Appendix I

Summary of the Panel's Recommendations Concerning Planning and Practices in Clayoquot Sound

Recommendations Relating to Silvicultural Systems

R3.1 Within the watershed planning unit, determine a rate-of-cut based on the watershed area. Specifically:

- Limit the area cut in any watershed larger than 500 ha in total area to no more than 5% of the watershed area within a five-year period.
- In primary watersheds of 200–500 ha in total area, limit the area cut to no more than 10% of the watershed area within a 10-year period. (This prescription provides flexibility for harvesting within small watersheds.)
- In any watershed larger than 500 ha in total area, and primary watersheds of 200–500 ha in total area in which harvest has exceeded 20% of the watershed area in the most recent 10 years, allow no further harvest until the watershed conforms with the specified rate-of-cut.
- In any watershed specified in the previous recommendations and in which the recent harvest is greater than 5% in the last five years, but less than 20% in the last 10 years, allow no further cutting until a watershed sensitivity analysis and stream channel audit have been completed. If these assessments indicate significant hydrological disturbance, substantial or chronic increase in sediment yield, or significant deterioration in aquatic habitat, cease harvesting until undesirable conditions are relieved. Otherwise, harvest may continue at a rate which will bring the drainage unit within the recommended rate-of-cut limits within five years.
- In any watershed larger than 500 ha in total area (and primary watersheds of 200–500 ha in total area) in which harvest has occurred, require a watershed sensitivity analysis and stream channel audit once every five years. Where such assessments identify hydrological disturbance, substantial increase in sediment yield, or significant deterioration in aquatic habitat, cease harvesting until these conditions are relieved. If such conditions are recognized at any other time, sensitivity analysis and/or stream channel audit shall be undertaken immediately.
- In watersheds where the harvestable area is less than 30% of the total area, allow resource managers to use professional judgement to vary these standards without changing the intent to regulate rate of harvest to minimize hydrological change.
- Periodically review these recommendations and reformulate as the results of monitoring accumulate.

- In watersheds important for their scenic values, complying with the visual landscape management objectives may restrict the rate-of-cut below the limits specified above.

R3.2 Within the harvestable areas, determine the size and configuration of cutting units based on consideration of topography, site and stand conditions, adjacent reserve areas, visual landscape management objectives and design principles, and operational constraints.

Once an annual rate-of-cut (in hectares per year) from the watershed is determined, no arbitrary limit on the size and adjacency of individual cutting units within a watershed is needed because the rate-of-cut limits proposed (R3.1) restrict the amount and rate of disturbance within a watershed. Exceptions occur where size and adjacency must be considered in relation to visual landscape management objectives. Riparian and other reserve areas established at the watershed planning level will protect values that require reserve forest.

R3.3 Adopt new terms to describe non-conventional silvicultural systems. Conventional terms are inappropriate to describe systems designed to protect multiple values, maintain ecosystem function, and produce a diversity of forest products.

R3.4 Replace conventional silvicultural systems in Clayoquot Sound with a "variable-retention silvicultural system." The purpose of this system is to preserve, in managed stands, far more of the characteristics of natural forests.

The variable-retention system provides for the permanent retention after harvest of various forest "structures" or habitat elements such as large decadent trees or groups of trees, snags, logs, and downed wood from the original stand that provide habitat for forest biota.

Forest structures are retained to meet the following specific ecological objectives:

- to provide, immediately after harvest, habitat (e.g., large trees, snags, and logs) important to the survival of organisms and processes that would otherwise be lost from the harvested area either temporarily or permanently;

- to enrich current and future forests by maintaining some remnant structural features and organisms from the previous stands. These features might otherwise be absent from the cutting unit for decades after logging; and

- to improve "connectivity" between cutting units and forest areas by facilitating the movement of organisms through the cutover areas.

Retention silvicultural systems facilitate protection of culturally important sites (e.g., culturally modified trees), and scenic and recreational values. The variable-retention silvicultural system provides for a range of retention levels. The type, amount, and spatial pattern of the retained material depend on site characteristics and management objectives.

R3.5 Specify prescriptions for variable-retention cutting units in terms of the types, spatial distribution, and amount of forest structures that are to be retained.

"Types of structures" refers to the kind of material that is selected for retention (e.g., snags, large live trees).

"Spatial distribution of structures" refers to whether retained trees are *aggregated* in small intact patches or strips of forest, or are *dispersed* as individual structures over the cutting unit. Aggregates are particularly useful in providing opportunities for safely retaining snags and "danger trees" important to biological diversity.

"Amounts of structures" refers to their density or cover within the cutting unit. The amount of live tree retention is described in terms of *numbers of stems* when retention is *dispersed*, and in terms of *area* when retention is *aggregated*.

R3.6 On cutting units *with* significant values for resources other than timber (e.g., visual, cultural, or wildlife resources), or *with* sensitive areas, implement high levels of retention. Examples of sensitive areas include dry floodplains (outside of riparian reserves), areas with high visual landscape management objectives (currently described by visual quality objectives of "preservation, retention, or partial retention"), steep slopes, and marginally stable slopes and soils (stability class IV). On such units:

- retain at least 70% of the forest in a relatively uniform distribution;
- when harvest occurs in small patches, limit opening sizes to 0.3 ha or less;
- retain at least some larger diameter, old, and dying trees; snags; and downed wood throughout the forest (but not necessarily in harvested patches); and
- identify "no-work zones" representing a minimum of 15% of the cutting unit area (i.e., areas including snags and other danger trees) before any harvesting takes place.

R3.7 On cutting units *without* significant values for resources other than timber, or *without* sensitive areas (e.g., with no steep slopes or unstable soils), implement low levels of retention. On such units:

- retain at least 15% of the forest;
- retain most material as forest aggregates of 0.1–1.0 ha well dispersed throughout the cutting unit;
- ensure aggregates are representative of forest conditions in the cutting unit (i.e., should not be disproportionately located in less productive portions of the cutting unit);
- retain aggregates intact as "no-work zones";
- regardless of retention level, ensure that no place in an opening is greater than two tree heights from the edge of an existing aggregate or stand; and
- when dispersed retention is employed, select the most windfirm, dominant trees present on the unit.

R3.8 Tailor prescriptions for retention to stand characteristics, topographic conditions, and other resource values on the working unit.

- In general, retain a representative cross-section of species and structures of the original stand.
- Select specific structures and patches to meet ecological objectives (e.g., provide future habitat for cavity-using species).
- Select patches to protect culturally important features (e.g., culturally modified trees, recreation sites, scenic features).
- Determine appropriate amounts of retention based on ecological sensitivity and forest values within the working unit.

R3.9 Exempt very small working units (i.e., less than four tree heights across) from the minimum 15% retention requirement in R3.7.

R3.10 Do not salvage blowdown in retention cutting units except where it threatens desired values (e.g., by establishing the potential for unnaturally large or frequent debris flows, especially ones that might threaten special sites such as spawning areas). Areas of blowdown provide live trees, snags, downed wood, or wood in streams which are habitat for many organisms in present and future stands. Abundant coarse woody debris is an important element in the forests and stream channels of Clayoquot Sound; its removal is potentially disruptive to the objectives of retention and, in most cases, is unnecessary.

R3.11 Design the size, shape, and location of areas to be harvested within a cutting unit to comply with topography and visual landscape management objectives established for the area.

R3.12 Develop restoration plans for areas where forest values have been degraded. Restoration plans should initially target:

- the restoration of hydroriparian zones; and
- large areas which have been clearcut in the past without retention of late successional features (e.g., large, old living trees; snags; and downed logs).

One feature of these plans would be to restore or hasten late successional conditions within the harvestable area through either extended "rotations" or appropriate stand tending (e.g., R3.16).

R3.13 In applying the variable-retention system, augment understanding of retention objectives with judgement and local experience. For example, use aggregated retention, mitigative measures, and local knowledge to reduce risks of windthrow, especially when mid-levels of retention are prescribed.

R3.14 Initiate training programs in new techniques (e.g., wildlife tree assessment, no-work zones, and riparian management) for forest workers.

R3.15 Provide incentives for tenure holders to implement the variable-retention system and to apply greater than minimum levels of retention. For example, incorporate

flexibility in the stumpage appraisal system so that innovation is not discouraged by undue reliance on historic costs.

R3.16 Encourage innovative approaches to silvicultural practices throughout the stand rotation to promote diverse forest structure and habitats, and to attain structural features of old-growth forests. For example, patches of wide spacing during pre-commercial and commercial thinning can encourage more rapid development of characteristics similar to old growth in both the overstory and understory.

R3.17 Post-harvest silvicultural treatments should approximate natural patterns. For example, regeneration of naturally occurring species mixes should be encouraged and prescribed burning should be limited to small areas.

R3.18 Devise methods of monitoring the multiple objectives of retention silvicultural prescriptions (i.e., expand the Pre-harvest Silviculture Prescription (PHSP) beyond the current emphasis on attaining regeneration).

R3.19 Implement an adaptive management strategy to incorporate new knowledge and experience. Establish research and monitoring programs to assess effectiveness of these initial recommendations in meeting ecological, cultural, scenic, and economic objectives, and to improve recommendations on an ongoing basis.

R3.20 Because innovative practices may have unanticipated consequences, policy also must be adaptive. Establish policies to modify standards and practices when consequences contrary to the objectives of sustainable ecosystem management are clearly documented or when alternative approaches for achieving objectives are recognized. Act to ensure that monitoring procedures anticipate surprise and that regulations can be quickly modified to reflect new information.

R3.21 Phase in the variable-retention silvicultural system in Clayoquot Sound over a five-year period, according to the following schedule of *minimum* achievements:

- 20% of the annual area harvested by end of 1996;
- 50% of the annual area harvested by end of 1998; and
- 100% of the annual area harvested by end of 1999.

R3.22 Fast-track watershed-level planning. While the Panel recognizes that some harvesting by the variable-retention system will be undertaken *before* appropriate watershed-level planning can be completed, harvest without requisite watershed-level planning should be minimized.

Recommendations Relating to Harvesting Systems

R4.1 Select a harvesting system that meets safety and other specified objectives (e.g., minimal ground disturbance) consistent with variable-retention silvicultural prescriptions.

R4.2 Plan and implement yarding to minimize soil disturbance, site degradation, and damage to retained trees. Restrict ground-based logging to hoe forwarding or similar low-impact yarding methods appropriate to the prevailing weather and

soil conditions in Clayoquot Sound. Use partial or full suspension cable yarding and helicopter logging as required to minimize detrimental soil disturbance and damage to retained trees.

R4.3 Undertake operational trials of harvesting with the variable-retention silvicultural system at a range of levels and distributions of retention to establish design parameters and procedures for cutblock layout, falling, and yarding, particularly for skyline methods involving lateral yarding. Because this information is needed to support the recommended phase-in of a variable-retention silvicultural system, a cooperative effort (e.g., B.C. Ministry of Forests Engineering Branch, Forest Engineering Research Institute of Canada, and members of the forest industry) is warranted, including consultation with experienced operators in the Pacific Northwest.

R4.4 Develop education and training programs to provide forest engineers, technicians, and forest workers with the knowledge and skills required to plan and implement harvesting operations appropriate to a variable-retention silvicultural system in Clayoquot Sound. Provide continuing education opportunities to encourage development of a skilled, motivated, and stable workforce.

Training must address silvicultural objectives (e.g., habitat, biological diversity, regeneration) and operational constraints (e.g., harvesting system requirements, windfirmness, yarding patterns, falling patterns) at all levels, including:

- professional foresters who prescribe the level, type, and distribution of retention in the Pre-harvest Silviculture Prescription;
- forest engineers who formulate logging plans, and technicians who lay out retention cutting units; and
- fallers who make on-site decisions about safe and efficient falling, bucking, and yarding, and other forest workers involved in harvesting.

This education and training is urgent in view of the recommended phase-in schedule.

R4.5 A university-level program of study in forest engineering that would qualify its graduates for professional registration in both forestry (registered professional forester) and engineering (professional engineer) is needed to fulfil the greater demands for complex forest engineering and planning that the Panel's recommendations require.

R4.6 Government, forest companies, and labour, through discussion, must address issues of increased manpower requirements, reduced productivity (i.e., cubic metres per shift), and increased costs involved with the variable-retention silvicultural system.

Recommendations Relating to Transportation Systems

R5.1 Respect the following priorities in resolving conflicts related to road location:

- Where irreplaceable values or highly sensitive features are on or near a proposed road location, select another road location or do not build a road. Such features and values include special or rare habitats (including habitats known to be occupied by endangered, rare, and vulnerable species), heritage and cultural features, active floodplain areas and channels, areas mapped as stability class V or Es1, and all but highly localized areas of marginally stable terrain.

- Where damage to watershed integrity and ecosystem function is possible, construct roads only if: no alternative route is available; the road is required to access a substantial harvestable area; *and* mitigating measures (e.g., special construction, rehabilitation) are biologically and physically feasible. Seek professional advice from appropriate specialists approved by the B.C. Ministry of Forests (e.g., professional agronomists (soil scientists), professional biologists, professional engineers, professional geoscientists) whenever road construction is contemplated in areas including: mapped stability class IV terrain; highly erodible soils; mapped Es2 areas; localized areas of marginally stable terrain; or areas where significant impact on growing sites, riparian zones, or aquatic ecosystems can be anticipated.

- Where significant damage to visual or recreational values is possible, use the proposed location only where mitigating measures are feasible according to appropriate specialists.

R5.2 Improve on-the-ground performance in construction and maintenance of road drainage structures (ditches, culverts, bridges) to meet the demands of the wet climate. Reduce the impact of roads on hydrological regimes by constructing roads that allow the passage of shallow subsurface groundwater. Achievement of this recommendation will require research.

R5.3 Require an overall road deactivation plan that addresses and effectively integrates the needs for long-term access for stand tending, protection, and recreation. The plan should reflect the fact that roads are a long-term investment, often needed to facilitate future land management.

R5.4 For main or branch roads on slopes consistently greater than 55%, use full bench cuts and endhaul construction, or seek professional advice to ensure that slope stability is maintained and potentially affected resource values are not diminished. In rock cuts, use controlled blasting techniques and follow manufacturers' specifications to: avoid damage to standing timber, retain shot-rock on the right-of-way, maximize the utility of the rock for subgrade or rip-rap, minimize over-breakage, and prevent blast-triggered slides.

R5.5 Revegetate all disturbed areas associated with roads. Promptly apply erosion control, grass-legume (or equivalent) seed mixes to all denuded mineral soil surfaces (i.e., surfaces other than clean shot-rock or bedrock associated with road construction), including cutslopes, fillslopes, borrow pits, and waste disposal areas. Use indigenous, non-invasive species for revegetation wherever possible to avoid deleterious effects on non-forest communities (e.g., white clover, *Trifolium repens,* can invade saltmarsh communities and replace the native springbank clover, *Trifolium wormskjoldii*). Research is anticipated to increase the number of indigenous species available for rehabilitation.

R5.6 With the increased skyline yarding to central landings, and helicopter yarding that are expected to accompany the variable-retention silvicultural system, many roads will serve only transportation requirements (i.e., will not be used as a landing). Therefore, determine required road widths based on anticipated vehicles (i.e., vehicles that will use the road) and traffic volumes. Road widths should not exceed 4.25 m except as required on curves for sidetracking of trailer units and for turnouts. Wider or higher standard roads may be justified by special needs or safety, such as heavy industrial or recreational use, or regular use by local communities.

R5.7 Determine the percentage of the productive forest landbase to be converted to permanent access (roads and landings) on a watershed-specific basis during watershed-level planning. The maximum percentage of the *harvestable* area designated for permanent access should normally be less than 5%. All other temporary roads and access trails must be rehabilitated to a productive state.

R5.8 Standards are required for dryland sort and log dump construction, operation and maintenance. Construct and operate dryland sorts to ensure that:

- the surface of the dryland sort slopes landward, rather than seaward; and
- surface runoff is intercepted by a ditch on the landward side of the dump. The ditch should direct runoff to a collecting basin from which solids are filtered and regularly removed.

R5.9 On all proposed log dump sites, undertake an ecological assessment that permits DFO to evaluate productivity and sensitivity of the system (including non-commercial species); a physical assessment to determine site exposure to waves and storms, anticipated wave velocities and direction, and near-shore terrain conditions; and an assessment of probable impacts (including noise) on heritage, scenic, wildlife, and recreational values.

R5.10 Minimize time logs are in the water, especially shallow water, by sorting on land and storing log bundles in deep water.

R5.11 Locate log dumps at sufficient distances from sensitive areas such as herring spawning sites, shellfish beds, estuaries, or eelgrass beds, to preclude physical disturbance or deposition of deleterious organic materials.

R5.12 Ensure log dump sites are deep enough to avoid problems with the propeller wash of dozer boats and grounding of booms or bundles.

R5.13 Restore sites that have been damaged by excessive accumulations of bark, woody material, or fine organic material.

Recommendations Relating to Scenic, Recreational, and Tourism Values and Resources

R6.1 Involve the provincial government, First Nations, regional and local governments, recreation and tourism groups, industry, and other public interest groups in the inventory, analysis, and planning of scenic resources. Provide opportunities for meaningful involvement by the public at large.

R6.2 Develop an inventory system for scenic resources with the following characteristics:

- Map scenic resources for all of Clayoquot Sound at a scale of 1:250 000 which considers overall landscape patterns and the role of the landscape in relation to existing and potential use.
- Develop a new inventory system for visual landscape units which would be used during subregional and watershed planning. During this inventory, divide the study area into landscape units based on similarities in landscape characteristics (e.g., physiography and level of alteration), the degree and type of human activity, and viewer-related factors. For each landscape unit, describe the landscape characteristics, including the degree of alteration or development and major land and water uses.
- Develop a new scale to describe visual quality objectives which: describes alteration by less technical terminology, is easier for the public to understand, is unrelated to silvicultural system terminology, and accounts for uses other than forestry. The following terms could be used: unaltered/undeveloped, natural-appearing, minimal alteration/development, moderate alteration/development, highly altered/developed, intensively altered/developed.
- Clearly summarize the landscape inventory information on maps (e.g., landscape characteristics, degree of alteration/development) so that participants in the planning process can understand and provide input to the inventory.

R6.3 Use the information from the landscape inventory, existing and potential use patterns, and public preferences in the area to analyze scenic resources. Determine the patterns in the landscape, levels of scenic quality, and opportunities and constraints for use related to future scenic resources. Conduct this analysis at the subregional and watershed levels. Computer modelling is an effective way to analyze the landscape inventory information. Involve the planning group in the analysis.

R6.4 Based on the analysis in R6.3, develop a long-term management plan (e.g., 100 years with review every five years) for scenic resources. This plan should identify visual landscape management units for all of Clayoquot Sound. For each management unit, include:

- a description of the essential characteristics of the scenery;
- existing and potential resource values and human uses;
- the relative value of scenic resources in the unit; and
- visual landscape management objectives, including the desired character of the area, the proposed level of alteration or development, needs and methods of rehabilitation, acceptable land and water uses, and any specific measures that may be required to protect scenic values.

Quantification of alteration should be avoided. Examples are a better way of showing intent. The plan should be developed in consultation with the planning group identified in R6.1.

R6.5 Integrate the recommendations of the visual landscape management plan into all other forest plans during subregional-level, watershed-level, and site-level planning. Where visual concerns must be reconciled with those of other resource values, do so in a collaborative manner with all disciplines represented, recognizing that the primary goal is to maintain ecosystem integrity.

R6.6 Use landscape design principles in the development of detailed silvicultural plans and development plans for other uses. Having someone with visual landscape skills involved in the initial layout of cutting units facilitates the design process. Require visual impact assessment and subsequent refinement of proposed alterations to meet visual landscape objectives on all of the most important scenic areas. Involve the public in the review of proposed harvest areas, providing illustrations that can be easily understood.

R6.7 Continue the development of visual landscape guidelines in consultation with interdisciplinary teams, using monitoring and research results to refine the guidelines so that all resource values are appropriately addressed.

R6.8 Integrate planning for recreational and tourism resources. Because of their strong interrelationships, plan recreation and tourism in concert with planning for scenic resources.

R6.9 Ensure that the First Nations, provincial, regional, and local governments, and recreation and tourism groups are the principals involved in the inventory, analysis, and planning of tourism and recreational resources. Create opportunities for meaningful involvement by other public and industry groups.

R6.10 Ensure that recreation inventories are conducted at subregional scales (e.g., 1:250 000) and watershed scales (e.g., 1:50 000 or 1:20 000). Display inventory information in a form that is easy for the public to understand.

R6.11 Analyze recreational and tourism opportunities, and develop plans for recreation and tourism at the subregional, watershed, and site levels. At the subregional level, these plans should include recreation opportunity spectrum (ROS), scenic, and other management objectives for all areas, including identification of acceptable activities and uses. At the watershed level, plans should include potential uses and facilities for specific sites, and management objectives for protecting the resources at those sites. Management objectives should include the level of protection required, from complete protection to protection of key features. At the site level, plans should ensure that key characteristics of the site are retained and that alteration or development is sensitive to the value of the resources to the public.

R6.12 Ensure that forest planning addresses recreational and tourism values and resources through explicit objectives.

Recommendations Relating to Planning for Sustainable Ecosystem Management in Clayoquot Sound

R7.1 Adopt an ecosystem approach to planning, in which the primary planning objective is to sustain the productivity and natural diversity of the Clayoquot Sound region. The flow of forest products must be determined in a manner consistent with objectives for ecosystem sustainability. This entails abandoning the specification of AAC as an input to local planning.

R7.2 Adopt physiographic or ecological land units, rather than administrative units, as the basis for planning. Use the watershed as the basic unit for planning and management, recognizing that more than one watershed may be required to plan for values such as biodiversity, scenery, and cultural features.

R7.3 Use practices that represent the best application of scientific and traditional knowledge and local experience in the Clayoquot region. To accomplish this, collect appropriate baseline information about the full range of biophysical and cultural forest resources and values, and use this information and knowledge to assess ecological responses to change.

R7.4 Engage the Nuu-Chah-Nulth and other local people in all phases of planning and managing the land, freshwater, and marine resources of Clayoquot Sound.

R7.5 Develop plans at subregional, watershed, and site levels, and establish internal consistency among these plans, so that plans developed for smaller areas and shorter time periods are consistent with plans for larger areas and longer time periods.

R7.6 Ensure that plans are consistent with land-use objectives for adjacent Protected Areas and special management zones.

R7.7 Base planning on a long-term perspective, at least in the order of 100 years when considering large areas, and 10 years for operational planning of smaller areas. These time frames are required to incorporate the cycles of many natural processes, and to ensure that operational plans address post-harvest management.

R7.8 Inventory, analyze, and plan for a full range of forest resources, forest uses, and forest management activities. Undertake new inventory as needed at an early stage of planning, prior to analysis.

R7.9 Monitor the effects of plans and check against management objectives to facilitate adjustments to better achieve intended goals; that is, employ adaptive management procedures.

R7.10 Recognize that the rate (percentage of area cut per unit time) and geographical distribution of timber harvesting are more important determinants than is the volume removed when wood harvest is planned. *After* analysis of resources and development of area-based plans, determine the anticipated annual volumes of timber to be cut for watershed-level planning units.

R7.11 Appoint a planning committee, which includes stakeholders and other interested parties and experts at all levels of planning, to coordinate the planning process in Clayoquot Sound. Committee members must be highly motivated,

knowledgeable about resources, and willing to adopt the protocol described in R7.14.

R7.12 Open planning committee meetings to public observation and participation. Interested members of the public should be able to request time on meeting agendas for making presentations. All papers, reports, and documents used by the planning committee should be available for public review.

R7.13 Notify subregional- and watershed-level planning committees about site-level plans. These committees do not need to be involved in site-level plans, although they should monitor the implementation of these plans to ensure that they are in accordance with watershed and subregional plans (e.g., Tsitika Follow-up Committee adopted a similar role). At the site level, the forest manager involved (i.e., tenure holder, licensee, or government agency) should undertake planning in accordance with higher level plans, and with appropriate expert assistance.

R7.14 Planning should include the following steps:

- Develop and agree on a working protocol, based on mutual respect, that will guide the planning process. The protocol must clarify how the group will work together, how disputes will be settled, how decisions (consensus or other) will be reached, and how the process (including meeting and work schedules) will proceed.

- Establish planning objectives in terms appropriate for each planning level. Identify the types of environmental and cultural resources that are to be protected.

- Based on these objectives, determine the methods and scope of the inventory required.

- Analyze data to determine status of resources, rates of biological processes, and consequent land and resource sensitivities and capabilities. Support planning as needed with technical analysis by experts from appropriate resource management agencies, forest companies, First Nations, and other parties. Identify areas to be reserved and areas where resource extraction or development may occur, including constraints that may limit the amount and type of activity.

- Develop plans for specific management activities based on input from members of the planning team and the public. Evaluate various plan options to determine which best meets planning objectives.

- Implement plans primarily at the site level (i.e., confirm boundaries of harvestable areas and specific locations of resource extraction and development activities). As noted in the Panel's second report, workers with education and training in ecosystem management must conduct this step; worker skills should be upgraded as required. Effects of implementation extend beyond the site. Monitoring should be instituted at site and watershed levels to track effects.

- Monitor ecosystem processes and components to assess the extent to which objectives are being met.

R7.15 Implement the following time frames for planning:

- 100 years for subregional-level planning with major revisions every 10 years, or more frequently if required;
- 100 years for watershed-level planning, showing projected activities in 10-year increments, with revisions every five years, or more frequently if required; and
- 10 years for site-level planning, starting five or more years ahead of the work, with revisions every year during active operations.

Resource planning should be conducted within a 100-year horizon, and operational planning should occur within a 10-year horizon. Planners and managers must realize, however, that factors operating on the longer time scales of the ecosystem may affect plans and activities within the 10- to 100-year scales. A very significant effect may be associated with the changing resiliency of animal populations in the face of clearing and fragmentation of formerly continuous forest habitat.

R7.16 At the watershed level, map and designate reserves in which no harvesting will occur to protect key hydroriparian ecosystems, unstable slopes and sensitive soils, red- and blue-listed species, late successional forest with forest-interior conditions, important cultural values, and areas with high value scenic and recreational resources. Integrate reserve establishment with the refinement and detailed mapping of various land-use zones (e.g., Protected Areas). Reserves include:

- Reserves to protect hydroriparian resources.

  Identify reserves that include the drainage system and hydroriparian zone around streams, lakes, wetlands, and marine shores to ensure adequate protection for aquatic and riparian ecosystems. Drainage features and their hydroriparian zones are critical to protecting ecosystems, especially in Clayoquot Sound. The approach to maintaining their functional integrity proceeds from a classification system based on both physical and biological features.

- Reserves to protect sensitive soils and unstable terrain.

  Identify reserves for unstable slopes by the extent of stability class V terrain as determined by the methodology outlined in the forthcoming *Mapping and Assessing Terrain Stability Guidebook.* Sensitive soils (e.g., blocky colluvium, very shallow folisols) which decline in productivity when disturbed must also be reserved. Only stable terrain and resilient soils should be available for forest harvesting operations.

- Reserves to protect red- and blue-listed plant and animal species.

  Red- and blue-listed species are either threatened, endangered, vulnerable, or rare. Identify and reserve habitats for species on these lists, recognizing that protection is often better implemented at the site level for widely ranging, rare species; and that planning their protection may occur at the subregional level.

- Reserves to protect forest-interior conditions in late successional forest.

  Some species of plants and animals are closely associated with microclimatic conditions found inside older forests. It is important, therefore, to maintain some patches of older forests that provide conditions similar to the interior of historic forests. Assuming tree heights of 50 m, a reserve width of 300 m will provide at least some forest-interior conditions. The Panel recommends that 20% of the forests in age classes 8 and 9 of a watershed-level planning unit should constitute forest-interior conditions.

  Use 1:10 000 to 1:20 000 scale air photos and forest cover maps to identify forest-interior conditions. Providing no evidence is found that age class 9 requires further subdivision, the Panel assumes that this habitat information is readily available from forest cover maps. Monitoring should be designed to evaluate this assumption.

- Reserves to protect cultural values.

  The Panel's report *First Nations' Perspectives Relating to Forest Practices Standards in Clayoquot Sound* discusses a variety of culturally important areas, including sacred areas, historic areas, and current use areas. These areas must be determined by the Nuu-Chah-Nulth Nations and protected in ways consistent with traditional knowledge.

- Reserves to protect scenic and recreational values.

  Protect areas with especially high scenic and recreational values from alteration. These areas include unprotected unaltered areas with the highest scenic values, unaltered scenic areas of high value which are important because of their location (e.g., visible from a community or an important recreation site), and important recreation sites such as beaches or bays with primitive use objectives. Identify these areas through the scenic and recreational planning processes.

- Reserves to represent all ecosystems.

  Calculate areas of each biogeoclimatic site series (or surrogate) contained within all designated reserve areas. Note that the previously mentioned reserves will commonly overlap. Add to these reserves, as necessary, to ensure that the entire variety of ecosystems is represented in the reserve system to maintain plants, animals, and other organisms that have specific habitat requirements. Reserve ecosystems that are rare in greater proportion than their representation in the area.

- Reserves to ensure linkages among watershed-level planning areas.

  Based on information from the subregional planning level, add to the reserve as necessary to allow migrations of animals, to provide connectivity among plant and animal populations, or to accommodate recreational opportunities.

R7.17 Designate the entire hydroriparian zone as a special management zone.

A special management zone is an area to which particular land management rules or constraints apply. These rules are the direct consequence of the quality of the terrain or features found in the area. The hydroriparian zone consists of the entire floodplain of the stream, alluvial fan surfaces, and, where channels are entrenched, the entire slope that rises immediately from the channel. Hydroriparian zones delimited by none of these features are defined according to microclimate influences around the stream, as previously discussed. The floodplain is the flat valley floor ("valley flat") constructed by the river, hence underlain by alluvial sediments.

R7.18 Reserve the entire "contemporary floodplain" of streams in Class A(1) (alluvial channels with gradient less than 8%), except areas of "dry floodplain" more than 50 m from a perennially or seasonally active channel or site of seasonal standing water. Dry floodplain may be a special management area harvested by a silvicultural system with high retention, provided that appropriate access can be arranged.

The "contemporary floodplain" is the valley flat adjacent to a stream channel that is subject to inundation in the contemporary streamflow regime and that, consequently, has soils composed of recently deposited stream sediments. "Active floodplain" denotes that part of the floodplain subject to frequent inundation; that is, occupation by standing or flowing water more often than once in five years. The five-year period is chosen because regional analyses of stream flooding in western North America show that nearly all streams with contemporary floodplains exceed "bankfull" and occupy at least a part of the floodplain at least once in every five years. At a frequency of once in five years, the annual and partial duration flood sequences essentially coincide: that is, water levels are unlikely to be so high more than once within the same year.

This one-in-five-year frequency definition of the active floodplain is operationally identical with that of "riparian woods" given in the *Proposed Wetland Classification System for British Columbia*.

"Dry floodplain" means floodplain areas subject only to occasional inundation (i.e., occupation by standing or flowing water at least once in 30 years), and not otherwise classified as "wetland." A period beyond 30 years is difficult to establish.

In practice, frequency of inundation on many floodplains cannot be precisely determined: the presence of water-tolerant understory plants will be the best indicator of the extent of the active floodplain. Dry floodplain areas may be discriminated by the presence of overbank stream sediments deeper than in the active floodplain, on which a substantial litter layer (LFH soil horizon) has accumulated. "Appropriate access" in this recommendation (R7.18) means access that does not, in the opinion of a professional biologist with expertise in riparian ecology, constrain or threaten ecosystem function in any way (as by establishing a barrier to waterflows or to the movement of animals).

R7.19 In Class A(2) (alluvial channels with gradient of 8–20%), reserve areas within 50 m of present channels (30 m for A(2)(i): channels less than 3 m wide), recently active channels, and any other routes that appear, in the opinion of a professional geoscientist or professional engineer with expertise in fluvial geomorphology or river engineering, to be subject to avulsion. Other portions of the hydroriparian

zone of Class A(2) streams may be harvested by a high retention system. In the case of alluvial fans, the "contemporary fan surface" shall be treated the same as the contemporary floodplain (R7.18) and reserved from logging.

R7.20 Treat streams in Class B(1)(a) (non-alluvial channels with gradient less than 8%, not entrenched) as Class A(1) (see R7.25 for exceptions).

It is probable that, in this class, a much larger portion of the valley flat will be dry floodplain, hence available for high retention harvest. In many cases, the "valley flat" will consist of a low terrace, but it will be difficult to obtain unequivocal evidence that the stream does not inundate the surface, or to obtain expert agreement on such a classification. This physiographic situation is common in British Columbia; in many situations, streams are very slightly degraded into early Holocene alluvium but have immediately armoured their bed with large rocks and have not formed trenches. In addition, the absence of hydrological measurements on most streams means that flood levels cannot be established with legal precision. This recommendation seeks to avoid the need for controversial decisions because frequent inundation is easy to demonstrate.

R7.21 For streams in Class B(1)(b) (non-alluvial channels with gradient less than 8%, entrenched), designate a reserve that extends to the top of the entrenchment slope or 50 m from the streambank (30 m for B(1)(b)(i), width less than 3 m), whichever is greater. Feathering for windfirmness may be permitted at the outer edge of the reserve (see also following comment). An additional reserve or "no machinery" zone of at least 30 m width will be designated beyond the top of slopes that are being actively undercut by the stream.

The top of the entrenchment slope coincides with the limit of the "inner gorge" as specified in the *British Columbia Forest Practices Code Standards with Revised Rules and Field Guide References*. The purpose of the additional reserve or special management zone above undercut slopes is to avoid aggravating potential instability by destroying the root network. Mature trees in this zone may be harvested if they can be felled away from the stream within a high retention harvest plan. Streams confined by stable rock slopes constitute a special case (see R7.28).

R7.22 Treat streams in Class B(2)(a) (non-alluvial channels with gradient 8–20%, not entrenched) as Class A(2) (see R7.25 for exceptions).

Streams in this category will often be flowing on steep alluvial fans where it is difficult to decide whether the surface is "active" (subject to frequent inundation). They may be subject only to very rare (but major) debris-flow events. Defining any part of the fan surface that is not liable to experience avulsion will be more difficult than in the case of Class A.

R7.23 Treat streams in Class B(2)(b) (non-alluvial channels with gradient 8–20%, entrenched) as B(1)(b).

R7.24 For streams in Class B(3)(a)(i) (non-alluvial channels with gradient greater than 20%, not entrenched, seasonal or perennial flow), designate a reserve that extends 20 m from the channel.

Seasonal or perennial streams, unlike ephemeral streams, have regular base flow, derived either from springs or persistent seepage through the banks.

R7.25 Designate no general reserve for streams in Class B(3)(a)(ii) (non-alluvial channels with gradient greater than 20%, not entrenched, ephemeral flow), and those channels in classes B(1)(a)(i) and B(2)(a)(i) (non-alluvial channels with gradient less than 21%, not entrenched, less than 3 m wide) that carry only ephemeral flow. But, require evaluation by a professional biologist to determine whether special management prescriptions are warranted for ecological reasons, and employ special management where deemed necessary.

This recommendation seeks to avoid excessive division of the landscape around small ephemeral channels. Nearly all of these channels will be directly downslope from channels in Class B(3)(a)(ii), which are similarly treated.

Ephemeral streams carry storm runoff only, which is derived from bank seepage or from overland flow. Ephemeral streams should be classified during ground-based terrain checking. Most of these streams will be less than 1 m wide. Special management prescriptions might specify local reserves, and no machinery (falling and yarding away from the hydroriparian zone).

R7.26 For streams in Class B(3)(b) (non-alluvial channels with gradient greater than 20%, entrenched), designate a reserve that extends to the top of the entrenchment slope or 20 m from the channel, whichever is greater. However, if the sidewalls adjacent to the channel (and including the channel zone) are classified as having low or no potential for instability, then apply criteria for Class B(3)(a). Apply gully assessment procedures to channels that are classified as gullies according to the *Gully Assessment Procedures for British Columbia Forests.* Most streams in this category in Clayoquot Sound will be gullies.

R7.27 Apply the gully management prescription according to the *Gully Assessment Procedures for British Columbia Forests.* However, modify the pre-logging management strategies described in their procedure for use in Clayoquot Sound so that all channels assessed as having high or moderate potential for downstream impact, and high or moderate potential for debris flow, water flood, or fan destabilization shall have no logging within the gully.

R7.28 Notwithstanding the foregoing recommendations, Class B streams (non-alluvial channels) that are confined by stable rock walls, and are classified as having low overall habitat value and low potential to affect downstream reaches have no special management requirements with respect to hydroriparian integrity. Where a V-notch in surficial material occurs immediately above a rock notch, apply the prescription for a trenched channel.

This recommendation seeks to avoid defining special management or reserves for barren rock-bound cascades and waterfalls. Of course, many such sites have special habitat value. Other constraints, in particular cultural or scenic constraints, may also apply.

R7.29 In community watersheds, make all channels above the intake subject to the previous prescriptions. In addition, extend the special management zone 50 m from any channel, even if the hydroriparian zone or entrenchment slope does not extend so far.

This prescription provides additional assurance that the soil near channels is not damaged in any way that would compromise its ability to effectively filter water seeping into the channel.

R7.30 Around all lakes, designate a special management zone that includes all the area under hydroriparian influence, or 50 m, whichever is greater. The first 30 m from the shore shall be a reserve. The remaining zone may be subject to retention systems of harvest provided it is outside the hydroriparian zone proper.

R7.31 Where special inshore lacustrine, ecological, or cultural values are identified (e.g., inshore spawning gravels), and steep slopes occur immediately behind the shore, extend the reserve or special management zone upslope as far as necessary to protect these special values.

R7.32 For Class (2) lakes smaller than 4 ha in area, designate a reserve that includes all the area under hydroriparian influence or 30 m, whichever is greater.

Lakes are superficially equivalent to contemporary floodplains which require a 50 m reserve. For a lake of 4.5 ha, the area of a 50 m surrounding reserve becomes equal to the area of a circular (most compact) waterbody. For smaller waterbodies the reserve is larger than the waterbody. Acknowledging the distance required for climatic factors such as wind, temperature, and humidity to adjust to a change in the character of the surface, designating a reserve zone very much larger than the protected waterbody appears unreasonable.

R7.33 On low gradient edges of a wetland, establish a reserve that extends to the limit of hydroriparian influence.

Low gradient in this case means essentially flat ground, less than 1% slope. Establishment of the "limit of hydroriparian influence" in the foregoing recommendations should be based on understory plant associations or on soil characteristics.

R7.34 On sloping edges of a wetland, establish a special management zone on the same basis as for lakes.

R7.35 On Class A(1) and A(2)(i) shores (low shores adjacent to open waters), extend a riparian reserve inland 150 m from the seaward edge of forest vegetation, or to the inland limit of shore-associated features (e.g., overgrown sand dunes), whichever is greater.

The distance is determined by wind forces and the distance for wind attenuation inside the forest. Measurements on the lower Alaskan coast indicate that 150 m is sufficient to achieve this.

R7.36 On the remaining Class A(2) shores (cliffs, bluffs, and steep shores adjacent to open waters), extend a riparian reserve 100 m inland from the top of the coastal slope or bluff. On eroding shores, a larger distance may be specified if required by slope stability criteria.

R7.37 On Class B marine shores, extend a riparian reserve 100 m inland from the seaward edge of forest vegetation, or to the inland limit of shore-associated features (e.g., sand dunes and lagoons, now within the forest), whichever is

greater. For lagoons within the forest, establish a reserve on the inland shore (R7.30).

R7.38 In estuaries proper, make a smooth transition from the marine shore reserve to the streamside special management zone.

R7.39 Avoid road construction in hydroriparian reserves. Where no practical alternative is possible, abandoning the development may be advisable. If the development does proceed, engineer and construct the road to minimize disturbance. Require professional engineering supervision at all stages of road construction. The chief circumstances where a road may have to enter a hydroriparian reserve is for direct crossing from one side to another of a stream reserve, or to follow an active floodplain or lakeshore where the higher terrain is not accessible or cannot be safely crossed.

R7.40 In hydroriparian reserves, engineer the road and bridges to ensure that the security of neither the road nor the hydroriparian ecosystem is jeopardized. The road shall not interfere with the circulation of water or with the movement of terrestrial or aquatic animals. In particular, the design must ensure that the roadway does not act as a dam during periods of high flow or storm surge, nor as a source of sediment.

R7.41 Roads constructed near the slope base at the edge of a floodplain or other hydroriparian zone must provide for passage of cross-drainage into the riparian zone. Design traffic and machinery holding places to prevent traffic-associated contaminants from escaping into the hydroriparian zone. Select road surface materials to minimize dust production.

Recommendations Relating to Monitoring

R8.1 Initiate a long-term monitoring program that includes both areas that are reserved from land-use practices and areas that will experience land-use practices.

R8.2 Incorporate into the monitoring program the elements summarized in Sections 8.2 through 8.4. Specifically, monitor:

- watershed and coastal integrity – including hillslopes and forest soils, stream channels, regional streamflow and water quality, and the coastal zone;
- biological diversity – including genetic variation, vulnerable and rare indigenous species, terrestrial environments, old-growth characteristics, and aquatic environments;
- human activities and values – including areas important to First Nations; scenic, recreational, and tourist values; and regional commodity production; and
- implementation of forest management plans.

R8.3 Use the findings of this program to modify, as required, management strategies as well as individual plans and practices.

Appendix II

Classification of the Hydroriparian System

1.0 Bases For Classification

The most basic division is defined by the nature of the waterbody, because this fundamentally determines the nature of the associated ecosystems. Lotic (streams), lentic (standing fresh water), and marine are the basic units.

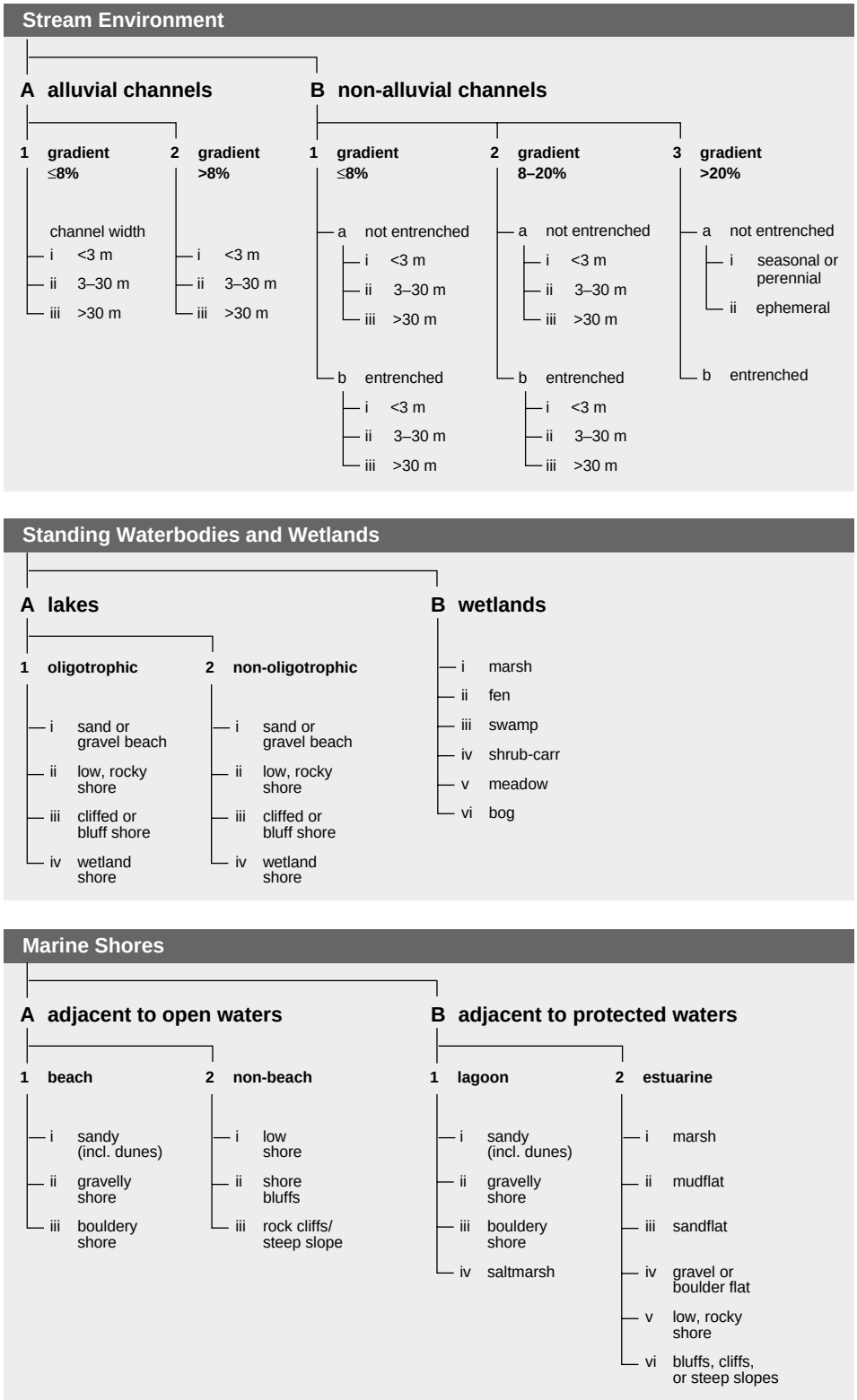
Within stream channels, the most basic division is between alluvial channels (ones flowing through their own deposits), and non-alluvial channels (flowing on bedrock, or on sediments other than alluvium). This criterion is coincident with the criterion of "confinement," because an unconfined channel is always one flowing with at least one alluvial bank. The next most important criterion is stream gradient, because this determines important aspects of fluvial processes and morphology. A third criterion is entrenchment: entrenched channels are those confined within fluvially eroded gullies or valleys of some depth. A final criterion is stream size, which influences some of the physical and biological processes. These criteria exert a powerful influence over the associated ecosystems. They can be determined (for purposes of classification) during terrain mapping. The latter is an important practical requirement.

Within the class of alluvial stream channels, the definition of a "floodplain" presents some difficulty. The genetic definition—the surface of a body of sediment deposited by the stream—ignores whether a change of stream regime has led to degradation and consequent development of a terrace (which is not subject to inundation). The difference is ecologically significant. A definition based on the possibility for inundation to occur needs some qualification about the frequency of inundation, but it is not practically applicable in terrain analysis procedures. The best discriminators probably are the presence of indicator plant species in the understory and immature cumulic soils, which can definitively be decided at the stage of field checking. Adoption of such criteria will require local guidelines.

Lentic freshwater environments are divided according to whether the water environment consists of permanent open water more than 1 m deep (a lake) or is a wetland. A second significant distinction is based on the nature of the lacustrine ecosystem: oligotrophic lakes are distinguished by relatively poor nutrient status. Wetlands have been further classified (e.g., as fen, marsh, swamp, bog). A second criterion is waterbody size. As in streams, this criterion determines some of the physical and biological processes between the waterbody and the adjacent land.

Marine units are classified by the physical nature of the shore, and by the nature of near-shore waterbody depth and circulation. A fundamental division, analogous to that between alluvial and non-alluvial channels, is that between shores with a beach and without.

(Figure 7.4) Classification of the hydroriparian system.



2.0 Classification

2.1 Stream (Lotic) Environment

A Alluvial channels

These are channels with a flanking floodplain, including estuarine channels in deltas, and alluvial fans (also called "fluvial fans"):

1 with gradient less than 8%
(i) channel width less than 3 m
(ii) channel width between 3 m and 30 m
(iii) channel width greater than 30 m

Notes: Channels with gradient less than 8% (4.6˚) have primary morphological units consisting of pools separated by riffles or extended rapids. Anadromous salmonids are found in these channels. Channels with gradients greater than 8%, up to 20% (11.3˚) have step-pool morphology. Resident fish may be present.

2 with gradient greater than 8%
(i)–(iii) width criteria (as in A(1))

Notes: In the case that the channel has one bank alluvial, and one bank non-alluvial, it will be classified as alluvial. The bed need not be alluvial, but cases of a non-alluvial bed with contemporaneously active alluvial bank will be rare to non-existent. In Type (1), many channels less than 3 m wide will be secondary channels on floodplains, which will be incorporated into the unit defined by the main channel. Type (2) will usually be alluvial fans; in Type (2), width criterion (iii) will be rare to non-existent.

B Non-alluvial channels

1 with gradient less than 8%

a) not entrenched
(i)–(iii) width criteria (as in A(1))

b) entrenched
(i)–(iii) width criteria (as in A(1))

Notes: These groups may include fairly large channels which have degraded and are now flowing on lag armour (unconsolidated material—typically cobbles or boulders—that the stream is not capable of moving, so that it is not alluvial in the current regime) between terraced banks. An entrenched channel is one that is continuously confined within banks sufficiently high that overflow may not occur, as the result of downward fluvial erosion. Gullies, ravines, and bedrock gorges are typical landforms of entrenchment.

2 with gradient in the range 8–20%

a) not entrenched
(i)–(iii) width criteria (as in A(1))

b) entrenched
(i)–(iii) width criteria (as in A(1))

Notes: (a) will principally be steep alluvial fans. In this gradient range, width class (iii) probably is non-existent. Most debris flows will stop in this gradient range.

3 with gradient greater than 20%

a) not entrenched
(i) seasonal or perennial
(ii) ephemeral

b) entrenched

Notes: Although streams in this class are steep, they retain significant hydroriparian function for maintaining water quality downstream, and significant values as animal travel routes and the growth site of riparian herbs and shrubs—including some with otherwise limited distribution. Fish are not normally present. Gradient is usually bedrock-controlled. In (a), one will classify mainly seasonal to ephemeral rills on hillsides. In (b), one will classify mainly gullies, but the class will include possibly sizable rivers cascading down bedrock-controlled channels from hanging valleys. Stream width will usually be less than 3 m. Gully floor width is more significant than channel width, but usually will not be critical for processes. Debris flows may start and will be maintained on these gradients. An upper limit for stream channel gradients (other than cascades and waterfalls on bedrock) is 60%.

In the Clayoquot Sound region, most of the channels belong either to A(1) or to B(3). This is a reflection of the dominantly steep slopes and glaciated main valleys. Class A(2) streams occur on footslopes, alluvial fans, and cones.

2.2 Standing Waterbodies and Wetlands (Lentic Environment)

A Lakes

1 oligotrophic
(i) sand or gravel beach
(ii) low, rocky shore
(iii) cliffed or bluff shore
(iv) wetland shore

2 non-oligotrophic
(i)–(iv) shore types (as in A(1))

B Wetlands

(i) shallow open water
(ii) marsh
(iii) fen
(iv) swamp
[(v) shrub-carr]
[(vi) wet meadow]
(vii) bog

Notes:

Types in square brackets do not occur in the Clayoquot Sound region.

Shallow open water denotes ponds and sloughs with submerged aquatic plants and less than 2 m water depth in midsummer.

A marsh has free-standing water with emergent vegetation or remains waterlogged throughout the growing season.

A fen (minerotrophic mire) is a wetland with limited peat accumulation, maintained by groundwater and runoff. Fens often occur as shoreline wetlands peripheral to lakes, ponds, and low gradient streams. These are particularly important as prime sources of the tall basket sedge (*Carex obnupta*), used by Nuu-Chah-Nulth people for basketry. The most productive sites for this sedge are near or under western redcedar and red alder where open fens grade to sparsely forested swamps.

A swamp is a forest or high shrub mineral wetland or peatland that is periodically flooded. Swamps include sparse, open-canopy to closed canopy forests of various mixes of western redcedar, red alder and shore pine (the latter is more commonly associated with bogs). Most of the surface is usually submerged, but there are periods when the soil may be dry and aerated. Very poorly drained, sparsely forested swamps are characterized by western redcedar, yellow-cedar (increasingly at higher montane to subalpine elevations), red alder, crabapple, salmonberry, stink currant, skunk cabbage, giant horsetail—all of which are culturally important. The poorly drained, closed-canopy forested swamps are less variable, with a predominance of western redcedar and an understory of western hemlock, both growing on raised microsites comprised largely of accumulations of rotting wood. Characteristic minor vegetation includes skunk cabbage growing in wet, mucky organic materials situated in depressions between the drier hummocks. On the minor hummocks, grows minor vegetation similar to that of mesic sites—*Vaccinium* spp., *Cornus canadensis, Hylocomium splendens, Rhytidiadelphus loreus,* etc. This latter type is properly classified as a western redcedar swamp forest, but is not generally recognized as such. Historically, only this type has been logged.

[In Clayoquot Sound, fens include shore-pine fens, and swamps include cedar swamps and *Carex* swamps within the forest.]

Shrub-carr is a shrub-dominated wetland developed on mineral soils that is periodically saturated but rarely inundated; a wet meadow is a herbaceous wetland that is rarely inundated. The latter two types are not waterlogged in the growing season. All six foregoing types are fed by inflowing surface or groundwater.

A bog (ombrotrophic mire) is a peat accumulation which has grown above the local water table so that the water in the upper peat is sustained by precipitation.

These definitions are consistent with the *Proposed Wetland Classification System for British Columbia* (Kistritz and Porter 1993).

Appendix III

Information Requirements for Planning

Information about the variety and composition of ecosystems in the Clayoquot Sound area, including all natural resources, is a basic requirement for planning. Inventory information also provides baselines for monitoring management activities. The detail of inventory required will vary with the decisions to be made. Where existing information is inadequate to support informed decision-making, additional information must be collected before planning continues. Information should be periodically updated as management activities proceed.

At time of writing, an interministry task force of the provincial government—the Resource Inventory Committee (RIC)—is developing and testing detailed provincial standards for about 80 categories of inventory, covering plant and animal species, soils, and other features. These standards will ensure that information collection, analysis, and interpretation are consistent; they may require adjustment for regional variations in the environment. In addition to these inventory standards, about 65 field guides are being developed in association with the proposed Forest Practices Code to provide standards for implementation of the Code. Some of these guides will specify procedures for resource inventory.

The ecosystem-based approach to forest planning advocated by the Panel may necessitate the collection of information additional to, or different from, that addressed in the RIC inventory standards or in the Forest Practices Code field guides. Accordingly, this appendix lists information required for ecosystem-based planning as detailed in Chapter 7 of this report. Information requirements for each planning level (subregional, watershed, and site) are organized by major themes considered during planning: watershed integrity, biological diversity, cultural values,[156] scenic resources, and recreation and tourism. Methods for monitoring growth and yield of wood fibre have a long history in forest management, are well-defined, and are not included here.

1.0 Historical Information

To ensure that the knowledge gained from past experience is used effectively, information on the history of logging and, where possible, natural disturbances, in Clayoquot Sound must be assembled, mapped, and made readily available to planners at all levels. Such information should include, but not be limited to:

- cutblocks – noting dates and details related to harvesting system, volume of wood of each species harvested, site preparation, rehabilitation, regeneration, and stand tending activities
- road network – noting dates and location of construction, deactivation activities, and any road-related slope failures or landslides

[156]The Panel's discussion of values in this appendix highlights First Nations' values. This focus is not intended to deny other values (see Sections 1.1 and 6.0).

- natural disturbances – noting extent and frequency of wind, insect, landslide, and fire
- human-induced disturbances – noting their type, duration, area of influence, and effects on resources.

2.0 Subregional-Level Information

Subregional planning addresses issues and resources that span large areas and often cross watershed boundaries. While the entire Clayoquot Sound area might be considered as a subregion, the Panel recommends dividing Clayoquot Sound into three subregions (see Section 7.3.1) because of the abundance of data and logistical difficulties of dealing with so large an area. Appropriate subregional mapping scales range from 1:50 000 to 1:125 000, depending on the resource of interest.

2.1 Watershed Integrity

At the subregional scale, information related to watershed integrity consists of basic geological and drainage information that provide the framework for mapping surficial materials, soils, drainage, and stream channel features at watershed and site scales, and that supply the context for understanding water quality and soil nutrient conditions. This includes:

- map of bedrock geology
- map and report of glacial and Holocene earth history[157]
- map of drainage basins and the drainage network showing all points for which hydrological and climatological information are available.

2.2 Biological Diversity (Aquatic and Terrestrial)

Subregional concerns related to biological diversity focus on maintaining adequate habitats to allow migration of animals and connectivity among plant and animal populations across watershed boundaries. The following information will help to identify those linkages:

- maps of major ecosystems showing:
  - areas of older forest[158] that link across watershed boundaries
  - major vegetation types (e.g., biogeoclimatic zones and subzones, and forest age classes), highlighting those that are rare

[157]The glacial and Holocene earth history provide the context for predicting the occurrence of certain surficial materials, soils, and natural stability problems that must be confirmed in more detailed mapping at a watershed scale.

[158]See footnote 132.

- maps showing current forest condition, including areas cut (from forest cover maps), state of regeneration, and silvicultural treatments on all disturbed sites
- maps of migration areas for species that migrate among watersheds (e.g., Roosevelt elk, black-tailed deer)
- maps showing areas of wildlife habitat particularly sensitive to human disturbance, and indicating where and how human interaction and development should be constrained
- maps showing private land boundaries, forest tenure boundaries, planning units (e.g., LRUPs), existing and proposed Protected Areas (e.g., Ecological Reserves), mineral claims, traplines, and guide-outfitter territories
- maps of existing developments such as roads (active and deactivated), bridges, major culverts, log sorts and dumps, and camps.

Inventory at the subregional and watershed planning levels requires some knowledge of vertebrate species presence, distribution, and habitat use.

2.3 Cultural Values

The regional geography of cultural activity—most particularly the long-established patterns of First Nations' activities—must be identified and mapped to highlight the scope of human concerns and interests in Clayoquot Sound. These include:

- maps of ***ha̲ḥu̲ulhi*** areas and description of ***ha̲ḥu̲ulhi***[159]
- maps of culturally important areas that extend across watershed boundaries
- map notations of culturally important plant and animal species
- map notations of non-timber forest product species and summaries of literature on their sustainable use.

2.4 Scenic Resources[160]

Much of the planning to maintain scenic values is done at the subregional scale. Information requirements include:

- maps of scenic landscape areas based on similarities in landscape characteristics (e.g., physiography, topography, slope, degree of alteration) and viewer-related characteristics (e.g., level of visibility, present and potential public use, and perceptions and expectations of specific groups) with descriptions of those characteristics.

---

[159] ***Ha̲ḥu̲ulhi*** refers to the plenary authority exercised by Nuu-Chah-Nulth hereditary chiefs over the people, land, and resources of their tribal territories. See *First Nations' Perspectives Relating to Forest Practices Standards in Clayoquot Sound* (Scientific Panel 1995b).

[160] For more detailed information on attributes, see *Clayoquot Landscape Inventory Phase 1: Methodology Development and Initial Inventory* (Juan de Fuca Environmental Consultants *et al.* 1994).

Examples of scenic landscape areas at the subregional level include:

- a fjord used primarily by kayakers, where there has been a moderate amount of forestry activity
- a highly scenic, largely undeveloped fjord with high potential for various types of boating
- a high elevation area not highly visible from public use corridors with an extensive amount of past forestry activity

The Clayoquot Sound Scenic Corridors Planning Process has completed such an inventory (Juan de Fuca Environmental Consultants *et al.* 1994; Juan de Fuca Environmental Consultants and Viewpoint Recreation and Landscape Consulting 1994).

2.5 Recreation and Tourism

Subregional-level recreational and tourism resources have largely been inventoried by the B.C. Ministry of Small Business, Tourism and Culture (coastal tourism resource inventory and Vancouver Island tourism resource inventory; see ARA Consulting Group 1992, 1993). These inventories should be revised by updating and refining:

- recreational and tourism use corridors (e.g. driving, boating, hiking), including notations about level of use
- locations and level of use of recreational and tourism use sites (e.g., parks, recreation sites, lodges)
- particular biophysical or cultural features of interest for recreational and tourism uses
- perceptions and expectations of First Nations and other community residents
- perceptions and expectations of specific groups (e.g., recreation groups, tourists, tourism operators).

3.0 Watershed-Level Information

At the watershed level, information is required to specify reserve (no-harvesting) areas required to maintain long-term ecosystem integrity, and to delineate harvestable areas. The mapping area is a specific watershed or group of small watersheds, generally under 35 000 ha in area. Appropriate mapping scales range from 1:10 000 to 1:20 000.

3.1 Watershed Integrity

At the watershed level, all features relevant to delineating and describing the hydroriparian zone must be identified and recorded. These include:

- maps showing the classification of surface waters (see Appendix II)

Drainage feature mapping can be incorporated into terrain mapping for cost-effectiveness. Information on published topographic maps is not sufficient, and ground checking is important.

- terrain map (field checked)
- site map (field checked)
- interpretive maps, derived from terrain maps and other assembled information (e.g., geology, drainage features, soils), showing slope stability classes and erodible materials.

  Details required in the interpretive map include:

  - detailed terrain stability mapping (classes I–V); especially class V (unstable under natural conditions) and class IV (potentially unstable)
  - erosion potential classes; especially terrain subject to surface erosion by running water under natural conditions
  - landslide inventory; all recognizable landslides (symbols for each slide scar, extent of tracks, code for approximate age)
  - avalanche tracks (for applying avalanche protection zones)
  - floodplains, alluvial fans, blocky and bouldery materials (some alluvial and colluvial fans, talus slopes, rockslide debris) where regeneration may be a problem
  - bedrock terrain:
    - that is bare or covered only with lichen, moss, or shallow organic material (less than 10 cm)
    - that is mantled by freely draining organic soils (folisols)
    - limestone and any other bedrock with special problems or attributes
  - poorly drained organic terrain.

3.2 Biological Diversity (Aquatic and Terrestrial)

At the watershed level, all features relevant to delineating and describing reserves for species at risk, late successional forests, and other important habitats must be identified and recorded. These include:

- descriptions of ecosystems:
  - map and refine subzone and variant boundaries at 1:20 000 or 1:10 000
  - describe and map major ecosystems within variants by site series mapping or by using forest cover maps to create general ecosystem description based on lumping polygons by leading species and height/age information.

For each major ecosystem (e.g., site series), map:

- tree species abundance and distribution (from forest cover maps)
- age class distribution[161] by tree species (from forest cover maps)
- an indication of level of fragmentation by describing the distribution of patch sizes in old growth and also of patches less than 20 years of age; note the locations of patches of old growth greater than 300 m wide
- baseline information on abundance of snags by size class and volumes of downed wood by leading tree species (collected during preliminary field cruises)

• other watershed information:

- location and extent of special ecosystems (e.g., spawning areas; eagle and osprey nest sites; heron rookeries; oldest trees, especially western redcedar and yew stands; areas with rare plants)
- baseline information for threatened or vulnerable species,[162] (e.g., species presence or absence, major ecosystem where located during each season, structural information on the habitat where located, and relative abundance)
- baseline information on species that are closely associated with particular habitats or habitat characteristics, for example:
  - coho, chinook, chum, pink, and king salmon (associated with stream estuary and ocean habitats)
  - eelgrass (associated with estuaries)
  - elk, Vaux's swift, and marten (associated with older forest)
  - black bear and hairy woodpecker (associated with interspersion of coniferous and deciduous trees)
  - pileated woodpecker and common merganser (associated with wildlife trees)
  - bald eagle and great blue heron (associated with large trees)
  - northwest and clouded salamanders (associated with downed wood)
  - beaver, river otter, and mink (associated with riparian habitats)
  - savannah sparrow and cowbirds (associated with open habitats including disturbed sites).

[161]Current forest age classes or refinement of the oldest age class if that proves necessary; see footnote 132.

[162]Examples of threatened species include the bat Keen's myotis and the Queen Charlotte Islands' goshawk. Examples of vulnerable species include marbled murrelet.

Vertebrate species can be inventoried through a combination of breeding and winter bird counts; riparian and estuarine transects to observe river otter sign, beaver sign, and common merganser broods (some riparian surveys can be done during drainage and terrain ground checks); winter track counts for elk, deer, and marten; and surveys of marked trees, and day beds for black bear. Several standard methods exist for fish surveys. Where possible, areas where animal surveys are carried out should be coordinated with placement of cruise plots that gather snag and downed wood information.

3.3 Cultural Values[163]

At the watershed level, all features relevant to delineating and describing reserves to protect important culturally important areas must be identified and recorded. These include:

- specific cultural areas requiring protection (e.g., sacred sites, historic areas, current use areas)
- culturally important species and areas
- hereditary/traditional ownership of specific areas.

The confidentiality of cultural inventory information must be respected.

3.4 Scenic Resources[164]

At the watershed level, all features relevant to delineating and describing specific landscape units[165] must be identified and recorded. These include:

- maps of specific landscape units based on similarities in physiography, vegetative cover, degree and type of land and water uses, viewer-related characteristics, and relationship to existing and potential tourism and recreation areas, with descriptions of those characteristics.

  Examples of landscape units might be:

  - a steep slope with a moderate amount of forestry activity oriented to a water use corridor
  - an unaltered, well-defined valley extending back from the shoreline.

---

[163]First Nations' values are discussed more fully in the Panel report: *First Nations' Perspectives Relating to Forest Practices Standards in Clayoquot Sound* (Scientific Panel 1995b).

[164]For more detailed information on attributes, see Juan de Fuca Environmental Consultants *et al.* (1994).

[165]"Landscape unit" is the term used by the B.C. Ministry of Forests. This departs from the Panel's use of the term "working unit" throughout this document.

The Clayoquot Sound Scenic Corridors Planning Process has completed such an inventory (Juan de Fuca Environmental Consultants *et al.* 1994; Juan de Fuca Environmental Consultants and Viewpoint Recreation and Landscape Consulting 1994).

3.5 Recreation and Tourism

At the watershed level, all features relevant to delineating and describing specific recreation areas[166] must be identified and recorded. These include:

- biophysical features that support recreation and tourism
- cultural features that support recreation and tourism
- existing recreation and tourism use activities and levels of use.

Attributes for these features can be based on the existing B.C. Ministry of Forests Recreation Inventory method, ensuring that:

- features described are particularly important to recreation and tourism
- scenic resource information is addressed in a general way in relation to specific sites (e.g., scenery is significant or not) to avoid duplicating the scenic resource inventory
- there is no limit to the number of features and activities relevant to a recreation area.

4.0 Site-Level Information

Site-level planning includes planning specific management actions for a variety of working units (e.g., recreation units, cutting units; see Section 7.3.3). Because of the range of management activities, working units may range in size from one to several tens of hectares. Typical mapping scales range from 1:2000 to 1:5000.

Site-level inventory identifies features requiring protection that were not identified during watershed-level planning (e.g., culturally modified trees) and features that affect operational decisions (e.g., bald eagle nest or danger trees). It also establishes baseline information for monitoring purposes.

4.1 Watershed Integrity

The objective at the site level is to identify all features that could affect operational management of the site, and to establish baseline information for subsequent audits to confirm the success or failure of management activities. Information collected at this level includes:

- classification and map of all drainage features
- description of drainage features to permit detailed road and harvest layout

[166] Similar to the B.C. Ministry of Forests recreation land unit or polygon.

- detailed terrain mapping including site inspections to confirm operational constraints
- baseline stream channel audits (see Section 8.2.2).

Some of this information will be aggregated for interpretation at the watershed or subregional scales.

4.2 Biological Diversity (Aquatic and Terrestrial)

The objective at the site level is to confirm the presence or absence of species or habitats that will affect operational management of the site, and to establish baseline information on stand structure for subsequent monitoring to confirm the success or failure of site management activities. Information should include:

- pre-harvest baseline information on wildlife tree species, sizes, and abundance; volumes and decay classes of downed wood; and numbers and sizes of very large trees
- for red-listed, forest-dependent species (plants or animals) identified at the watershed level, field confirmation of the presence of species within the proposed working units.

4.3 Cultural Values

The objective at the site level is to identify any features in working units that limit management activities. These features include:

- detailed mapping of areas and species important to First Nations as determined by the Nuu-Chah-Nulth of Clayoquot Sound
- identification of any areas requiring archaeological investigation.

4.4 Scenic Resources

The objective at the site level is to assist detailed planning for maintaining scenic landscapes in conjunction with management activities. Relevant information includes:

- key viewpoints, and the type and level of existing and potential public use
- accurate mapping of visible and non-visible areas from key viewpoints
- from the key viewpoints, descriptions of landscape form, line, colour, texture, and pattern.

4.5 Recreation and Tourism

The objective at the site level is to refine recreation information. This includes updating and refining the watershed-level recreation inventory by:

- identifying specific working units dedicated to recreation

- refining inventory boundaries
- adding information on features and use.

Appendix IV

Glossary

Active floodplain: the portion of the floodplain that is frequently (more than once in five years) inundated by flooding.

Adaptive management: the rigorous combination of management, research, and monitoring so that credible information is gained and management activities can be modified by experience. Adaptive policy acknowledges institutional barriers to change and designs means to overcome them.

Adjacency: see *Green-up.*

Age class: any interval into which the age range of trees, forests, stands, or forest types is divided for classification and use.

Aggregated retention: retaining trees in patches throughout a cutblock or cutting unit.

Alienate: to voluntarily transfer title to property; to convey.

Alienation: any land that has had its "right-to-use" transferred from the Crown through grant, lease, or permit or has a special interest noted, as in reserves. Land may be so designated permanently or temporarily.

Allochthonous: originating outside the area, as food sources for stream residents entering from the surrounding terrestrial landscape to support the stream food chain.

Allowable annual cut (AAC): the annual rate of timber harvesting specified for an area of land by the chief forester of the B.C. Ministry of Forests. The chief forester sets AACs for timber supply areas (TSAs) and tree farm licences (TFLs) in accordance with Section 7 of the *Forest Act*, and for Certified Tree Farms in accordance with the *Assessment Act*. In sustained yield theory (Hanzlik and followers) it is also a volume of timber equal to the mean annual increment, or mean annual increase in standing volume; therefore, the quantity that can be harvested continuously from the area.

Alluvial fan: a fan-shaped deposit of fluvial sand and gravel, usually located at the mouth of a tributary valley.

Alluvium: material deposited by a stream; fluvial (alluvial) materials.

Anadromous: describing fish that spawn in freshwater and migrate to sea to grow to maturity.

Annual flood sequence: the sequence of highest streamflows in each year, sometimes recorded as the highest daily mean flow, and sometimes as the highest instantaneous flow in the year. On small streams, there may be large differences between these two flows. The annual flood sequence is commonly analyzed to determine the frequency with which a flow of a given specified magnitude is apt to recur or (which is the same thing) how many years may elapse, on average, between successive recurrences of flows of the same magnitude; thus, for example, one specifies the "once in five years" flood.

Autotrophic: describing organisms that can produce their own organic material from inorganic chemicals and an external source of energy (e.g., plants and specialized bacteria).

Avulsion: an abrupt shift in the location of a stream channel on a floodplain.

Backspar trail: a pathway over which a mobile backspar travels.

Bag booms: temporary enclosures of logs ("boomsticks") chained together for short-term log storage. Bag booms may be towed short distances in sheltered waters but cannot be towed far, or in exposed waters.

Balloon yarding: yarding done using cables attached to balloons, which provide lift and carry logs to a stationary yarder at a landing.

Basal till: material that accumulates underneath a glacier by melting out from basal ice; includes lodgement till and basal meltout till.

Baseline information: information collected to provide a standard against which future measurements can be compared.

Bedrock: solid rock, usually older than Quaternary (except rock formed by cooling of lava); either exposed at the land surface or underlying surficial deposits or regolith of varying thickness.

Benthic: pertaining to organisms living on the floor of a waterbody.

Biodiversity: See *Biological diversity*.

Biogeoclimatic ecosystem classification (BEC): a hierarchical classification system with three levels of integration: regional, local, and chronological; and combining climatic, vegetation, and site factors.

Biogeoclimatic zone: a large geographic area with a broadly homogeneous macroclimate. Each zone is named after one or more of the dominant climax species of the ecosystems in the zone, and a geographic or climatic modifier.

Biological diversity: the diversity of plants, animals, and other living organisms in all their forms and levels of organization, including genes, species, ecosystems, and the evolutionary and functional processes that link them.

Biomonitors: organisms that are used to assess effects of physical and other stresses (e.g., waterflow or water quality) on themselves and other organisms.

Biota: living organisms; the flora and fauna of a region or time period.

Blowdown (windthrow): uprooting by the wind; also refers to a tree or trees so uprooted.

Blue-listed species: In British Columbia, 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.

Bog: is a peatland with the water table at or near the surface. The bog surface (which may be raised or flat) is unaffected by minerotrophic ground water. The major source of water is precipitation, which is low in nutrients. Bogs may be treed or treeless, and they are usually covered with *Sphagnum* moss and ericaceous shrubs. A peat accumulation that has grown above the local water table so that the water in the upper peat is sustained by precipitation.

Boom (log boom): a floating enclosure comprised of logs chained together to contain logs during storage and/or transportation on the water.

Borrow areas or borrow pits: areas of land from which materials such as sand and gravel are extracted for use elsewhere, mainly for road surfacing purposes.

Botanical forest products: non-timber based products gathered from forest and range land. There are seven recognized categories: wild edible mushrooms, floral greenery, medicinal products, fruits and berries, herbs and vegetables, landscaping products, and craft products.

Brackish: possessing a moderate degree of salt; hence, water produced by the mixing of salt and freshwater (approximately 0.5–17.0 parts per thousand).

Bunks: cradle-like structures in which logs of various species and grades are accumulated until the desired log bundle size—usually about 50 m^3—is attained.

Cable logging: a yarding system employing winches, blocks, and cables.

Cants: partly manufactured logs that are roughly squared, usually for export.

Channel avulsion: an abrupt diversion of the stream from one course to another during a flood, or as a result of blockage of the original channel by sediment or woody debris.

Chokers: cables attached to logs during yarding operations.

Clearcut-with-reserves: a variation of the clearcutting system which retains a variable number of reserve trees either uniformly or in small groups for purposes other than regeneration.

Clearcutting silvicultural system: a system in which the timber crop is cleared from an area at one time and an even-aged, replacement stand is established. Clearcutting is designed so that most of the opening has full light exposure and is not dominated by the canopy of adjacent trees (this produces an open area climate). The minimum size of a clearcut opening is generally considered to be 1 ha.

Coarse woody debris: sound and rotting logs and stumps that provide habitat for fungi, plants, animals, and their predators.

Colluvial fan: a fan-shaped mass of sediments deposited by mass wasting, most commonly debris flows.

Colluvium: (i) materials that have reached their present positions as a result of direct, gravity-induced mass movements; no agent of transportation such as water or ice is involved, although the moving material may have contained water or ice. Includes talus, landslide debris, and debris flow deposits. (ii) As above definition, but also including deposits resulting from slope wash.

Commercial thinning: a partial cut in older immature stands where trees have reached merchantable size and value, carried out to provide an interim harvest while maintaining or restoring a high rate of growth on well-spaced final crop trees.

Commission on Resources and Environment (C.O.R.E.): a body established by the British Columbia government, that is independent of the various provincial ministries, and whose mandate is to deal with resource and environmental management issues.

Community watersheds: those watersheds designated by the B.C. Ministry of Environment, Lands and Parks for domestic water production.

Conductance: the ability of a substance to transmit an electrical current (the reciprocal of electrical resistance); here, it is specifically the ability of water to transmit an electrical current, which depends upon the dissociation of molecules into ions in water. Because many mineral impurities in water dissociate ionically, electrical conductance is a useful measure of the mineral contaminant load of water.

Constrained maximization approach: in this report, a planning approach where timber production receives top priority and consideration of other resources occurs as restrictions or constraints on the allowed timber harvest.

Contemporary floodplain: valley floor adjacent to stream channel subject to inundation by current hydrological regime.

Conventional ground skidding: log yarding using any combination of rubber-tired or tracked skidding equipment to drag, slide, or carry logs on the ground.

Conventional logging: any combination of mechanical or hand felling and rubber-tired or tracked skidding equipment. On the British Columbia coast, cable logging is considered conventional.

Critical wildlife habitat: part or all of a specific place occupied by a wildlife species or population that is recognized as essential for maintaining the population.

Crop tree: a tree in a young stand or plantation selected to be carried through to maturity until an interim or final harvest.

Crown land: land that is owned by the Crown; referred to as federal Crown land when it is owned by Canada, and as provincial Crown land when owned by the Province.

Culvert: a pipe, pipe arch, or log structure covered with soil and lying below the road surface, used to carry water from one side of the road to the other; a *cross-drain culvert* is a pipe or log structure covered with soil and lying below the road surface.

Cumulative effects: effects on biota of stress imposed by more than one mechanism (e.g., stress in fish imposed by both elevated and suspended sediment concentrations in the water and by high water temperature).

Cumulic: of soils, persistently aggrading by the addition of mineral materials to the surface. Typically occur on floodplains where mineral sediments are deposited from flood waters.

Cut: (i) the excavation required to lower the natural ground line to the desired road profile; (ii) the forest harvesting operation.

Cut-and-fill: a system of bench construction on hillslopes to produce road rights-of-way and landings whereby convex slopes are excavated and concave slopes (gullies) are filled; also, excavation of the upslope side of the right-of-way, and fill on the downslope side ("half-bench" construction).

Cutblock (or cutting unit): a specific area, with defined boundaries, authorized for harvesting.

Cutting cycles: the planned, recurring interval of time between successive cuttings in a crop or stand.

Cutting Permit: a legal document that authorizes the holder to harvest trees under a licence issued under the *Forest Act.*

Danger tree: a tree or any part of a tree that has sufficient structural weakness to pose a high risk of falling and causing personal or property damage.

DBH (diameter breast height): the diameter of the tree stem at "breast" height (approximately 1.3 m above the point of germination).

Deactivation: measures taken to stabilize and close roads and logging trails during periods of inactivity, including the control of drainage, the removal of sidecast where necessary, and the re-establishment of vegetation for permanent deactivation.

Debris avalanche: rapid downslope movement on steep slopes of saturated soil or surficial material, commonly including vegetative debris; a very rapid to extremely rapid debris flow.

Debris flow: rapid flow of a slurry of saturated debris, including some or all of soil, surficial material, weathered rock, mud, boulders, and vegetative debris. A general designation for all types of rapid downslope flow, including mudflows, rapid earthflows, and debris torrents.

Debris slide: the sliding of soil and vegetation cover downslope. Usually the slip plane is the sharp boundary between partially saturated soils and unweathered surficial material or bedrock.

Debris torrent: a variety of debris flow that includes little fines (silt and clay) and that follows a pre-existing stream channel.

Deferred area: a forest area in which a restriction of activity order is put into effect for a specific period of time.

Designated skid road or skid trail: a pre-planned network of skid roads or skid trails, designed to reduce soil disturbance and planned for use in subsequent forestry operations in the same area. Multiple passes by tracked or rubber-tired skidders or other equipment are anticipated.

Detritus: materials worn or detached from forest organisms, usually referring to partially disintegrated leaves and twigs from trees.

Developed watersheds: watersheds having some degree of development. Development may include forestry operations, roads, or housing.

Dispersal: movement of organisms away from their birth place to establish living space elsewhere.

Dispersed retention: retaining individual trees scattered throughout a cutblock.

Dissolved oxygen: the quantity of oxygen contained in solution in water; the characteristic range of dissolved oxygen content in stream waters is 3–12 mg/l.

District (forest district): an administrative unit within a forest region.

Downed wood: see *Coarse woody debris.*

Drainage basin: area of the Earth surface from which surface drainage all flows to a single outlet stream; a watershed in North America.

Drainage system: (i) the network of stream channels in a drainage basin; (ii) a culvert, cross-ditch, swale, or outslope/inslope to move water from one side of the road to the other.

Dropline: a skidding line that can be dropped from below the carriage to increase the lateral reach of the chokers.

Dryland sort: an area on land where logs are sorted, graded, and often bundled.

Ecosystem: a functional unit consisting of all the living organisms (plants, animals, and microbes) in a given area, and all the non-living physical and chemical factors of their environment, linked together through nutrient cycling and energy flow. An ecosystem can be of any size (a log, pond, field, forest, or the Earth's biosphere) but it always functions as a whole unit. Ecosystems are commonly described according to the major type of vegetation, for example, forest ecosystem, old-growth ecosystem, or range ecosystem.

Ecosystem integrity: the soundness or wholeness of the processes and organisms composing the ecosystem. The Panel defines "maintaining ecological integrity" as maintaining functioning, self-sustaining ecosystems with characteristics similar to the original ones.

Ecosystem productivity: the ability of an ecosystem to produce, grow, or yield products whether trees, shrubs, of other organisms.

Edaphic: related to or caused by particular soil conditions, as of texture or drainage, rather than physiographic or climatic factors.

Edge effect: habitat conditions (such as degree of humidity and exposure to light or wind) created at or near the more-or-less well-defined boundary between ecosystems, as, for example, between open areas and adjacent forest.

End hauling: removal of excess materials from one section of road to another or to a designated waste area, instead of sidecasting.

Endangered species: see *Red-listed species.*

Entrenched: describing stream channels that are confined within fluvially eroded gullies or valleys of some depth.

Environmentally Sensitive Areas (ESAs): areas requiring special management attention to protect scenic values, fish and wildlife resources, historical and cultural values, and other natural systems or processes. ESAs for forestry include potentially fragile, unstable soils that may deteriorate unacceptably after forest harvesting (Es), and areas of high value to non-timber resources such as fisheries, wildlife (Ew), water, and recreation.

Ephemeral: applies to streams and lakes that may contain water for only a short period of time. Ephemeral streams carry only storm runoff, derived from saturation seepage or from overland flow.

Epiphytic: refers to a plant (epiphyte) that grows above the ground, supported non-parasitically by another plant or object, and derives its moisture and nutrients from the air and rain.

Escapement: an estimate of the numbers of adult fish returning to a stream to spawn.

Estuary: the embayed mouth of a river where the tide meets the river flow. (Locally, the term also connotes the lowermost, tidal reach of a river.)

Even-aged silvicultural system: a silvicultural system designed to regenerate and maintain an even-aged stand (e.g., clearcutting, seed tree, and shelterwood systems).

Existing visual condition (EVC): the level of human alteration in the landscape.

Felling and bucking: the processes of cutting down standing timber and then cutting it into specific lengths for yarding and hauling.

Fen: is a peatland with the water table usually at or a few centimetres above or below the surface. The waters are nutrient-rich and derived from mineral soils. Dominant vegetation is sedges, grasses, reeds, and brown mosses with some shrubs and, at times, a sparse tree cover.

Fill: the height of material required to raise the desired road profile above the natural ground line.

Fillslopes: slopes created by fill material (used to support the road); can be excavated from adjacent cutslopes when building roads, or trucked in from elsewhere.

Flood discharge criterion: the volume of flood that a bridge or culvert must be designed to accommodate.

Floodplain: level or very gently sloping surface bordering a river that is formed of fluvial sediments, and is subject to flooding.

Fluvial: pertaining to streams and rivers; similar to alluvial; *fluvial sediments* are materials transported and deposited by running water.

Foliar analysis: analysis of the nutrient content of leaves or needles. Foliar analyses can be used as a bioassay of environmental conditions affecting tree growth.

Folisols: well-drained organic soils derived from forest litter. These consist primarily of the organic forest floor layer and typically rest directly on bedrock. If a shallow mineral soil layer is present over the bedrock, the forest floor must be more than

twice the thickness of the mineral layer, otherwise the soil is considered a podzol, gleysol, or other mineral soil type.

Forest cover: forest stands or cover types consisting of a plant community made up of trees and other woody vegetation, growing more or less closely together.

Forest cover map: a map showing relatively homogeneous forest stands or cover types, produced from the interpretation of aerial photos and information collected in field surveys. Commonly includes information on species, age class, height class, site, and stocking level.

Forest development plan: an operational plan guided by the principles of integrated resource management (the consideration of timber and non-timber values), which details the logistics of timber development over a period of usually five years. Methods, schedules, and responsibilities for accessing, harvesting, renewing, and protecting the resource are set out to enable site-specific operations to proceed.

Forest floor: comprised of layers of fresh leaf and needle litter, moderately decomposed organic matter, and humus or well-decomposed organic residue.

Forest practice: any activity that is carried out on forest land to facilitate uses of forest resources, including but not limited to timber harvesting, road construction, silviculture, grazing, recreation, pest control, and wildfire suppression.

Forest Practices Code (FPC): legislation, standards, and field guides that govern forest practices in British Columbia.

Forest resources: resources or values associated with forest land, including but not limited to water, wildlife, fisheries, recreation, timber, range, and heritage.

Forest-interior conditions: conditions found deep within forests, away from the effect of open areas. Forest-interior conditions include particular microclimates found within large forested areas.

Free-growing: an established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed, and excessive tree competition; or young trees that are as high as or higher than competing brush, with one metre of free growing space around their tops.

Fully benched road: a road where the entire running surface is supported by a cut into the hilltop. In contrast, a partially benched road has only part of the running surface on a cut into the hillside and part supported by fill material excavated from the cut.

Genetic diversity: variation among and within species that is attributable to differences in hereditary material.

Geographic Information System (GIS): a computer system designed to allow users to collect, manage, and analyze large volumes of spatially referenced information and associated attribute data.

Geological processes: actions and events that take place at and below the Earth's surface, and result in effects such as earthquakes and volcanism, mountain building, erosion, and the development of the landscape. See *Geomorphology*.

Geomorphology: the study of the origin of landforms, the processes whereby they are formed, and the materials of which they consist.

Glacial abrasion: the scouring action of particles embedded in glacier ice.

Glacial drift: sediments associated with glaciers, comprised of such varied deposits as till, outwash gravel, and sand.

Glacial lake: a lake that is dammed by a glacier or resting on glacial ice.

Glacial trough: a valley with a U-shaped cross profile due to erosion by a valley glacier.

Glaciofluvial: pertaining to the channelized flow of glacier meltwater (meltwater streams); *glaciofluvial materials* are sediments that exhibit clear evidence of having been deposited by glacial meltwater streams either directly in front of, or in contact with, glacial ice.

Glaciolacustrine: pertaining to glacial lakes; *glaciolacustrine materials* are sediments deposited in or along the margins of glacial lakes; primarily fine sand, silt and clay settled from suspension or from subaqueous gravity flows (turbidity currents), and including coarser sediments (e.g., ice-rafted boulders) released by the melting of floating ice; also includes littoral sediments (e.g., beach gravels); accumulated as a result of wave action.

Glaciomarine: pertaining to processes, sediments, and landforms associated with glacier termini in marine waters, such as receding glaciers in fjords and ice shelves; *glaciomarine materials* are sediments of glacial origin laid down from suspension in a marine environment in close proximity to glacier ice, and deposits of submarine gravity flows; includes particles released due to the melting of floating ice and ice shelves; primarily fine sand, silt and clay, and stony muds; marine shells or shell casts may be present.

Gleysols: poorly drained mineral soils with a high or fluctuating water table that are characterized by gleyed or mottled colours. Gleyed soils are dull, blue to olive in colour, indicative of reducing (rather than oxidizing) conditions. Mottled soil horizons consist of dull colours interspersed by brighter, usually yellow to orange patches, indicative of periodic entry of air to allow localized oxidation of minerals (notably iron oxides).

Grapple yarding: a cable-based yarding method that uses a grapple on a swing yarder (a yarder with a 15–17 m crane built on a hydraulic excavator-like chassis).

Green tree retention: the retention of live trees within a cutblock or cutting unit.

Green-up: the minimum height and stocking levels which trees on a cutblock must achieve before an adjacent stand of timber may be harvested.

Group selection: an uneven-aged silvicultural system in which trees from a stand are removed and regenerated in small groups. The size of each group is usually no larger than twice the height of the mature trees.

Guideline: an optional practice or new practice not currently in the Forest Practices Code. Although guidelines are generally voluntary, the implication is that practitioners will use these concepts and principles in meeting their resource objectives.

Gully: a small valley or ravine, longer than wide, and typically from a few metres to a few tens of metres across.

Haḥuulḥi: the plenary authority exercised by Nuu-Chah-Nulth hereditary chiefs over the people, land, and resources of their tribal territories.

Harvest pattern: the spatial distribution of cutblocks and reserve areas across the forested landscape.

Harvestable area: specific areas within a watershed where forest harvesting or other resource uses will not compromise the long-term integrity of the forest ecosystem, its use by First Nations people, or its recreational or high scenic value.

Harvesting prescription: detailed plan on how, when, and where timber will be harvested from an area.

Harvesting system: the mix of felling, bucking, and yarding systems used in logging a stand of timber.

Height class: an interval into which the range of tree or stand heights is divided for classification and use. Also, the trees or stands falling into such an interval.

Helicopter logging, or heli-logging: logging in which yarding is done using cables attached to a helicopter. Typically used in sensitive or inaccessible terrain.

Heritage areas: sites of historical, architectural, archaeological, paleontological, or scenic significance to the province.

Highgrading: the removal of only the best trees from a stand (e.g., trees above a certain size class), often resulting in a residual stand of poor quality trees.

High sensitivity areas: areas associated with special concerns, issues, or having the potential for negative impacts on forest values, including any soils with high hazard of compaction, erosion, mass wasting, or displacement.

Holocene (Epoch): the most recent 10 000 years of Earth history; more generally, the time since the end of the last major glaciation. In Clayoquot Sound, post-glacial conditions were established about 12 000 years ago.

Humic: a descriptor applied to organic materials; refers to material at an advanced stage of decomposition; it has the lowest amount of fibre, the highest bulk density, and the lowest saturated water-holding capacity of the organic materials; fibres that remain after rubbing constitute less than 10% of the volume of the material.

Hydrological features: refers to water-related features visible at the land surface, such as stream channels, seepage zones, springs, and soil moisture, including soil moisture characteristics as deduced from vegetation characteristics.

Hydrological regime: the pattern of occurrence in time of water at or near the surface of the Earth; e.g., temporal changes in streamflow, soil moisture, groundwater levels, precipitation.

Hydrology: the scientific study of the distribution and characteristics of water at and close to the Earth's surface.

Hydrophobic: describing an entity that repels water.

Hydroriparian ecosystem: aquatic ecosystems plus those of the immediately adjacent terrestrial environment; the latter occupying all land adjacent to waterbodies that is both influenced by and influences the aquatic system and its associated biota.

Hydroriparian zone: the entire floodplain of the stream, alluvial fan surfaces, and, where channels are entrenched, the entire slope that rises immediately from the channel.

Hyporheic: pertaining to the interstitial spaces in the phreatic (saturated) sediments of riverbed and floodplain, which are inhabited by small riverine organisms.

Igneous rocks: rocks produced under conditions involving intense heat (i.e., of volcanic or molten magma origin).

Impact assessment: a study of the effect of resource development on other resources.

Indicator species: a species whose response to a change in ecosystem condition may be used to indicate the likely response of other species.

Integrated resource management (IRM): The identification and consideration of all resource values, including social, economic, and environmental needs, in land use and development decision-making. It focuses on resource use and land use and management, and is based on a good knowledge of ecological systems, the capability of the land, and the mixture of possible benefits.

Intrusive rock: a rock that solidified from a mass of magma that invaded the Earth's crust but did not reach the surface.

Invertebrates: creatures without a backbone (vertebrae); e.g., insects, worms, slugs, spiders, crustaceans.

Karst: pertains to landforms and processes associated with dissolution of soluble rocks such as limestone, marble, dolomite, or gypsum; characterized by underground drainage, caves, and sinkholes.

Lacustrine materials: sediments that have settled from suspension or underwater gravity flows in lakes; also includes littoral sediments (e.g., beach gravels) accumulated as a result of wave action.

Lagoon: a shallow body of salt water separated from the sea by a spit or barrier beach.

Land and Resource Management Plan: a strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision-making, and resource sustainability.

Landform: any physical, recognizable form or feature of the Earth's surface, having a characteristic shape, and produced by natural processes.

Landing: an area that has been constructed for logs to be yarded or skidded to for sorting and/or loading.

Landscape inventory: the identification, classification, and recording of the location and quality of visual resources and values.

Landscape management unit (LMU): a large area with similar characteristics visible from a scenic corridor that is assigned a visual quality objective (VQO).

Landscape sensitivity: a component of the landscape inventory that assigns a landscape sensitivity rating (LSR) based on the visual prominence or importance of features; conditions that affect visual perception; and social factors that contribute to viewer perceptions. LSR summarizes the visual importance based on a combination of biophysical characteristics and viewing and viewer-related factors.

Large organic debris (LOD): entire trees or large pieces of trees that provide channel stability or create fish habitat diversity in a stream channel.

Lateral reach: the ability to reach perpendicular from the main yarding corridor into the stand to yard logs from the stand to the main corridor.

Lateral yarding: See *Lateral reach.*

Leave trees: all trees, regardless of species, age, or size, remaining on a harvested area as a result of a predetermined silviculture prescription to address a possible range of silviculture or resource needs.

Lentic: pertaining to standing fresh water.

Lift: the upward force applied to a log by a cable yarding system.

Line loader: a log loader employing wire rope (cable), rather than hydraulics (as in hydraulic log loaders) for controlling machine movements.

Littoral zone : strictly speaking, the intertidal zone; customarily, the zone between the upper limit of wave action (the back of the storm beach or cliff base), and the seaward limit of frequent wave action on the seabed (approximately the 10 m depth contour).

Load line: the line or cable that hangs from a helicopter to which the chokers are attached.

Log barge: a self-propelled or towed vessel used to transport logs.

Log bundling: the tying of several logs into bundles during or after sorting operations.

Long snorkelling: short yarding from roads using modified line loaders.

Lotic: pertaining to streams (flowing fresh water).

Marine borers: ocean-dwelling organisms, usually molluscs, that bore holes in logs or wood found in marine waters.

Marine materials: sediments deposited in the ocean by settling from suspension and by submarine gravity flows, and sediments accumulated in the littoral zone due to wave action.

Marine sensitive zone: area of the sea or seabed supporting an easily disturbed ecosystem; includes herring spawning areas, shellfish beds, marsh areas, juvenile salmonid rearing areas, and adult salmon holding areas.

Marsh: a mineral wetland that is permanently or seasonally inundated up to a depth of two metres by standing or slowly moving water. The waters are nutrient-rich and the

substrate is usually mineral soil. Marshes have emergent rushes, grasses and reeds, and submerged or floating aquatic plants in open water areas.

Mass movement: a general term for downslope gravitational movement of earth materials by processes such as rockfall and debris slides.

Mass wasting: (i) a general term for a variety of processes, including weathering and erosion, that together effect reduction of slopes and lowering of the land surface; (ii) see *Mass movement*.

Mature timber: stands of timber where the age of the leading species in a stand is greater than the specified cutting age. In even-aged management, those trees or stands that are sufficiently developed to be harvestable, and which are at or near rotation age (includes overmature trees and stands if an overmature class has not been recognized).

Meadow (wet meadow): a seasonal wetland developed on mineral materials that are periodically saturated but seldom inundated. Vegetation is a mixture of flood-tolerant grasses, low sedges, rushes, and forbs.

Metamorphic rock: "changed-form" rock, any rock that has been changed in texture or composition by heat, pressure, or chemically active fluids after its original formation.

Microclimate: the climate conditions (wind, temperature, humidity, etc.) of a local area. The area may range from a few centimetres (e.g., for micro-organisms in the forest floor) to several tree heights in diameter.

Micro-organisms: unicellular or simple many-celled organisms (e.g., bacteria).

Mineral soil: soil made up of eroded parent geologic materials; mineral soils contain no, or very little, organic material.

Ministry of Environment, Lands and Parks (MOELP): provincial government ministry responsible for the protection, management, and enhancement of British Columbia's environment, while sustaining the quality of life.

Ministry of Forests (MOF): provincial government ministry responsible for the management and protection of the province's forest and range resources for the best balance of economic, social, and environmental benefits to British Columbians.

Monoculture: in general, even-aged, single-species forest crops.

Multi-span configuration: involves two or more spans of the skyline by using intermediate supports.

Mycorrhizae: describing a symbiotic relationship between trees and fungi that grow in and around their roots that enables tree roots to better take up nutrients from the soil.

Natural disturbance regimes: the historic patterns (frequency and extent) of fire, insects, wind, landslides, and other natural processes in an area.

Natural regeneration: the renewal of a forest stand by natural (rather than human) means, such as seed on-site from adjacent stands or deposited by wind, birds, or animals.

No-work zones: an area in which equipment and people are not allowed during forestry operations, usually for safety or ecological reasons.

Non-timber resource values: values within the forest other than timber which include but are not limited to biological diversity, fisheries, wildlife, minerals, water quality and quantity, recreation and tourism, cultural and heritage values, and wilderness and aesthetic values.

Non-vascular plants: plants without conducting tissue (e.g., algae, mosses, liverworts).

Off-highway trucks: logging trucks of a size (width or weight) that exceeds legal highway specifications.

Old growth: a forest that contains living and dead trees of various sizes, species, composition, and age-class structure. Old-growth forests, as part of a slowly changing but dynamic ecosystem, include climax forests but not sub-climax or mid-seral forests. The age and structure of old growth varies significantly by forest type and from one biogeoclimatic zone to another.

Old-growth attributes: structural features and other characteristics (e.g., microclimate) of old-growth forests including: large live trees, variable spacing, variable tree sizes, dead and dying trees, understory patchiness, and deep canopies.

Old-growth management areas: areas that contain specific structural old-growth attributes, and which are mapped out and treated as special management areas.

Oligotrophic: containing few nutrients and few organisms.

Operational plans: within the context of area-specific management guidelines, operational plans detail the logistics for development. Methods, schedules, and responsibilities for accessing, harvesting, renewing, and protecting the resource are set out to enable site-specific operations to proceed.

Optical turbidity: the property of water which limits the transmission of light through it as the result of the presence of (fine) particulate materials in suspension. The property is measured in standardized geometric arrangements between light source and detector and the observed turbidity can be correlated with the concentration of particulate materials, hence providing a convenient index measure of suspended sediment concentration.

Organic soil: soil derived from plant material which contains greater than 30% organic matter.

Outwash (outwash fan): (i) the mass of detritus deposited by fast-flowing, heavily loaded water whose velocity is suddenly checked (e.g., at the mouth of a gorge); (ii) glaciofluvial deposits.

Parallel yarding corridors: describes parallel paths along which logs are yarded to a landing.

Partial cutting: an ill-defined term commonly encompassing both genuine silvicultural systems (e.g., selection cutting) and selective harvest (not a silvicultural system).

Partial duration flood sequence: is the sequence of all flows that exceed some specified threshold level (e.g., bankfull). At moderate threshold levels, there is apt to be more than one such event in each year, so this sequence diverges from the annual flood sequence, but at high threshold levels, more than one such flow in a year is unlikely. The two sequences coincide for flows more extreme than the one-in-five-year flood. The partial duration sequence is the relevant flow record for assessing extreme flow effects on aquatic biota, or for assessing the associated sediment transport, since all events exceeding the threshold for effective action are significant.

Phreatic zone: the earth below the water table which is saturated with water; in particular, the region below a floodplain and stream course which is saturated.

Physiography: the assemblage of features and attributes that form the landscape, including relief and topography, bedrock geology and structure, and geomorphological history.

Plankton: small organisms (plant or animal) floating in the water column (in fresh or salt water).

Pleistocene (Epoch): the first epoch of the Quaternary Period, lasting approximately two million years and ending 10 000 years ago; the epoch of the most recent major glaciations on Earth.

Podzols: rapidly to imperfectly drained mineral soils characterized by accumulations of humified (well decomposed) organic matter combined with various iron and aluminum oxides. The dominant soil horizon is typically reddish-brown, which may be overlain by a distinct grey horizon.

Polymorphism: simultaneous presence in a population of two genetically different forms of a trait at frequencies higher than could be maintained by recurrent mutation.

Porosity: the amount of pore (void) space present, expressed as a percentage of the total volume of the material.

Post-glacial: pertaining to the time interval since the disappearance of glaciers or an ice sheet from a particular area; similar to the Holocene Epoch.

Pre-commercial thinning: see *Spacing*.

Pre-harvest Silviculture Prescription (PHSP): a site-specific management plan; since 1987 a legal prerequisite to logging on Crown land. PHSPs specify planned forest activities, the methods to be used, and the proposed constraints necessary to protect the site and its resource values.

Prescribed burning: the knowledgeable application of fire to a specific area to meet management and silvicultural objectives.

Primary watershed: a watershed that drains directly into the ocean.

Productive forest landbase: that part of the landbase able to support trees of sufficient quality to be economically important.

Protected Areas: areas such as provincial parks, federal parks, wilderness areas, ecological reserves, and recreation areas that have protected designations according to federal

or provincial statutes. Protected areas are land and freshwater or marine areas set aside to protect the province's diverse natural and cultural heritage.

Quaternary (period): the most recent period in Earth history, approximately the last two million years, comprising the Pleistocene and Holocene Epoch.

Radiating yarding corridors: see *Yarding corridors.*

Rain-on-snow events: rainstorms that result in large amounts of surface runoff due to the combined effects of heavy rainfall and snow melt. Rapid snow melt is caused by heat supplied from the warm air that is characteristic of intense rainstorms, and by heat released during condensation of moisture from the air onto the snow surface.

Rate-of-cut: the proportion of the watershed area allowed to be cut each year. It should be an input to the planning process.

Recreation feature: biological, physical, cultural, or visual features that have an ability to attract and sustain recreational use.

Recreation inventory: the identification, classification, and recording of the types and locations of recreation features.

Recreation opportunity spectrum (ROS): a range of outdoor settings based on remoteness, area size, and evidence of humans, which provides for a variety of recreation activities and experiences. The settings are classified on a continuum and are described as: rural, roaded resource, semi-primitive motorized, semi-primitive non-motorized, and primitive.

Red-listed species: In British Columbia, 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 B.C. *Threatened* species are any indigenous species that are likely to become endangered in B.C. if factors affecting that vulnerability are not reversed.

Referral: the process by which applications for permits, licences, leases, etc., made to one government agency by an individual or industry, are given to another agency for review and comment.

Regeneration: the renewal of a tree crop through either natural means (seeded on-site from adjacent stands or deposited by wind, birds, or animals) or artificial means (by planting seedlings or direct seeding).

Reserved trees: trees specifically reserved from harvesting and often referenced in Pre-harvest Silviculture Prescriptions or cutting authorities or by map notations.

Reserves: areas established to protect ecosystem integrity or various forest resources. These areas are normally excluded from harvesting.

Resident fish: fish that spend their entire life cycle in one stream or lake.

Resource Inventory Committee (RIC): a committee with representatives from various ministries and agencies for the federal and provincial governments and First Nations

peoples, established to develop a common set of standards and procedures for provincial resources inventories.

Retention: retaining, during logging, or saving a portion of the original stand in clusters, clumps, or as scattered individual trees.

Rigging: setting up spars and supports for cable-yarding systems.

Right-of-way logging: cutting of linear strips that will become a road; essentially a right-of-way easement corridor.

Riparian area: the land adjacent to the normal high water line in a stream, river, lake, or pond and extending to the portion of land that is influenced by the presence of the adjacent ponded or channelled water. Riparian areas typically exemplify a rich and diverse vegetative mosaic reflecting the influence of available surface water.

Road deactivation: the process of rendering a road impassable to vehicular traffic. See *Deactivation*.

Road prism: the geometric shape formed by the road from the top of the cut to the toe of the fillslope. *Road prism width*: the distance from the top of the cut to the toe of the fillslope (several meters less than the clearing width which is the width in which all trees are cut prior to road construction).

Rotation: the planned number of years between the formation or regeneration of a tree crop or stand and its final cutting at a specified stage of maturity. In the variable-retention silvicultural system recommended by the Panel, rotation length does not consistently have the same meaning as when applied to conventional clearcutting. Although specific areas may be subject to long-term even-aged management, both reserves and trees retained during logging may differ during subsequent harvest; that is, time between harvest at any one location can be highly variable.

Saltmarsh: a marsh influenced by brackish or saline waters of tidal marine origin.

Salvage harvesting: logging operations specifically designed to recover damaged timber (dead or in poor condition) but still yield a wood product. Often carried out following fire or insect attack, or wind disturbances.

Seasonal streams: streams that flow throughout most of the year but may dry up during portions of the dry season.

Secondary watershed: a watershed that drains through a primary watershed before emptying into the ocean.

Sedimentary rock: rock formed by the laying down of sediments in marine or lake environments.

Sedimentation: the process of deposition of matter carried in water; usually the result of the reduction of water velocity below the point at which it can transport the material.

Seed orchard: a plantation of specially selected trees that is managed for the production of genetically improved seed.

Seed tree silvicultural system: an even-aged silvicultural system that leaves selected standing trees scattered throughout the cutblock to provide seed sources for natural regeneration. The number of seed trees to be left depends on the desired number of seedlings per hectare, the seed crop frequency, seed dissemination distance, and the length of time that the seedbed remains receptive, but is commonly 30 trees/ha.

Seed trees: trees selected to be left standing to provide seed sources for natural regeneration. Selection is usually on the basis of good form and vigour, the absence of serious damage by disease, evidence of the ability to produce seed, and wind firmness.

Seepage zone: an area where soil is saturated due to emerging groundwater.

Selection silvicultural system: a silvicultural system that removes mature timber either as single scattered individuals or in small groups at relatively short intervals, repeated indefinitely, where the continual establishment of regeneration is encouraged and an uneven-aged stand is maintained.

Selective logging: removal of certain trees in a stand as defined by specific criteria (species, diameter at breast height, or height and form). It is analogous to "high grading." Not to be confused with the selection silvicultural system.

Sensitive slopes: any slope identified as prone to mass wasting. See *Mass wasting*.

Sensitive soils: forest land areas with a moderate to high likelihood of increase in landslide frequency due to logging or roadbuilding activities.

Sensitive species: see *Blue-listed species*.

Sensitive watershed: a watershed used for domestic water supply purposes or having significant downstream fisheries values, and in which the quality of water resource is very responsive to changes in the environment. Such watersheds typically lack settlement ponds, are relatively small, are located on steep slopes, and have concerns such as high risk of erosion.

Seral stage: any stage of development of an ecosystem from a disturbed, unvegetated state to a climax plant community.

Shelterwood silvicultural system: a silvicultural system that removes the old stand in a series of cuttings to promote the establishment of an essentially even-aged new stand under the overhead or side shelter of the old one. Regeneration may be obtained naturally or by planting. Cuts may be done uniformly, in groups, or in strips. The "shelterwood" is removed once regeneration is well-established.

Shot-rock: bedrock that has been fragmented by explosives, consisting of a variable mixture of angular fragments.

Shrub-carr: a seasonal, shrub-dominated wetland, developed on mineral materials, that is periodically saturated but rarely inundated. The shrub layer is 1–2 m high (occasionally to 3 m); species include birch and willow that commonly grow on tussocks.

Sidecast: material moved onto the downslope side of the road during road construction; *sidecasting* refers to moving excavated material onto the downslope side during construction.

Siltation: deposition of silt (mud or fine soil) causing build-up of material.

Silvicultural regime: a series of site-specific silviculture treatments planned over time.

Silvicultural system: a planned cycle of activities by which a forest stand is harvested, regenerated, and tended over time. Any harvesting done *without* planning of subsequent regeneration and stand tending cannot be considered part of a silvicultural system.

Silvicultural treatment: any silviculture activity (e.g., harvesting, site preparation, stand tending) on forest stands to meet stand-specific objectives.

Silviculture: the art of producing and tending a forest, and the application of the knowledge of silvics in the treatment of a forest; the theory and practice of controlling forest establishment, composition, and growth.

Silviculture prescription: a site-specific integrated plan to carry out one or a series of silviculture treatments.

Site preparation: the preparation of a site by manual, mechanical, or chemical means to create favourable conditions to promote the establishment of the regeneration crop. The soil may be prepared for either naturally or artificially disseminated seed or for planted seedlings.

Site-level planning: the most detailed planning level; working unit level.

Site: an area described or defined by its biotic, climatic, and soil conditions in relation to its capacity to produce forest; the smallest planning unit.

Skid road: an excavated or bladed trail used by track or rubber-tired skidders to drag logs from the felling site to a landing.

Skid trail: a pathway travelled by ground skidding equipment while moving trees or logs to a landing. A skid trail differs from a skid road in that stumps are cut very low and the ground surface is mainly untouched by the blades of earth-moving machines.

Skidder: a wheeled or tracked vehicle used for sliding and dragging logs from the stump to a landing.

Skidding: the process of sliding and dragging logs from the stump to a landing, usually applied to ground-based yarding operations.

Slash: the wood residue left after harvesting operations, stand tending, breakage, mortality, or other natural phenomenon. Slash includes material such as logs, splinters or chips, tree branches and tops, uprooted stumps, and broken or uprooted trees and shrubs.

Slide: a mass movement process in which slope failure occurs along one or more slip surfaces and in which the unit generally disintegrates into a jumbled mass en route to its depositional site. A debris flow or debris torrent may occur if enough water is present in the mass.

Slope processes: mass movement processes, such as debris slides, and surface wash whereby fine sediments are transported downslope by overland flow.

Slope stability: pertains to the susceptibility of slope to landslides and the likelihood of slope failure.

Slump: a mass movement process in which slope failure occurs on a usually curved slip surface and the unit moves downslope as an intact block, frequently rotating outward. Slumps appear as discrete block movements, often in place, whereas slides usually break up and travel downslope.

Small Business Forest Enterprise Program (SBFEP): this program permits the B.C. Ministry of Forests to sell Crown timber competitively to individuals and corporations who are registered in the SBFEP. Approximately 10% of the province's timber allocation is directed towards this program.

Smolt: a young salmonid migrating to the sea for the first time; commonly applied to steelhead, cutthroat, coho, chinook, and sockeye at one or two years of age. The name implies that the fish has undergone a major physiological change that enables it to go from a freshwater to saltwater environment.

Snag: a standing dead tree or part of a dead tree.

Soil creep: slow (imperceptible) downslope movement of soil.

Soil horizon: a zone in the soil that is generally parallel to the land surface and distinguished from zones above and below by characteristic physical properties, such as colour, structure and texture, and soil chemistry.

Soil productivity: the capacity of a soil, in its normal environment, to support plant growth.

Spacing: the removal of undesirable trees within a young stand to control stocking, to maintain or improve growth, to increase wood quality and value, or to achieve other resource management objectives.

Species richness: the numbers of species in an area.

Stand: a community of trees sufficiently uniform in species composition, age, arrangement, and condition to be distinguishable as a group from the forest or other growth on the adjoining area, and thus forming a silviculture or management entity.

Stand development: changes in forest structure over time, during and after disturbances.

Stand dynamics: the study of changes in forest stand structure with time, including stand behaviour during and after disturbances.

Stand structure: the distribution of trees in a stand, which can be described by species, vertical or horizontal spatial patterns, size of trees or tree parts, age, or a combination of these.

Stand tending: a variety of forest management treatments, including spacing, fertilization, pruning, and commercial thinning, carried out at different stages during a stand's development.

Stocking: a measure of the area occupied by trees, usually measured in terms of well-spaced trees per hectare, or basal area per hectare, relative to an optimum or desired level.

Stream audit: measurements of stream characteristics, possibly including length of channel cut to streambank, length of bank with active erosion, amount and distribution of large organic debris, length of pool, riffle and glide habitat, and evidence of scour or sedimentation.

Stream class: as set out in the *British Columbia Coastal Fisheries/Forestry Guidelines*, Class A includes streams or portions of streams that are frequented by anadromous salmonids and/or resident sport fish or regionally significant fish species, or streams identified for fishery enhancement in an approved fishery management plan; stream gradient is usually less than 12%. Stream Class B includes streams or portions of streams populated by resident fish not currently designated as sport fish or regionally significant fish; stream gradient is usually 8–20%. Stream Class C includes streams or portions of streams not frequented by fish; stream gradient is usually greater than 20%.

Stream morphology: the characteristics of a stream including pool and riffle sequences and bank characteristics.

Stumpage (assessment): the price paid to the provincial government for timber harvested on Crown land. The market value of timber on an area of Crown land scheduled for harvesting is assessed, and the difference between the timber's market value and the operating costs necessary to get it to an acceptable market condition is determined. This difference is the stumpage value.

Subglacial till: material that accumulates directly from melting ice at the base of a glacier; includes basal till and lodgement till.

Subgrade: the material placed to construct the roadway, excluding surfacing.

Subregional planning level: a planning level that includes large areas made up of aggregations of watersheds.

Subtidal zone: the area between the low tide line and the outer limit of the littoral zone.

Surficial deposits (materials): relatively young, non-lithified sediments, usually of Quaternary age; usually classified as to their genesis, hence fluvial sediments, colluvium, glaciolacustrine sediments, etc.

Suspended sediment: sediments suspended in water.

Suspension (full, partial, or ground lead): describing the lifting of logs during yarding. During full suspension logs are entirely off the ground during yarding operations; partial suspension indicates that one end of the log contacts the ground during yarding; ground lead exerts no lift on the logs, resulting in little or no clearance of the log from the ground.

Sustainability: the concept of producing a biological resource under management practices that ensure replacement of the part harvested, by regrowth or reproduction, before another harvest occurs.

Swamp: is a wooded mineral wetland or a wooded peatland with standing or gently flowing water in pools and channels. The water table is usually at or very near the surface. Waters are nutrient-rich. Vegetation is a dense cover of deciduous or coniferous trees or shrubs, herbs, and some mosses.

Swing yarder: a yarder that has a slackpulling carriage that provides lateral yarding capability.

Talus: angular rock fragments accumulated at the foot of a steep rock slope and being the product of successive rock falls; a type of colluvium.

Tenure: the holding, particularly as to manner or term (i.e., period of time), of a property. Land tenure may be broadly categorized into private lands, federal lands, and provincial Crown lands. The *Forest Act* defines many forestry tenures by which the cutting of timber and other user rights to provincial Crown land are assigned.

Terrain: (i) a comprehensive term to describe a tract of landscape being studied with respect to its natural features; (ii) pertains to maps showing surficial materials, material texture, surface expression, present day geomorphological (geological) processes, and related features.

Terrain analysis: the process of terrain mapping and interpretation or assessment of terrain conditions for a specific purpose such as construction of logging roads or urban expansion.

Thermal regimes: the pattern of heat building up and cooling over a period of time in an area.

Thinning: see *Commercial thinning, Spacing*.

Threatened species: see *Red-listed species.*

Till: unstratified glacial drift deposited directly by the ice and consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Timber supply area (TSA): the revised and consolidated former Public Sustained Yield Units within which the forest companies manage the timber resource according to strategic resource management plans prepared by the Ministry of Forests. Land is designated as a TSA under Part 3, Division (4) of the *Forest Act*.

Total resource plan: a plan for long-term forest management over an entire area, such as a watershed. The plan identifies known resource values, capabilities, and sensitivities; confirms or refines management objectives for those values; and establishes detailed management guidelines by which to achieve those objectives on the ground.

Tree farm licence (TFL): a licence entered into under Part 3, Division (2) or (5) of the *Forest Act*. The TFL is a stewardship agreement over a sustained yield management unit. This includes the right to harvest a specified volume of timber annually and the obligation to carry out all phases of forest management on behalf of the Ministry of Forests. The licence has a term of 25 years and is replaceable every 10 years.

Trophic processes: the processes (photosynthesis, herbivory, predation, scavenging, etc.) that link levels in the food chain.

Understory: any plants growing under the canopy formed by others, particularly herbaceous and shrub vegetation under a tree canopy.

Uneven-aged silvicultural systems: silvicultural systems that maintain or create stands with a wide range of tree ages and sizes. See *Selection silvicultural system.*

Unmerchantable: timber that is not economical to harvest due to size and quality constraints.

Utilization standards: the dimensions (stump height, top diameter, base diameter, and length) and quality of trees that must be cut and removed from Crown land during harvesting operations. Utilization standards can vary by species and timber supply areas (or supply blocks in TSAs).

Vascular plants: plants having cells for transferring water and nutrients up from the roots. Includes flowering plants and ferns.

Vertebrates: organisms with backbones.

Visual absorption capability (VAC): the landscape's capacity to absorb human-induced changes without reducing its visual qualities or integrity.

Visual green-up: the mix of herbaceous growth and deciduous and coniferous trees which acts to blend the cutblock into the surrounding forested landscape, making the cutblock less obvious.

Visual landscape management: the identification, assessment, design, and manipulation of the visual features or values of a landscape, and the consideration of these values in the integrated management of provincial forest lands.

Visual quality objective (VQO): an approved resource management objective that reflects a desired level of visual quality based on the physical and sociological characteristics of the area; refers to the degree of acceptable human alteration to the characteristic landscape.

Visual quality: the character, condition, and quality of a scenic landscape or other visual resource and how it is perceived, preferred, or otherwise valued by the public.

Visually sensitive areas: viewsheds that are visible from communities, public use areas, travel corridors—including roads and waterways—and any other viewpoint so identified through referral or planning processes.

Vulnerable species: see *Blue-listed species.*

Wall-base channels: small channels that originate at the base of valley walls and may run parallel to them. These are fed by groundwater from floodplain and adjacent valley slopes, and drain into the main stem of streams.

Water stage: the level of water (in a stream channel, lake, or the sea) measured relative to a fixed datum (which may be arbitrary). Stage establishes a consistent basis for measuring the variation in water level at a place.

Water table: the upper surface of groundwater (of the zone of saturation) in rocks or surficial materials.

Water-sorting: sorting logs by species and size in the water.

Watering bundles: the placing of bundles of logs (usually from a dryland sort or directly from a logging truck) into the water (ocean, lake). Bundles are usually pushed down inclined skids into the water.

Watershed: total region draining into a given waterway, lake, or reservoir; a drainage basin.

Watershed planning level: a planning area consisting of a specific watershed or groups of small watersheds, generally under 35 000 ha in area.

Watershed sensitivity analysis: in general, a procedure designed to determine whether, and in what degree, land use or land development will affect the flows of water and/or sediment in a watershed. See *Watershed Assessment Procedure (Interim Methods)* for specific procedures (B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks 1994).

Wetland: land that is saturated with water long enough to promote wetland or aquatic processes; indicated by poorly drained soils, hydrophilic vegetation, and biological activity that is adapted to a wet environment. Includes fens, swamps, marshes, and bogs.

Wilderness: an area of land generally greater than 1000 ha that predominantly retains its natural character and on which the human impact is transitory and, in the long run, substantially unnoticeable.

Wildlife trees: dead, decaying, deteriorating, or other designated trees that provide present or future critical habitat for the maintenance or enhancement of wildlife.

Yarding (yarding methods): in logging, the hauling of felled timber to the landing or temporary storage site from where trucks (usually) transport them to the mill site. Yarding methods include cable yarding, ground skidding, and aerial methods such as helicopter and balloon yarding.

Yarding corridors (yarding roads): the roughly linear paths that logs travel as they are pulled by cables (lines) from where they are felled and bucked to a landing or roadside. Depending on the yarding system, corridors may be parallel to one another or radiate from a central landing. In the latter case, the area logged is fan-shaped to roughly circular.

Appendix V

Members of the Scientific Panel for Sustainable Forest Practices in Clayoquot Sound

Co-Chair	**Dr. Fred Bunnell**, Professor of Forest Wildlife Ecology and Management; and Director of the Centre for Applied Conservation Biology, University of British Columbia, Vancouver
Co-Chair	**Dr. Richard Atleo**, Hereditary Chief UMEEK; Instructor, Malaspina University-College; and Researcher, Consultant, Indigenous Human Resources, Nanaimo

Other members of the Scientific Panel, by area of expertise:

Biodiversity	**Dr. Ken Lertzman**, Assistant Professor, Forest Ecology, Simon Fraser University, Burnaby
	Dr. Chris Pielou, Ecologist, Denman Island
	Laurie Kremsater, Consultant, Forest Management and Wildlife Biology, Vancouver
Ethnobotany	**Dr. Nancy Turner,** Professor, Environmental Studies, University of Victoria, Victoria
First Nations	**Ernest Lawrence Paul**, Hesquiaht Elder; expert in Hesquiaht history, culture, traditional resource use and language, Hesquiat
	Roy Haiyupis, Ahousaht Elder; expert in Ahousaht history, culture, language and traditional use of resources, Lillooet
	Stanley Sam, Ahousaht/Tla-o-qui-aht First Nations Elder; expert in First Nations history, language, culture, and traditional resource use, Ahousat
Fisheries	**Dr. Gordon Hartman**, Consultant, Fisheries Biology, Nanaimo
Forest Harvest Planning	**Keith Moore**, Registered Professional Forester; Consultant, Environmental Forestry, Queen Charlotte City *(resigned from Panel December 16, 1994 when assumed position as Chair, Forest Practices Board, Victoria)*
Hydrology	**Dr. Mike Church**, Registered Professional Geologist (B.C.); Professor, Fluvial Geomorphology, Department of Geography, University of British Columbia, Vancouver

Roads and Engineering	**Dr. Peter Schiess**, Professor and Head of Forest Engineering, University of Washington, College of Forest Resources, Seattle
Scenic Resources, Recreation, and Tourism	**Catherine Berris,** Consultant, Landscape Architecture and Land Use Planning, Vancouver
Silvicultural Systems	**Dr. Jerry Franklin**, Professor, University of Washington, College of Forest Resources, Seattle
Slope Stability	**Dr. June Ryder**, Consultant, Terrain Analysis, Vancouver
Soils	**Dr. Terry Lewis**, Consultant, Soils and Land Use, Courtenay
Wildlife	**Dr. Alton Harestad**, Associate Professor, Wildlife, Simon Fraser University, Burnaby
Worker Safety	**Jim Allman**, Regional Manager, Workers' Compensation Board, Victoria *(resigned from Panel February 24, 1995 when assumed position as Manager of Occupational Health and Safety, B.C. Ministry of Forests, Victoria)*
Secretariat to the Panel	**Melissa Hadley**, Registered Professional Forester, Cortex Consultants Inc., Halfmoon Bay

For more information contact:

Cortex Consultants Inc.
201-1290 Broad Street
Victoria, BC, Canada V8W 2A5
Phone (604) 360-1492
Fax (604) 360-1493