowflows, and water quality. If large enough, these increases in flow can impact channel conditions causing channel scour, channel widening, bank erosion, infilling of pools and creation of extensive bar deposits, etc. (Dobson Engineering Ltd., unpublished report, February 2000).

The following provides further details regarding the hydrological information for the Tlell River watershed:

- Small first and second order channels in the upper sub-basins of the Tlell watershed are characterized by coarse sediment input from natural bank failures with transport to downstream low gradient channels (Dobson Engineering Ltd., unpublished report, February 2000). Small marshlands and lakes are present throughout the upper sub-basins serving to trap sediment larger than silt and clay. Mainstem channels in the upper sub-basins are typically low gradient with short sections of bedrock and boulder control, and sometimes canyon confinement (Dobson Engineering Ltd., unpublished report, February 2000). Natural bank failures with some larger landslides are common through deeply incised reaches. All sub-basin mainstem channels drain into the Pontoons where a series of meandering alluvial channels and small ponds are present. Coarse sediment transported into the Pontoons is deposited and it is unlikely that sediment larger than fine sand is transported through this area (Dobson Engineering Ltd., unpublished report, February 2000).

- The Tlell River downstream of the Pontoons is an underfit stream incised into an historic glacial meltwater channel and outwash estuary (Dobson Engineering Ltd., unpublished report, February 2000). Numerous large debris jams are present from the Pontoons to the mouth where minor channel erosion and fine sediment deposition occurs (L. Lee, personal communication, 2000). The tide influences the lower channel for approximately 9.6 km upstream from the mouth where flooding is common due to the combined effects of high tides and high stream flows (Dobson Engineering Ltd., unpublished report, February 2000).

Dobson Engineering Ltd. (unpublished report, February 2000) makes recommendations regarding watershed restoration, and any future forest development in the watershed. A number of the recommendations regarding the rate of cut and the equivalent clearcut area[16] (ECA) in an early draft of the report were highly contentious, resulting in these recommendations being dropped from the final report.

[16] Equivalent clearcut area (ECA) is a model used to provide a threshold of activities (harvesting and road building) that can be allowed in a watershed.

In a summary of 95 paired catchment studies in the United States, Stednick (1996) suggests that as little as 15% of the catchment area could be harvested for a measurable increase in annual water yield at the catchment level in the Rocky Mountain region in contrast with 50% in the Central Plains, although the system responses are variable.

In a study of changes in storm hydrographs after road building and clear-cutting in 6 small watersheds in the Oregon Coast Range, Harr et al. (1975) concluded that peak flows were increased significantly after road building, but only when roads occupied at least 12% of the watershed. Roads had no detectable effect on volumes of runoff of storm hydrographs. By reducing transpiration and interception, clear-cutting increased peak flow, delayed flow, and total storm hydrograph volume of some of the streams in the study (Harr et al., 1975). Most of the increases were largest in the fall when maximum differences in soil water content existed between cut and uncut watersheds.

Appendix F: Hydroriparian areas

Landscape ecologists describe riparian strips in forest landscapes as "corridors" because they differ substantially from the surrounding upland areas on both sides (Ministry of Forests Research Program – Prince Rupert Forest Region, 1998).

The following information is collected from the Jim Pojar (Prince Rupert Forest Region (PRFR) – Ministry of Forests regional ecologist) / Phil LePage (PRFR regional silviculturist) ecosystem function workshop held in May 1999; the Tlell LRUP functional riparian features workshop held in November 1999 with Dave Daust[17], Karen Price[18], and Phil Burton[19]; some of the findings of the Clayquot Sound Scientific Panel; and from various readings suggested by those knowledgeable in riparian ecosystems.

By protecting the integrity of the aquatic and riparian ecosystems, a protected zone also forms the skeleton of a continuously connected forest environment that allows the movement of animals and plants through the landscape, including connectivity into adjacent watersheds (Clayquot Sound Scientific Panel, 1995). Harris states "*riparian corridors are important for preserving biodiversity at the landscape level*" (as cited in Ministry of Forests Research Program – Prince Rupert Forest Region, 1998, p.5). Stevens et al. (1998) state, "*In British Columbia, 59% of rare, threatened, and*

[17] Dave Daust is a registered professional forester and holds a masters degree in conservation biology. One of his areas of expertise is landscape modeling, including riparian management at a large scale.
[18] Karen Price is a behavioural ecologist and conservation biologist. Karen worked in Clayquot Sound on a community-based research project with the Science Panel developing riparian management recommendations for riparian area management.
[19] Philip Burton, Ph.D, is a plant ecologist and works as a consultant with Symbios Research based out of Smithers, BC. He is also an adjunct professor in the Department of Forest Sciences at the University of British Columbia.

endangered species have all or part of their habitat needs met by riparian areas." (as cited in Ministry of Forests Research Program – Prince Rupert Forest Region, 1998, p.5).

Forest cover has a dramatic effect on the microclimate conditions in the stream. Some climatic factors change more rapidly than others do with distance into the forest from an edge (J.Pojar, personal communication, 1999). The major micro-climatic factors of interest are solar radiation and air temperature, both of which influence stream temperature, soil moisture and soil temperature. Major changes to these factors occur over a distance of 50 m; although a substantial portion of the riparian forest effect on the stream channel occurs within about 30 m of the streambank (Clayquot Sound Scientific Panel, 1995). Based on these factors and depending on the site circumstances, according to the Clayquot Sound Scientific Panel (1995), a special management zone of up to 30 m on each side of the steam may also be necessary in order to protect the hydroriparian reserve from windthrow. The Panel also suggests that a combined reserve and special management zone of 60 m would also attenuate ground-level humidity fluctuations, light levels, and wind along the stream. A 30 m hydroriparian reserve on each side of the stream is ample to ensure the provision of litterfall and large woody debris to the stream, shade, and root strengthening of stream banks (Clayquot Sound Scientific Panel, 1995).

Appendix G: Soils and slope stability

The Coastal Western Hemlock wet hypermaritime (CWH wh1, wh2) zones are the two biogeoclimatic zones within the Tlell watershed. A variety of soils can be found within these variants, although loamy humo-ferric and ferro-humic podzols are most common (A. Banner, unpublished paper, 1989).

On upper slopes and well-drained ridgecrests in the headwaters of the Tlell, folisols and podzols can occasionally be found (A. Banner, unpublished paper, 1989). The areas on middle to toe slopes and on active alluvial landforms are more common, where intermittent or constant lateral flow of mineral seepage provides a turnover of nutrients and ensures adequate soil aeration. Repeated erosion and deposition of alluvial sediments and soil mixing from colluvial action and windthrow are characteristic on these sites (A. Banner, unpublished paper, 1989).

In areas with poorly drained, gently undulating to flat terrain - predominant in the Hecate Lowlands ecosection portion of the Tlell watershed - gleyed podzols, gleysols and organic soils are common (A. Banner, unpublished paper, 1989). Throughout the Pontoons and in the lowlands in the northeast portion of the watershed, wetlands, extensive bogs, marshes, and swamps exist (A. Banner, unpublished paper, 1989).

Maintaining the organic matter of forest soils is critical because it contains virtually all of the available nutrients, has high water-absorbing and water-retaining capability, improves soil porosity and permeability, and protects the mineral soil from surface erosion (Ministry of Forests, 1994).

Appendix H: Fish and fish habitat

The following bullets are summarized from the unpublished report entitled *TSA portion of the Tlell River Watershed: Reconnaissance (1:20,000) Fish and Fish Habitat Inventory* prepared by L. Lee, M.T.E. Enterprises for the Haida Fisheries Program in 1999:

- A 5 m high vertical rock falls is located just downstream of an incised canyon (Reach 11) in the Upper Tlell mainstem upstream of Lella Creek and is a barrier to anadromous fish migration. Upstream of the falls, resident fish are present: Cutthroat trout have been caught in previous fish sampling conducted by the Tlell Watershed Society (TWS) (L. Lee[20], personal communication, 1999).

- The TWS has established a permanent fish sampling and channel-monitoring site downstream of the falls on the Upper Tlell mainstem. Coho salmon, cutthroat trout, rainbow trout, Dolly Varden char, three-spined stickleback, steelhead, and lamprey are known to use the habitat up to the falls (Haida Fisheries Program, unpublished report, 1999).

- The TWS has a fish sample and channel monitoring site on the Lella Creek mainstem (maximum 400 m elevation) - Coho salmon, cutthroat trout and Dolly Varden char were found in previous sampling. The lower reaches of the major tributary, flowing in on the left-hand bank appears to have been affected by

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[20] Lynn Lee is a fisheries biologist, director of the Tlell Watershed Society, and member of the Tlell LRUP working group and technical committee.

beaver activity and it is unknown whether anadromous fish have access upstream in this tributary (Haida Fisheries Program, unpublished report, 1999).

- The Pontoons area is a large wetland complex that becomes seasonally flooded during high water stages. The Survey/Three-Mile and Feather Creek sub-basins drain into the south end of the Pontoons (Haida Fisheries Program, unpublished report, 1999).

- Random sample sites are concentrated in the lower reaches of tributaries to the Pontoons. Local knowledge indicates that numerous overflow channels exist between the lower reaches of Feather and Survey Creeks (Haida Fisheries Program, unpublished report, 1999).

- The Lower Tlell , downstream of the Pontoons, is located on a historic estuary complex within a plains setting with very low rolling hummocks and a maximum elevation of approximately 65 m. Fish are expected to use all tributaries of the Lower Tlell watershed due to the extremely low gradients and limited development (Haida Fisheries Program, unpublished report, 1999).

- The Geikie Creek drainage is located in a plains setting with a maximum elevation of approximately 50m. Previous sampling by the TWS in Geikie Creek, downstream of the southernmost Highway 16 crossing, caught coho salmon juveniles (Haida Fisheries Program, unpublished report, 1999).

Appendix I: Wildlife – Species at risk

Keen's long-eared myotis (*Myotis keenii*) is restricted in distribution to the coastal forests of the Pacific Northwest and has one of the smallest geographical ranges of any North American species of bat (PRIAMC, unpublished report, 1999). Knowledge of the bat's basic behaviour and habitat is mostly speculative since little research has been conducted on this species (MOF and MELP, 1997). The Keen's long-eared myotis has been observed in low elevation mature and old growth forests, but its forest structural stage requirements are unknown (MOF and MELP, 1997). The species has red-listed[21] status in B.C. due to its limited distribution, apparent rarity and the lack of knowledge about its basic biology (PRIAMC, unpublished report, 1999). No specific inventories or assessments have been completed on this species in the Tlell River Watershed.

The sandhill crane is a blue-listed[22] species because of its lack of data on breeding populations, its habitat loss, and the degradation of habitat in other parts of the province (MOF and MELP, 1997). It roosts and feeds in open wetland areas such as bogs, swamps, marshes, estuaries, fens, and dry upland areas. It nests in secluded freshwater wetlands that are surrounded by forest cover (MOF and MELP, 1997). No specific

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[21] Red-listed species: In BC, the designation of an indigenous species, sub-species, or population as endangered or threatened because of its low abundance and consequent danger of extirpation or extinction. Endangered species are any indigenous species threatened with imminent extinction or extirpation throughout all or a significant portion of their range in BC. Threatened species are any indigenous species that are likely to become endangered in BC if factors affecting that vulnerability are not reversed.

[22] Blue-listed species: In BC, the designation of an indigenous species, sub-species, or population as being vulnerable or at risk because of low or declining numbers or presence in vulnerable habitats. Included in this classification are populations generally suspected of being vulnerable, but for which information is too limited to allow designation in another category.

inventories or assessment have been completed on this species in the Tlell River watershed.

The Queen Charlotte black bear (*Ursus americanus charlottae*) may be at risk in some areas of the islands (PRIAMC, unpublished report, 1999). Hunting pressures, ecosystem fragmentation, loss of critical habitat and increased human access are potential threats to the species.

Research on black bear ecology in the Queen Charlotte Islands-Haida Gwaii or in the Tlell watershed has not been undertaken. Population densities have been estimated to be from one bear per two square kilometres to one bear per five square kilometres (A. Cober[23], Ministry of Environment, Land and Parks (MELP), personal communication, 1999). Using these figures as a broad indicator, it is estimated that the Islands bear population is in the order of 1940 to 4850 individuals.

The forest ecosystem specialist based on the Queen Charlotte Islands, has identified spring foraging habitat and denning habitat as being the two most critical habitat requirements that are likely to impact resource use planning in the Tlell River watershed (A. Cober, MELP, personal communication, 1999?):. The following riparian ecosystem-types have been identified as potential spring foraging habitats (A. Cober, MELP, personal communication, 1999):

12 western redcedar/Sitka spruce – skunk cabbage

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[23] Alvin Cober, R.P. Bio., is the forest ecosystem specialist for the Ministry of Environment, Land and Parks based in the Queen Charlotte Islands Forest District. He was also a member of the Tlell LRUP working group and the technical committee.

07 Sitka spruce – lily-of-the-valley

08 Sitka spruce – trisetum

09 red alder – lily-of-the-valley

Cober (personal communication, 1999) identified the following habitats as potential black bear denning habitat:

- western redcedar trees greater than 1 m in diameter, ideally with heart rot
- stands that are > 250 years old in the following ecosystems:
    - 03 western redcedar/Sitka spruce – sword fern
    - 04 western redcedar/western hemlock – salal
    - 05 western redcedar/Sitka spruce – foamflower
    - 06 Western redcedar/Sitka spruce – conocephalum

According to an unpublished article (1997) entitled "Guidelines for maintaining denning habitat for coastal black bears at the stand level" written by H. Davis of Artemis Wildlife Consultants of Westwold, BC, black bears in coastal British Columbia tend to den in structures made of wood - either in hollow standing trees, stumps or pieces of coarse woody debris (CWD).

A potential black bear habitat map based on terrestrial ecosystem mapping (TEM) information, TFL management plan #8 information, and TSA forest cover information used for Timber Supply Review II has been prepared that identifies areas in the watershed that have the potential to provide a source of early spring food for bears, and denning habitat. This map is based on criteria provided by A. Cober (Ministry of

Environment, Land and Parks, Queen Charlotte Forest District). The map identifying the location of bear spring forage has been agreed to by the WG as part of the map folio that illustrates the sensitivities within the watershed.

Little is known about the nesting ecology of marbled murrelets (*Brachyramphus marmoratus*). The marbled murrelet is a small seabird found in coastal areas of the eastern Pacific Ocean from Alaska to central California (MOF and MELP, 1997). It spends the majority of its time at sea, where it feeds on small ocean fish such as sand lance and herring (MOF and MELP, 1997). Locally, these birds nest on branches of old growth trees on the large platforms created by festooned moss growths (PRIAMC, unpublished report, 1999).

Marbled murrelets are listed as a threatened species by COSEWIC and a red-listed species by the BC Conservation Data Centre (1999). The primary threats to this species are considered to be the loss of nesting habitat from old-growth forests and at-sea mortality caused by gill-netting and oil spills (MOF and MELP, 1997; Rodway et al., 1991).

The Queen Charlotte goshawk (*Accipiter gentilis laingi*) is a subspecies of the northern goshawk (MOF and MELP, 1997). It is a red-listed species because its population is sparse, restricted to coastal forest, and heavily reliant on mature to old-growth forest (MOF and MELP, 1997).

Murrelets and goshawks are also designated as 'identified wildlife' species in the *Forest Practices Code of BC Act* (FPC) (MOF and MELP, 1997). Management guidelines in the FPC suggest that special consideration should be given to the protection of murrelet and goshawk nesting habitat. To date, little inventory work has been completed on either species in much of the Tlell River watershed.

The home range for the Queen Charlotte goshawk is composed of nest sites, nest areas, a post-fledging area and a foraging area. The nest area is usually characterized by large, old trees with a dense canopy cover and is at the centre of all breeding movements and behaviours (MOF and MELP, 1997). The post-fledging area surrounds the active nest area and a number of alternate nest areas (MOF and MELP, 1997). The typical goshawk foraging area is estimated to occupy about 2 400 hectares and usually contains a diversity of landforms and forest cover types (MOF and MELP, 1997).

A preliminary species-habitat model was completed for goshawks; however there was not sufficient data for the Queen Charlotte Islands to develop a similar model for murrelets (YUNI Environmental Consulting, unpublished draft report entitled "Northern goshawk and marbled murrelet habitat mapping for the Tlell River Watershed, Queen Charlotte Islands/Haida Gwaii, British Columbia" (draft), 1999). Both the goshawk species-habitat model and a habitat summary for murrelets were used to develop preliminary habitat ratings for each species for ecosystem units in the Tlell River watershed. The rated ecosystem units were applied to the 1:20,000 TEM maps (1999) that were produced for the Tlell watershed. Goshawk and murrelet habitat ratings in the Tlell were ground-truthed and verified for accuracy during 1999.

Mature forests characterized by larger stand sizes are often associated with goshawk nest sites. The number of potential nesting platforms in a stand has been identified as one of the main habitat attributes in determining murrelet habitat suitability. Potential nesting platforms met the following attributes: platforms > 18 cm in diameter on trees > 60 cm dbh (YUNI Environmental Consulting, unpublished draft report, 1999). In a study conducted by the Canadian Wildlife Service on the Queen Charlotte Islands, Rodway et al. (1991) noted that marbled murrelets were detected in most of the old-growth areas that they sampled, whereas the number of marbled murrelet detections was very low in second growth forest (40-60 years old).

TEM-based species-habitat maps were produced for the Tlell River watershed for both murrelets and goshawks. The species-habitat maps identified areas in the southern half of the Tlell River watershed, or the western portion of the combined Yakoun and Tlell River watersheds as having the best quality nesting habitat for both species (YUNI Environmental Consulting, unpublished draft report, 1999).

Goshawks are considered more habitat generalists than murrelets and, consequently, utilize a greater variety of habitat types and structural stages (YUNI Environmental Consulting, unpublished draft report, 1999). Generally, field assessments suggested that structural stages 1-4 provided little, if any, nesting habitat value for goshawks, while structural stages 1-5 were not of value for murrelets (YUNI Environmental Consulting, unpublished draft report, 1999).

One goshawk nest has been found in the Tlell watershed, in the Survey Creek area, at a low elevation, and on a moderate southwest slope. The active nest was found in an old growth area in the CWH wh1 (01) site series (western hemlock/Sitka spruce – lanky moss) (YUNI Environmental Consulting, unpublished draft report, 1999). All other goshawk nests on the archipelago have been found on SW facing aspects in old growth forest (YUNI Environmental Consulting, unpublished draft report, 1999). No evidence of marbled murrelet nesting was found in the Tlell River watershed (YUNI Environmental Consulting, unpublished draft report, 1999).

With regards to marbled murrelet, McLennan et al. (2000) used the following general descriptions of stands in the different habitat suitability classes for mapping purposes:

Habitat suitability class	**Stand description**
No value	Non-forested and recently cut areas
Poor	Young stands (mostly structural stages 3-8) regeneration after harvesting or natural disturbance; some age class 9 stands occur in this class: these stands are generally above 300 m elevation, have a height class of 1-2, and a canopy closure class of 1-2
Fair	Mostly age class 9 stands that are height class 3, or height class 4 with overly dense or open canopies
Good	Mostly age class 9 stands that range from height class 4 to 6 with desirable canopy closure
Superior	This describes only a few stands that are age class 9, height class 7 and have a canopy closure class range of 4-6.

Source: McLennan et al., (2000), p.11.

Maps identifying potential marbled murrelet habitat and potential northern goshawk habitat in the watershed have been produced for use by the Working Group (Tlell LRUP technical committee, unpublished potential marbled murrelet and northern goshawk habitat maps, 2000).

Appendix J: Wildlife – Introduced species

Sitka black-tailed deer (*Odocoilius hemionus sitkensis*) were first introduced to the Queen Charlotte Islands-Haida Gwaii in the early 1900's, and several times between 1911 and 1925 (Sharpe 1999). Deer are now found throughout the islands. Although population density and dynamics, and the seasonal movements of deer on the islands have not been adequately studied, current population estimates are about 60,000 individuals (PRIAMC, unpublished report, 1999).

The density and persistence of deer could have a long-term ecological effect on the islands. Deer browsing pressure has led to reduced abundance and vigour of shrub, fern and herb communities (Pojar, 1999). Some plant species such as devil's club and skunk cabbage have become rare and the regeneration of redcedar and yellow-cedar has also been affected (Pojar, 1999). Deer effects have also resulted in changes to the availability and quality of habitat for indigenous wildlife such as black bear, Haida ermine, small mammals, ground-nesting and ground-feeding birds, the boreal toad and various species of micro-fauna (PRIAMC, unpublished report, 1999). These changes in habitat have likely reduced the abundance and distribution of some species of endemic wildlife.

Deer hunting is permitted on the Queen Charlotte Islands, but even with the liberal hunting quotas, this seems to have had little effect on reducing the deer population (PRIAMC, unpublished report, 1999). Sharpe (1999) notes four major management options that have been considered for reducing deer impacts: mechanical barriers, nontoxic chemical repellents, silviculture techniques for habitat modification, and deer population control. Each of these options has both positive and negative impacts for the ecosystem as a whole.

Racoons were introduced to Graham Island in 1946. Their range, still expanding, now includes Moresby Island and a number of the smaller islands (PRIAMC, unpublished report, 1999). The potential impact of racoons on seabird colonies is significant, as they are known to prey on eggs, young, and adult birds. Racoons frequent intertidal areas where they feed on marine invertebrates. The effect of this predation and potential secondary impact of racoons on native land mammals is currently unknown.

In 1950, the BC Forest Service introduced red squirrels to a number of the islands in an attempt to assist with the collection of spruce cones (PRIAMC, unpublished report, 1999). These squirrels now occur on Graham Island. It is suggested that the introduction of red squirrels may have created a larger prey base for the marten, which has lead to larger, healthier marten populations (PRIAMC, unpublished report, 1999). The increase in marten numbers may be putting downward pressure on the ermine population (PRIAMC, unpublished report, 1999). Predation by red squirrels on bird eggs is also reducing the nesting success of some bird species (A. Cover, MELP, personal communication, 1999).

The Pacific tree frog (*Hyla regella*) is the only amphibian or reptile known to have been introduced to the islands. It was introduced on Graham Island in 1960 and spread rapidly to Moresby Island (PRIAMC, unpublished report, 1999). There is no information available on its distribution or the impact that it may be having on other species, although there is some concern that the tree frog may be replacing the endemic boreal toad (PRIAMC, unpublished report, 1999).

Beavers have had considerable impact on the hydrology of the Tlell River watershed (particularly in Upper Survey Creek (Dobson Engineering Ltd., unpublished report, 2000). Beaver habitat is typically in low-lying areas where water is to be found (either flowing or standing). Beavers appear to thrive when harvesting occurs in riparian areas and red alder is permitted to establish itself as a pioneer species in the newly disturbed areas (A. Cober, MELP, personal communication, 1999).

Appendix K: Ecological function, old growth and fire legacy stands

The old growth forests within the Tlell River watershed are characterized by uneven canopies with gaps where old trees have died and new ones are regenerating in well-developed understory layers, and by trees of a wide range of ages and sizes. Small openings of less than 0.2 ha, where only a few trees have died, are common in old-growth forests (Clayquot Sound Scientific Panel, 1995; Pojar, personal communication, 1999). In such openings, the dead trees – which result from various events i.e., windthrow, disease - are often in different stages of decay. The variety of forms of dead wood provide diverse habitats for numerous organisms and facilitates a wide range of ecological processes (Clayquot Sound Scientific Panel, 1995; Pojar, personal communication, 1999). Canopy gaps are associated with a well-developed and diverse understory vegetation layer which is often more productive than in adjacent closed-canopy areas (Clayquot Sound Scientific Panel, 1995).

The extent of the forest canopy affects wind, light, variation in temperature and moisture, and patterns in snow accumulation and melt both within the stand and in adjacent open areas (Clayquot Sound Scientific Panel, 1995). This microclimate influence of the forest canopy extends from less than half a tree height to as much as six to eight tree heights into a stand (Clayquot Sound Scientific Panel, 1995), depending on the slope and aspect of the stand. For most variables, the microclimate influence of the canopy is negligible beyond two tree heights from the stand edge (Clayquot Sound Scientific Panel, 1995).

Non-vascular plants, lichens and fungi are very important in an old growth forest. Slowly decaying mosses contribute to the soil's water retaining capability and form an important component of the soil organic matter once they decay. Many of the fungal species form partnerships with mycorrhizae which are thought to be essential for normal tree growth. Other fungi decompose dead wood and facilitate nutrient cycling (Clayquot Sound Scientific Panel, 1995; Pojar, personal communication, 1999).

Similarly, the forest fauna contribute significantly to ecosystem processes. Most of these fauna are invertebrates, many of which we know very little about. These invertebrates contribute to soil building, decomposition, nutrient cycling, pollination, and seed or spore dispersal (Clayquot Sound Scientific Panel, 1995).

Vertebrates also play a critical role in ecological processes in the Tlell watershed, as in other coastal areas. Many species that use both forest and open areas prefer edge habitats where canopy influence is substantial. For instance, deer often feed on early seral vegetation in openings, but prefer to stay within two to three tree heights of the canopy edge (Clayquot Sound Scientific Panel 1995). Smaller mammals tend to stay even closer to the edge. Many of these forest-dwelling vertebrates also make significant use of riparian areas within the watershed (Pojar, personal communication, 1999).

Small headwater streams in the Tlell River watershed usually are heavily shaded. Most nourishment for animals in these streams comes from outside the stream itself, based on input of insects, leaves and twigs from adjacent riparian areas. Water temperatures tend to be relatively stable and low throughout the day. The surrounding vegetation critically influences small streams.

In the progression downstream, the stream channel, in general, becomes less shaded, daily range in temperatures increases, algae production increases, and more food energy is produced in the stream itself (Clayquot Sound Scientific Panel, 1995). The increased daily range of temperatures permits greater diversity of insect species that form the basis of several food chains, including salmon, eagles and bears (Clayquot Sound Scientific Panel, 1995).

The following information is summarized from the Jim Pojar (Prince Rupert Forest Region (PRFR) – Ministry of Forests regional ecologist) / Phil LePage (PRFR regional silviculturist) ecosystem function workshop held in May 1999, some of the findings of the Clayquot Sound Scientific Panel, and from readings suggested by those knowledgeable in old growth ecosystems.

Some features of old-growth forests are readily apparent to most observers. Trees typically vary in species and size. The multi-layering tree canopy produces filtered, diffuse light. The understory of tree seedlings, shrubs, and herbs is variable and patchy. Numerous logs in various stages of decay litter the forest floor, and standing dead trees are common (Clayquot Sound Scientific Panel, 1995).

Standing dead trees and down dead trees provide nesting sites, food sources, protection, and runways for mammals and birds. Decaying logs are important seedbeds or "nurseries" for reproducing western hemlock and Sitka spruce (Pojar, personal communication, 1999). Large logs are also critical to the maintenance of physical and biological stability of forest streams.

The structural complexity, vertical stratification, and horizontal patchiness of old-growth forests permit a relatively diverse and abundant fauna to develop. By comparison, young, dense, second-growth coastal forests provide habitat for fewer animal species and individuals than the old-growth forests (Clayquot Sound Scientific Panel, 1995; Pojar, personal communication, 1999).

Based on TEM maps, Timber Supply Review II (TSR II) forest cover information, and TFL management plan #8 information, a map of the watershed was prepared identifying the location of old growth (defined as structural stage 7, and older than 250 years, and taller than 37.5 m).

These legacy stands from the 1860's fire are thought to perform a role as habitat refugia for a number of wildlife species in the watershed (Pojar, personal communication, 1999). Although the fire did burn fairly extensively throughout this area, the 120-140 year old fire-disturbed stands within the watershed also exhibit a number of the characteristics that are typically associated with old growth stands (Pojar, personal communication, 1999). Considerable vertical and horizontal structure, in the form of snags and downed trees, remained in the fire-initiated stands after the fire. This structure functions as wildlife habitat for various species.

Appendix L: General Islands economic trends

The Haida Nation claim they have never relinquished its ownership and jurisdiction over all of the lands and waters surrounding the Queen Charlotte Islands / Haida Gwaii. The uncertainty concerning the Haida land claim may have implications for the economy of the Islands (Holman, unpublished report, 1997). The Haida are at the preliminary stages of negotiating a treaty intended to define their rights to lands and resources in Haida Gwaii. Resolution of the Haida land claim will likely involve funding for economic development which will create employment for the Haida, but hopefully also other residents of the Islands (Holman, unpublished report, 1997).

In March 2003, the Haida launched a B.C. Supreme Court lawsuit in which they claim title to the Queen Charlotte Islands and the surrounding waters. In September 2003, the province of British Columbia countered with a take-it-or-leave-it offer of 20% of the Crown land on the Queen Charlotte Islands. Half of the land would be owned by the Haida, with the rest reserved for tenures, protected areas or co-management. The Haida immediately rejected the offer and are pursing their lawsuit.

According to the 1996 Canada Census, the estimated population of the Islands was, at that time, 6,100 people. In 1991, the Haida population as a proportion of the total islands population was 20.7% (Holman, unpublished report, 1997). Due to the recent expansion of the Haida population over the last 12 years, and non-Haida out-migrations, this proportion is currently estimated to be closer to 30%.

In the long term, there may be a continued influx of Haida people returning to the Islands, although the lack of job opportunities will continue to be a constraining factor. The continuation of SMFRA development funding, economic development investments funded by Gwaii Trust, more labour-intensive harvesting with an increase in local timber processing, and the proposed Community Forest Pilot Agreement may all contribute to a growing population (Holman, unpublished report, 1997). The most recent population forecasts for the Islands from BC STATS (April 1996) predict slow growth, averaging about 0.3% over the 1996 – 2021 period (Holman, unpublished report, 1997).

Education rates are lower than the provincial average, but very similar to northwestern British Columbia. About 42% of the Islands population over 15 years do not have a high school certificate. This is approximately twice the proportion for British Columbia (Holman, unpublished report, 1997). Census data indicates that education levels are much lower, and unemployment rates are much higher among the Haida than for the Islands as a whole. Unemployment rates of 35% and 24% were estimated in the 1991 Census for Old Massett and Skidegate, respectively (Holman, unpublished report, 1997). There is nothing to indicate that this three-fold dimension of provincial unemployment rates has been reduced.

Ministries of Finance and Corporate Relations economic dependency estimates updated to 1996, indicate the following (Holman, unpublished report, 1997):

- Approximately 29% of the after tax "basic income" and 31% of employment in the Islands is attributable to forestry. There is a wide variation of dependency on forestry among communities, with Port Clements being over 55% dependent on forestry income and employment.

- Almost 70% of basic income is attributable to non-forestry sectors (e.g., public sector, transfer payments, pension and investment income, tourism).
- The government sector is second only to forestry as a source of basic income (25%) and employment (30%) in the Islands.
- Tourism is the third largest basic sector, accounting for 16% of total basic employment in the Islands. Tourism is less important as a source of income because of relatively low average earnings in this sector.

Appendix M: Tlell Watershed timber supply estimate

The following rate of harvest estimates are based on an average realized mean annual increment (MAI) of 4 to 5 $m^3 ha^{-1} yr^{-1}$, assuming an average level of environmental constraints (harvesting practices consistent with the *Forest Practices Code of British Columbia*) (M. Mana, Ministry of Forests, personal communication, 1999). If environmental constraints are much higher than average, the sustainable long-term rate of harvest will be reduced accordingly. Conversely, if actual MAI is higher than previously estimated[24] the sustainable long-term rate of harvest will be higher than estimated (M. Mana, Ministry of Forests, personal communication, 1999).

The following timber harvesting landbase (THLB) within the Tlell watershed was determined (by M. Mana, Timber Supply Forester for the Vancouver Forest Region) from data prepared for the 1994 timber supply review of the Queen Charlotte TSA. The THLB includes the total forest area remaining after the following exclusions have been deducted as defined in the data package and analysis report for TSR1:

- lands not managed by BC Forest Service (TFL and park),
- non-forest land,
- areas dominated by brush cover,
- areas with low forest productivity,
- streamside management zones (based on *Operational Planning Regulation* widths),

[24] MAI is higher than previously estimated due to underestimated site productivity in older stands (by approximately 14% across all species) – as was found to be the case in the Inventory Audit conducted for Timber Supply Review II for the Queen Charlotte TSA.

- 'preservation' visual quality objective (VQO) areas,
- environmentally sensitive areas,
- inoperable areas,
- existing roads trail and landings, and
- a landbase deduction for the management of cultural heritage resources an additional reduction of 5% to account for the incremental impact of the Forest Practices Code requirements.

An average MAI in timber volume of between 4 and 5 $m^3ha^{-1}yr^{-1}$ is a reasonable, but conservative estimate of productivity for the Tlell areas. This estimate assumes that sub-optimal (longer) rotation ages are necessary in some areas to conserve non-timber values. The long-term sustainable harvest level for the Tlell TSA forest areas, estimated by multiplying mean MAI of 4 – 5 $m^3ha^{-1}yr^{-1}$ by the THLB (from TSR 1) of 5 640 ha, is between 22 500 and 28 500 m^3 yr^{-1} (M. Mana, Ministry of Forests, unpublished data, 1997). If the same equation is used, but the Tlell THLB within the TSA as defined in TSR II is used (6 895 ha) instead, the long-term sustainable harvest level for the Tlell TSA forest area is estimated to be between 27 580 and 34 475 m^3 yr^{-1}. Tabular information detailing the timber harvesting landbase and volume by species type and age class information follows on the next page (from Myles Mana Tlell TSA Timber Supply estimate, September 1997 – based on TSR 1 data).

Timber harvesting landbase, and volume by species type and age class for the TSA portion of the Tlell River watershed (from Myles Mana Tlell TSA timber supply estimate, September 1997 – based on TSR 1 data).

Cover type	SI	Data	Age class 1	Age class 4	Age class 5	Age class 6	Age class 7	Age class 8	Age class 9	Total
Cedar	10	Sum of net area (ha)	0	0	0.3	12.95	97.66	0	430.45	541.4
Cedar	10	Sum of volume (m3)	0	0	51	2196	19803	0	142,673	164,723
Cedar	15	Sum of net area (ha)	0	0	1.9	130.2	2366	28	759	3267
Cedar	15	Sum of volume (m3)	0	0	458	42,310	792,173	10,948	412,510	1,258,399
Cedar	20	Sum of net area (ha)	0	0	0	34	611	0	4	649
Cedar	20	Sum of volume (m3)	0	0	0	18,071	304,900	0	3,009	325,980
Cedar	25	Sum of net area (ha)	0	0	0	0	38	0	0	38
Cedar	25	Sum of volume (m3)	0	0	0	0	26,020			26,020
Cedar	all	Sum of net area (ha)	0	0	2.2	177	3,114	28	1,194	4,515
Cedar	all	Sum of volume (m3)	0	0	509	62,578	1,142,896	10,948	558,192	1,775,122
Hem/ Bal	10	Sum of net area (ha)	0	0	0	0	0	0	310	310
Hem/ Bal	10	Sum of volume (m3)	0	0	0	0	0	0	152,420	152,420
Hem/ Bal	15	Sum of net area (ha)	0	0	0	0	.5	0	188	189
Hem/ Bal	15	Sum of volume (m3)	0	0	0	0	166	0	118,044	118,209
Hem/ Bal	20	Sum of net area (ha)	5	0	0	0	83	0	0	88
Hem/ Bal	20	Sum of vol. (m3)	4	0	0	0	41,171	0	0	41,175
Hem/ Bal	all	Sum of net area (ha)	5	0	0	0	83	0	498	586
Hem/ Bal	all	Sum of vol. (m^3)	4	0	0	0	41,337	0	270,464	311,805

Cover type	SI	Data	Age class 1	Age class 4	Age class 5	Age class 6	Age class 7	Age class 8	Age class 9	Total
Pine	10	Sum of net area (ha)	0	1	1	.5	21	2	1	26
Pine	10	Sum of volume (m3)	0	12	73	87	3,182	706	233	4,293
Pine	15	Sum of net area (ha)	0	1	4	1.5	189	5.5	0	201
Pine	15	Sum of volume (m3)	0	73	569	482	70,372	2,344	0	73,840
Pine	20	Sum of net area (ha)	0	0	1	73	108	0	0	183
Pine	20	Sum of volume (m3)	0	0	632	38,991	59,722	0	0	99,346
Pine	25	Sum of net area (ha)	0	0	0	0	108	0	0	108
Pine	25	Sum of volume (m3)	0	0	0	0	74,902			74,902
Pine	all	Sum of net area (ha)	0	2	6	75	426	8	1	517
Pine	all	Sum of volume (m3)	0	85	1,295	39,560	208,178	3,050	233	252,401
Spruce	10	Sum of net area (ha)	0	0	0	0	.1	0	0	.1
Spruce	10	Sum of volume (m3)	0	0	0	0	65	0	0	65
Spruce	15	Sum of net area (ha)	0	0	0	0	1	0	5.5	6.5
Spruce	15	Sum of volume (m3)	0	0	0	0	418	0	4,903	5,321
Spruce	20	Sum of net area (ha)	5	0	0	0	0	0	0	5
Spruce	20	Sum of volume (m3)	0	0	0	0	0	0	0	0
Spruce	25	Sum of net area (ha)	0	0	0	.2	0	0	7	7.2
Spruce	25	Sum of volume (m3)	0	0	0	157	0	0	7,963	8,121
Spruce	30	Sum of net area (ha)	1	0	0	0	0	0	0	1
Spruce	30	Sum of vol. (m3)	4	0	0	0	0	0	0	4

Cover type	SI	Data	Age class 1	Age class 4	Age class 5	Age class 6	Age class 7	Age class 8	Age class 9	Total
Spruce	35	Sum of net area (ha)	0	0	0	0	0	0	1	1
Spruce	35	Sum of volume (m3)	0	0	0	0	0	0	527	527
Spruce	all	Sum of net area (ha)	6	0	0	.2	1	0	14	20
Spruce	all	Sum of volume (m3)	4	0	0	157	483	0	13,393	14,037
Total	all	Sum of net area (ha)	10	1.5	8.5	252	3,623	36	1,706	5,638
Total	all	Sum of volume (m3)	8	85	1,804	102,295	1,392,893	13,997	842,282	2,353,364

(Adapted from: from Myles Mana Tlell TSA Timber Supply estimate, September 1997 – based on TSR 1 data)
SI = site index at age 50 years

Appendix N: Silvicultural systems, harvesting and road transportation systems

Silvicultural systems

The clearcutting silvicultural system removes all trees in a given area in one cutting, after which an even-aged stand is established by planting or natural regeneration. Clearcuts generally exceed 1 ha so that most of the opening is not shaded or sheltered by the surrounding forest. The seed tree silvicultural system leaves selected standing trees scattered throughout a cutblock to provide seed sources for natural regeneration. The shelterwood silvicultural system removes the existing stand in a series of two or more cuttings, typically 5 to 10 years apart, which opens the stand to encourage regeneration (Clayquot Sound Scientific Panel, 1995). An even-aged stand (or mostly even-aged stand) develops under the temporary shelter of the remaining trees.

Selection silvicultural systems involve repeated cuttings, each of which removes some trees in all merchantable size classes in a stand, either as individuals, in small groups, or in strips (Clayquot Sound Scientific Panel, 1995). In selection systems, young trees are planted or regenerate naturally among the remaining older trees. The periodic cutting and continual regeneration of trees maintains an uneven-aged stand structure. At the completion of the planned cuttings, all or most original trees may have been cut within the target stand.

Single tree selection and group selection are variations of the selection system (Clayquot Sound Scientific Panel, 1995). Single tree selection involves harvesting trees from each diameter class more or less uniformly throughout the stand. Mature trees are removed, at intervals, as scattered individuals or in groups of two or three trees. Single tree selection is impractical when applied to old-growth forests of large trees because it is usually impossible to remove single trees safely (Clayquot Sound Scientific Panel, 1995). Group selection involves the harvesting of groups of trees in patches of less than one hectare distributed throughout the stand. Group selection creates a patchwork of small openings providing favourable microclimates for tree species that regenerate better with more shade or shelter than is present in larger openings (Clayquot Sound Scientific Panel, 1995). Group selection differs from small patch clearcutting in that a series of entries, creating an uneven-aged structure, is planned.

Harvesting Systems

Harvesting systems typically consist of four phases: falling and bucking, yarding, loading, and hauling.

The three major yarding methods are as follows:

- helicopter yarding,
- ground-based yarding (skidders, hoe forwarders), and
- cable yarding (high-lead, skyline, grapple).

Ground-based yarding:

This yarding method is very sensitive to weather and is limited to slopes of less than 35%. During heavy or prolonged rain, the operation may be suspended because the soil loses strength, resulting in increased potential for soil and/or root damage.

Cable yarding:

Cable yarding methods require stationary yarders which move logs by cables along a yarding corridor to a landing or roadside. The amount of soil disturbance from cable yarding depends on the extent to which the logs remain in contact with the ground as they travel from the cutblock to the landing. High lead yarding distances are limited to 200-300 m, typically (Clayquot Sound Scientific Panel, 1995). Skyline systems can yard up to 1 000 m or more given appropriate topography (Clayquot Sound Scientific Panel, 1995). By attaching chokers to the skyline, lateral yarding capability can range up to 30 m. Grapple yarders are best suited to clearcuts with short yarding distances (less than 150 – 200 m) (Clayquot Sound Scientific Panel, 1995).

Helicopter yarding:

Helicopters are typically used to yard logs in sensitive or inaccessible terrain. Optimal flight distance is 600 -1 000 m, but maximum yarding distance can be as much as 2 000 m if the timber is of high value (Clayquot Sound Scientific Panel, 1995).

Factors affecting the choice of yarding system (Clayquot Sound Scientific Panel, 1995):

- topography (slope steepness and variability),
- soil – sensitivity to disturbance,
- silvicultural system (level of retention),
- timber characteristics,
- potential road access, and
- yarding distances and direction.

Silvicultural systems that retain a significant number of trees will favour yarding methods with partial or full suspension and lateral yarding capabilities.

Road transportation systems

Logs will likely be transported via roads in the Tlell River watershed. The road network will be used for hauling logs, access by logging and silviculture workers, movement of equipment, and access by recreational users and residents.

The following factors must be considered when determining the location of roads (Clayquot Sound Scientific Panel, 1995):

- operational and physical considerations:
    - existing road system,
    - planned silvicultural and harvesting systems and resulting layout,
    - engineering control points, and
    - topography;
- environmental considerations:
    - slope stability, and surface erosion hazard,
    - potential damage to growing sites,
    - avoidance of riparian areas, special habitats and ecologically sensitive sites,
    - avoidance of cultural and heritage sites, and
    - potential visual impacts and impact on recreational areas; and
- economic considerations:

- road construction costs in relation to value of timber accessed by various harvesting systems, and
- maintenance costs.

Appendix O: Islands tourism and recreation

Tourism is typically defined as employment and income generated by the spending of non-Queen Charlotte Islands residents to the area on such activities as accommodation and food, recreation activities, and transportation (Holman, unpublished report, 1997). Recreation is defined as activities enjoyed by residents and non-residents of the Islands. Although recreationists and tourists are often undertaking the same activities in similar locations, economists typically assume that spending by resident recreationists does not generate net employment and income for an area. This is based on the premise that without local recreation opportunities, residents would simply divert expenditures to other locally-produced goods and services (Holman, unpublished report, 1997). Recreation opportunities contribute greatly to the quality of life on the Islands.

Wilderness tourism (sport fishing and wilderness guiding) continues to grow, although the benefits of this growth to the local economy are not being maximized because many of the operators are non-local (Holman, unpublished report, 1997).

Historically, annual hunter days are estimated to be 10 000 with approximately 50% of this total accounted for by non-Queen Charlotte hunters hunting deer, elk, and to some extent, black bear (Holman, unpublished report, 1997) - 90% of hunter days are attributable to deer. Non-local hunting effort has probably increased over historical levels due to the establishment of daily ferry service. Although hunting is readily available in many other areas of the province, the Islands offer a unique experience (Holman, unpublished report, 1997).

Naikoon Park is primarily known for clam digging, beach combing, and hiking, and is used by local residents year round. There were approximately 104 000 visitors to Naikoon in 1996, of which about 85% were day use (Holman, unpublished report, 1997). A significant proportion of these visitors were off-island visitors.

Appendix P: Non-timber forest products

The Islands mushroom industry contributes to a world-wide trade in mushroom products. The principal markets for these are Europe and Japan. Local data is starting to be collected due to recent assessments into the potential for developing the non-timber forest product industry on the Islands, particularly mushrooms. Some Islands residents are involved in seasonal mushroom picking, although non-residents undertake the majority of the commercial harvest (Holman, unpublished report, 1997). Reasonable mushroom potential is felt to exist in the Tlell River. There is also an abundance of floral greenery plants in these areas, but the commercial viability of this product on the Islands is not well established.

In a normal year, QCI produces approximately 250,000 lb of mushrooms and as much as 350,000 lb in an exceptional year (Tedder et al., 2000). The Pacific golden chanterelle (*Cantharellus formosus)* is the main NTFP harvest from the Islands. Other mushrooms commercially harvested include the King Bolete (*Boletus edulis)* and the blue chanterelle *(Polyozellus multiplex),* and to a lesser extent, oyster *(Pleurotus ostreatus)*, chicken-of-the-woods *(Laetiporus sulphureus),* and pine mushrooms *(Tricholoma magnivelare)* (Tedder et al., 2000).

The most productive sites for edible wild mushrooms depend on various forest conditions, one of which is the age class of the forest (Tedder et al., 2000). Studies and anecdotal information indicate that chanterelles are most productive in forest stands where the trees range in age from about 25 or 30 years to 80 years (Tedder et al., 2000).

Certain patterns of harvesting, thinning, and pruning and other silvicultural treatments create or improve the conditions for non-timber forest products that do not thrive under closed canopies (Tedder et al., 2000). No studies have been conducted on the Islands to examine the differing effects of alternative silvicultural systems on mushroom production. The construction and maintenance of roads for timber harvesting provide access to forested areas for other uses such as mushroom harvesting.

Growth in non-timber forest product harvesting is likely to continue although the commercial potential is just beginning to be understood since there are definite limitations to the harvest on the Islands (Holman, unpublished report, 1997).

Many concerns have been raised about the commercial development of NTFPs. Some of the issues identified include the lack of baseline ecological, economic and social information required to make informed decisions on the management of the harvest. There are also few measures to monitor the ecological, economic and social impacts of the NTFP industry (Tedder et al., 2000). Some felt that the dominance of timber interests in the management of forest resources means that valuable non-timber resources are largely ignored in forest planning. Members of the Haida Nation have expressed their opposition to further commercial development that may affect traditional use and failure to recognize and protect aboriginal rights and title (Tedder et al., 2000).

The second most important sector in British Columbia of the NTFP industry after mushrooms is greenery and floral products. Salal, sword fern, and Christmas greenery such as boughs and wreaths are all potential opportunities from the Tlell (Tedder et al., 2000).

No specific information has been gathered on existing food gathering sites although the Terrestrial Ecosystem Mapping (TEM) in conjunction with 'Vancouver Forest Region Site Identification Field Guide' (1994) have been used to identify areas in the watershed that have a high and moderate potential for berry production, given the ecosystem type. Edible berries such as salal berries, red and black huckleberries, blueberries, high bush and bog cranberries are all available on the islands, but to what extent they exist within the Tlell watershed is unknown. At present, due to the limited access within the Tlell, opportunities for food gathering are somewhat limited. With the anticipated expansion of the road network for forestry activity, the opportunities for access to food-gathering sites are likely to increase.

An extensive list of medicinal plants historically used by the Haida is available to the Tlell Working Group. No site-specific information is available that could be used to identify areas within the watershed where the collection of these plants currently occurs. Although it would be possible to get some indication as to the relative potential of finding medicinal plants in various ecosystems within the watershed using a combination of the terrestrial ecosystem mapping (TEM) information and the 'Vancouver Forest Region Site Identification Field Guide' (1994), the technical group felt that the these two sources of information are not well enough correlated to enable its extrapolation to medicinal plants.

The 'Vancouver Forest Region Site Identification Field Guide' (1994) is useful for identifying the relative frequency of select plants from the list of indicator plant species in any given ecosystem. Many of the medicinal plants are not on the select list of indicator plant species discussed in the 'Vancouver Forest Region Site Identification Field Guide' (1994).

Deer are an introduced species on the Islands with no natural predator and are considered to have a large effect on the Islands ecosystems. With population numbers ranging from 50 000 – 500 000, the potential for the commercial sale of venison is considerable, although current provincial policy is against the commercial use of wild animals (Tedder et al., 2000) (although deer are an introduced species on the Islands).

Appendix Q: Society

Aboriginal peoples

In December 1993, a statement of intent was filed by the Council of the Haida Nation (CHN) to enter into comprehensive land claim negotiations with the governments of British Columbia and Canada. The Haida Nation has laid claim to all the lands on the Queen Charlotte Islands and the surrounding waters. The CHN has not moved beyond Stage 2 of the treaty process with the intent of having more favourable conditions prior to beginning negotiations.

From the CHN's viewpoint, favourable conditions may result from a number of pending initiatives. First, a higher court has been asked to make a decision on whether the Haida hold aboriginal title to its traditional territories. The writ of summons launching the Council of the Haida Nation's title case was filed in the BC Supreme Court on March 6th, 2002. Because the Haida live in a defined area with ample archaeological evidence of a long and uninterrupted occupation, they are in a unique position to prove aboriginal title by meeting the conditions for doing so laid out in the Delgamuukw court case (Lordon, 2002). Secondly, in 1997, the CHN challenged the replacement of TFL 39 and the B.C. Court of Appeal ruled that aboriginal title constitutes an encumbrance under the provisions of the *Forest Act* to area-based licenses, if aboriginal title can be proven to exist. In February 2002, the B.C. Court of Appeal ruled the Haida had not been adequately consulted by the province when Weyerhaeuser's Tree Farm Licence 39 was replaced in 2000. The B.C. Court of Appeal (Council of the Haida Nation versus Weyerhaeuser Co. and the Province of British Columbia) found that:

> *...the Crown Provincial have now, and had in 1999 and 2000, and earlier, a legally enforceable duty to the Haida people to consult with them in good faith and to endeavour to seek workable accommodations between the aboriginal interests of the Haida people, on the one hand, and the short term and long term objectives of the Crown and Weyerhaeuser to manage TFL 39 and Block 6 in accordance with the public interest, both aboriginal and non-aboriginal, on the other hand.*

The Court also included the company in the duty to consult aboriginals regarding decisions that may affect their traditional territory, whether or not aboriginal title has been established.

In 1993, the CHN requested a moratorium on forestry development activities with 14 areas-of-interest on Haida Gwaii - the Tlell River watershed in one of these 14 areas. At present, the vast majority of the landbase within the Tlell River watershed is Crown land that is managed as part of the Provincial Forest. Approximately 5 640 ha of this Crown land is within the Queen Charlotte Timber Supply Area in the Tlell River watershed. This is typically available for harvest either through the Small Business Forest Enterprise Program (SBFEP), through Woodlot Licenses, or Forest Licences (Ministry of Forests forest cover maps, 1998). Approximately 10 800 ha of Crown land within the watershed are managed as part of Tree Farm Licence 39 by Weyerhaeuser.

A map identifying the location of the Haida-declared protected area within the Tlell watershed is available (Tlell LRUP technical committee, unpublished Haida-declared area map, 2000).

The Haida represent roughly 30% of the Islands' current resident population, based on the 1996 census data. The Haida people view the forest and its resources as gifts of the Creator, to be used with respect and to be maintained by careful stewardship through the hereditary chiefs and the Council of the Haida Nation (PRIAMC, unpublished report, 1999). Traditional practices of forest resource management include harvesting of selected trees (particularly western redcedar and yellow-cedar) and other forest products; controlled burning to promote the production of berries; and monitoring and use of all lands and waters and their resources through stewardship of hereditary chiefs.

Guujaw, president of the Council of the Haida Nation, maintains that the "*health of the Haida…and the health of the environment are inextricably linked*" (Victoria Times Colonist, November 9, 2003. p.D5). While future tussles with the province might be over oil and gas, and title (yet to be defined despite B.C. Supreme Court proceedings), the big tussle is over forestry.

As of February 2002, the province and Weyerhaeuser must take Haida concerns into account. Currently, logging is much reduced compared with a decade ago; the loggers have switched allegiance from Weyerhaeuser to the Council of the Haida Nation because of "*more faith in the latter's long-term interest in the Islands*" (Victoria Times Colonist, November 9, 2003. p.D5). Guujaw says that the Haida are taking the long view – they "*want a 500-year cedar plan, not one built around plantation forestry and a 60-year crop rotation*" (Victoria Times Colonist, November 9, 2003. p.D5). And yet Weyerhaeuser and Husby Forest Products are having difficulty getting permits to meet even recently reduced allowable annual cuts (reduced by half to 600 000 m^3 for Weyerhaeuser).

The Haida had an agreement with the province for the application of eco-forestry land use processes, but the government 'working forest' concept aims to redefine what eco-forestry means: to the Haida, Guujaw says, it means "*Log without wrecking the land*" (Victoria Times Colonist, November 9, 2003. p.D5).

Traditional use

The Haida traditionally used a wide range of plants for food, medicinal and other purposes. The Haida gathered a variety of roots, rhizomes and leafy parts of plants such as spiny wood fern, the liquorice fern and the bracken fern, lupine, eelgrass, western dock, and stonecrop, and several types of seaweed (Turner, 1995). Berries and other fruits, especially Pacific crab apple, were gathered and preserved for winter stores. Common berries included highbush cranberry, salal berry, red huckleberry, blueberry, strawberry, and bog cranberry (Turner, 1995). By using the terrestrial ecosystem mapping (TEM) available for the Tlell River watershed and knowledge of the plant associations typically found in these ecosystems, some mapping work has been completed in an attempt to identify areas within the watershed with the potential for berry-producing plants. Local knowledge has been invaluable in identifying areas that are good hunting grounds for deer and elk.

Cedar strategy

The Haida have used the bark and wood of western redcedar and yellow-cedar for a considerable length of time. The Haida, for various spiritual and cultural practices, use all sizes of western redcedar and yellow-cedar trees. Bill Reid once wrote:

> *Oh, the cedar tree!*
> *If mankind in his infancy*
> *had prayed for the perfect substance*
> *for all material and aesthetic needs,*
> *an indulgent god could have provided*
> *nothing better.*

The Ministry of Forests Queen Charlotte Islands district office has established a cedar policy for biodiversity and ecological reasons that states that western redcedar and yellow-cedar must be maintained on the landscape. The policy outlines the minimum densities of red and yellow-cedar to be re-established on harvested areas. The policy also describes varying densities of cedar to be established based on the ecosystem and the proportion of cedar in the mature stand.

Appendix R: Recreation – historical trails and scenic resources

Historical trails

There are excellent opportunities for recreation in the Tlell watershed, such as natural history outings along the coastline in Naikoon Provincial Park, along the Tlell River, into the Pontoons, and to old-growth forests. Hiking and hunting in this area depend greatly on the natural resources in the Tlell.

There are a number of historical trails and sites that can be accessed in the watershed from various locations. These include:

- Settlers Trail, including the North Road and the trail south toward Chinukundl Creek,
- Pretty John's farm, and
- trap line trails.

The Queen Charlotte Islands, in general, is recognized as one of the premier Steelhead angling locations in British Columbia (Mullins and Tedder, 1994). Freshwater sports fishing for steelhead and pink salmon is popular on the lower reaches of the Tlell River. Although local residents participate in the majority of the freshwater angling, the Tlell River also attracts anglers from other parts of British Columbia and other provinces, and outside Canada. The Tlell River was designated as a Class II river by the Ministry of Environment in 1992. A Class II designation requires non-residents of British Columbia to fish with a licensed angling guide.

Scenic resources

Forest visual landscape management was first adopted in the early 1980's and has been improving ever since. Through a gradual awareness about scenic values, the forest industry has started to incorporate landscape design principles into forestry plans. In this process, a landscape expert travels along scenic corridors and maps visible landforms as visual landscape units. The characteristics of each visual landscape are described in the following manner (Ministry of Forests – Recreation Branch, 1994):

- the visual importance based on the biophysical characteristics;
- the ability of the landscape to absorb human changes without a reduction in visual qualities or integrity; and
- the level of human alteration in the landscape.

Based on these factors, a visual quality objective (VQO) is recommended which defines the limit of acceptable visual change in the landscape as a percentage of a landscape unit that can be harvested by clearcut methods (Ministry of Forests – Recreation Branch, 1994). This limit is not intended to replace landscape design of harvesting units. By using retention silvicultural systems, the visual impact of the harvesting unit can be considerably reduced.

Appendix S: 19th and 20th century settlers

European history on the Islands is well documented. On July 18, 1774, the first Europeans reached the Islands as Juan Perez sailed near present day Langara Island (Prince Rupert Interagency Management Committee (PRIAMC), unpublished report[25], 1999). Other explorers arrived soon after and contact with the Haida increased in frequency with a particular interest in trading for furs. Many of the early contacts in the late 1700's and early 1800's resulted in battles between the ships and the Haida (PRIAMC, unpublished draft report, 1999).

The arrival of the Hudson's Bay Company ships by 1825 was the beginning of a new era of fur-trading which increased exploration of the Islands and contact with the Haida (PRIAMC, unpublished draft report, 1999). Through the 1860's and 1870's small pox decimated the Haida population that was estimated to be as high as 14 000. It is believed that as much as 83% of the population died from the epidemic (PRIAMC, unpublished draft report, 1999).

Non-Haida settlers came to the Islands mistakenly believing that a good living could be made through agriculture on the Islands. Mining at Jedway was underway in the early 1900's, and logging for spruce to build aircraft was started in 1917 utilizing the some of the large Sitka spruce on the Islands (PRIAMC, unpublished draft report, 1999). Whaling stations at Rose Harbour, Kunghit Island, and Naden Harbour were active by the early 1900's but were shut down by 1941 (PRIAMC, unpublished draft report, 1999).

[25] PRIAMC, unpublished draft report entitled "Queen Charlotte Islands – Haida Gwaii - Background report: An overview of natural, cultural, and soci-economic features, land uses and resources management", 1999.

Fishing also started during the early 1900's and between 1909 and 1950 salmon salteries and canneries, cold-storage plants, fish-meal works, oil and fertilizer plants, black-cod fishing companies, and clam canneries became established. However, none of these companies survived the depression and the high transportation costs to markets (PRIAMC, unpublished draft report, 1999).

Evidence of the settlement history is found in museums in each of the communities and at sites around the Islands. There is an extensive system of trails that have been documented. Many are overgrown roads leading to abandoned homesteads such as Pretty John's Farm.

At present, access to the watershed is limited due to its predominantly undeveloped state. Vehicular access to the upper end the watershed can be made via the Elk and Survey mainlines from the Queen Charlotte mainline within TFL 39. Vehicular access to the northern end of the watershed is limited to Wiggins Road, Beituish Road, the Misty Meadows camp ground, and Highway 16 which crosses the Tlell River just to the north of the Naikoon Provincial Park boundary.

With the exception of small boat access (i.e. kayak or canoe), the remaining access is limited to helicopter or hiking. Established hiking access points include the Naikoon Provincial Park access point immediately to the north of the Tlell River bridge, points off Lawn Hill Road, Pots Purchase into Teapot Corner, Big Bend, and from Wiggins Road. Of course, access by foot can also be made from anywhere along the highway as long as the hiker has a good sense of direction or a compass and topographic maps.

A map identifying all of the current road access within the watershed has been produced based on the TSA TSR II forest cover database and the TFL management plan #8 database (Tlell LRUP technical committee, unpublished current access map, 2000).