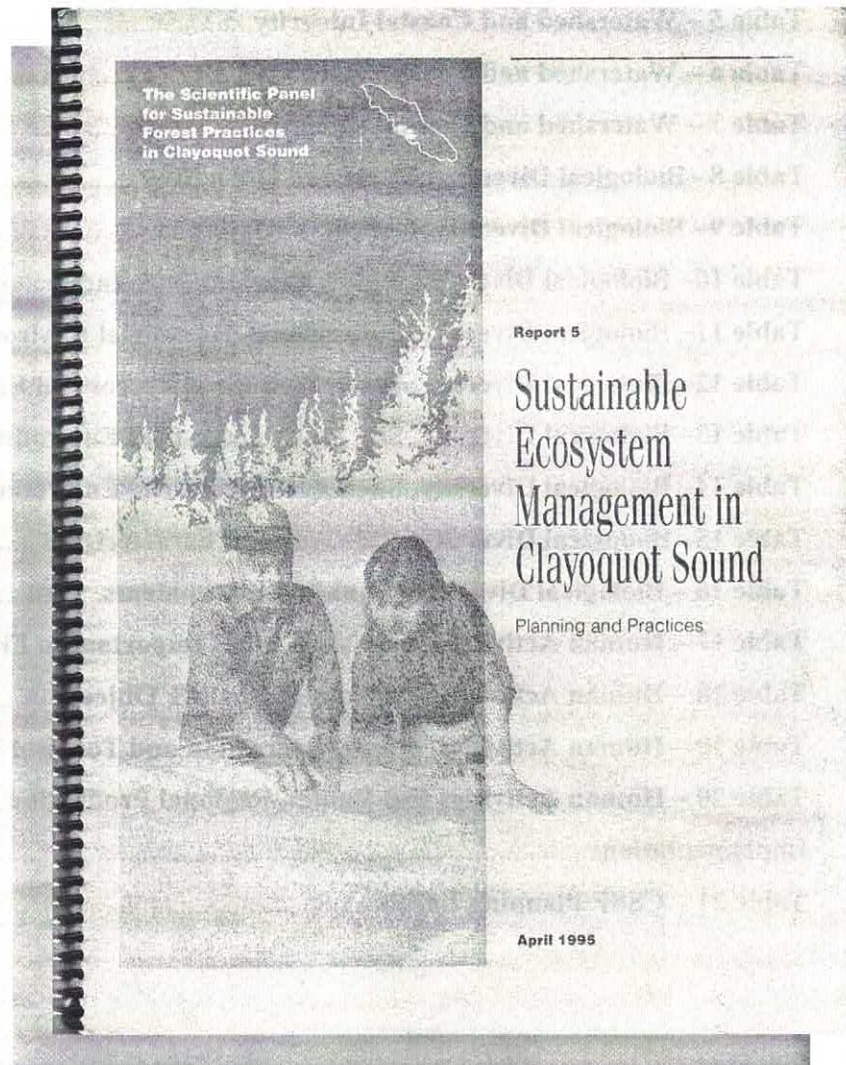


Clayoquot Sound Scientific Panel Recommendations

- Summary of CSSP Recommended Monitoring and Indicators -

Reports 1 - 5



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Monitoring Introduction:¹

Monitoring is an essential part of active adaptive management and improving management practices. Monitoring of forest ecosystems of Clayoquot sound will have three goals:

- to ensure that forest activities and practices comply with prescribed standards for ecosystem integrity and cultural integrity;
- to detail whether the forest practices standards adopted for Clayoquot Sound are appropriate for the intended management objectives; and
- to improve the basis for understanding mechanisms, both natural and those induced by human activity, that cause events and create changes in the ecosystem.

Panel recommendations emphasize the second goal – monitoring to evaluate success in attaining objectives². This requires a long-term monitoring program covering areas that are reserved from land-use practices and areas that will experience land-use practices. To this end, the Panel recommends objectives for monitoring (R8.2):

- **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 characteristics³, and aquatic environments;
- **human activities and values** – including areas important to First Nations; scenic, recreation, and tourism values; and regional commodity production; and
- implement forest management plans

For each of these areas the Panel discusses key indicators for evaluating the success of sustainable ecosystem management, as well as specific monitoring activities. In some cases, alternate monitoring procedures are presented.

The Panel believed local interest and involvement in monitoring are essential to the success of a monitoring program. To assure program efficacy and technical excellence, a professional land manager is also required. Because of labour requirements, the value of cumulative experience in many aspects of monitoring, and the need to secure local commitment to ensure continuation of the program, many aspects of monitoring should be the responsibility of participants from local communities.

Clayoquot Sound is an excellent place to test the concept of local responsibility for sustainable ecosystem management.

R 3.19 Implement an adaptive management strategy to incorporate new knowledge and experience. Establish research and monitoring programs to assess the effectiveness of these initial recommendations in meeting ecological, cultural, scenic, and economic objectives, and to improve recommendations on an ongoing basis.

Report 5, Chapter 7

Plan components should include a monitoring plan that assures compliance with standards and assesses the effectiveness of the standards. The monitoring plan must identify activities at the watershed level and sampling designs for collecting information at the site level.

¹ CSSP Report 5, Executive Summary p. xix, Chapter 8 p. 189

² Consensus is emerging that to detect impacts of human activities, samples should be taken repeatedly (sometimes over long periods) and contemporaneously at the potential impact site, and at one or more control sites during periods before and after the impact has begun (p.191).

³ Scattered anecdotal information indicates that forests support a unique biota after about 400-600 years of age. Available information is insufficient to delimit the age class; the Panel recommends that one objective of monitoring be to estimate further meaningful subdivisions of age class 9 (p. 159)

CSSP Recommended Monitoring and Indicators Summary

Table 1 – CSSP Report 1

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
1	None	None	N/A

Table 2 – CSSP Report 2

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
2	Monitoring for adaptive management	Monitoring and Research Program	Goals: - to ensure that forest activities and practices comply with prescribed standards for ecosystem integrity and cultural integrity; - to detail whether the forest practices standards adopted for Clayoquot Sound are appropriate for the intended management objectives, - to improve the basis for understanding mechanisms, both natural and those induced by human activity, that cause events and create changes in the ecosystem, and - monitoring to evaluate success in attaining objectives
	Channel integrity	Volume, stability and distribution of LWD Rate of channel bank erosion Frequency of lateral stream relocation Scour rates Sediment deposition rates Degree of channel aggradation (and consequent de-watering during low flow) Increase in channel width to depth ratio	Goal: to manage watershed systems to prevent alteration in hydrological regimes, increases in sediment input, and loss of riparian vegetation, with resulting loss of channel integrity and dependent biological productivity. Objectives: - to maintain full-length stream channel integrity, - to maintain the character of the riparian area and the integrity of the channel in the floodplain of the stream, - to minimize the deposition of fine sediment and sand in the channel system, and maintain the quantity and quality of spawning gravel used by fish, - to maintain the structural diversity of the channel by maintaining the volume, stability, and distribution of LWD, - to maintain the floodplain and the riparian area to assure a continuing supply of LWD to the channel, and - to manage the slopes and gully systems to maintain, at natural frequency, the episodic input of large volumes of broken woody debris.

Table 3 – CSSP Report 3

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
3	Incorporate NTC TEK into environmental planning, inventory, monitoring and research (p viii)	N/A	Objective: Recognition and protection of heritage values
	Full consultation and active participation of NTC in planning and decision making processes in all operational forestry activities (including inventory and mapping) and in monitoring and evaluation related to ecosystem management (p viii)	N/A	
	R6 Standards for forest practices must also include TEK. Conflicts between scientific knowledge and TEK must be resolved in consultation with the NTC of Clayoquot Sound. Inventory, monitoring, and research must also recognize and include TEK.	N/A	
	R21 All ongoing ecosystem management activities must incorporate monitoring programs for impacts on biodiversity, soil, water quality, fisheries and marine systems, and cultural sites, with full consultation of and participation by the NTC of Clayoquot Sound	N/A	

Table 4 – CSSP Report 4

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
4	Scientific and TEK of Clayoquot Sound must continue to be encouraged through research, experience, and monitoring activities. Both management and regulation must be adaptive, incorporating new information and experience as they develop.	N/A	N/A

Table 5 – Watershed and Coastal Integrity

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
5	Monitoring Watershed and Coastal Integrity ⁴ • Monitor hill slopes and forest soils		
	Monitoring slope stability	Number of failures and volume displaced per unit time ⁵	The goal: for hillslopes and soil is to maintain the integrity of the soil Objectives: • To retain the soil within the ecosystem, and • To maintain the physical, nutritional, and biological characteristics of the soil.
	Monitor soil health	Forest floor cover (or the obverse, mineral soil exposure) Tree foliar nutrients ⁶ (soil biology)	
		Quality of road drainage water (fine sediment)	

⁴ Monitoring watershed integrity encompasses the hydrological cycle, sediment processes (including slope stability), soils geochemical cycles (nutrients), and stream environments (p. 192)

⁵ Maintain record of all debris slides, debris flows, and other mass movements (p.194)

⁶ Foliar nutrients are expected to be a good indicator for both nutritional and biological health of soil (soil biology and nutritional status are inextricably linked) (p. 194)

Table 6 – Watershed and Coastal Integrity

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
5	Monitoring Watershed and Coastal Integrity		
	Stream Channels ⁷	Changes in riparian zone shading (length of channel along which the forest has been cut to the stream banks)	Goal for stream channel: to maintain the integrity of aquatic ecosystems Objectives: • to maintain water flow and critical elements of water quality within the range of natural variability on both seasonal and event basis; • to maintain the character of the riparian area and the full-length integrity of the stream channel system; • to minimize deposition of fine sediment and sand in the channel system and maintain the quality and quantity of spawning gravels; and • to maintain the structural diversity of channels by maintaining the volume, stability, and distribution of LWD, and to manage the riparian area to assure a continued supply of this debris.
		Changes in flow levels	
		Changes in quantities of suspended sediment	
		Changes in turbidity	
		Changes in dissolved O ₂ in the water column and in gravel interstices	
		Changes in substrate permeability	
		Changes in abrasion at streambed level	
		Changes in bedload movement	
	Channel Structure ⁸	Changes in the dislodging or circumvention of natural log jams	
		Length of bank with active erosion	
		Amount and distribution of LWD in the channel	
		Length of pool, riffle, and glide habitat	
	Special habitats associated with the streams and rivers of old-growth forests	Photographic records ⁹	
		Benthic sampling	
		Submerged logs over various sizes and other woody debris, log/debris jams, pools; pools under overhanging root-bound banks; backwaters and side channels, flood channels; and stable, long established floodplains ¹⁰	

⁷ These factors must routinely be inferred from simple measurements of channel disturbance (p.196 & 197) (Source of practical approach to monitoring stream channels Tripp et al. 1992; Tripp 1994a and 1994b "Sources Sited on p. 234)

⁸ Monitoring (audit) methodology is described in greater detail on p. 197. CSSP stream (and water body) classification can be seen on p. 176 and 255-259.

⁹ For major channels, consideration should be given to obtaining helicopter-based video or 70-mm stereo photography (p.196)

¹⁰ These features area related to Tables 5 - 7, and 15. The rationale for monitoring these features is to establish linkages between ecosystem structure and biological diversity (p.211). In addition to periodic sampling, these habitats and their features should be surveyed after major flood events.

Table 7 – Watershed and Coastal Integrity

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
5	Monitoring Watershed and Coastal Integrity • Regional Monitoring of Streamflow and Water Quality ¹¹		
	Water Quality	Balance of precipitation ¹² and runoff (stream flow) ¹³	Goal for stream channel: to maintain the integrity of aquatic ecosystems Objectives: • to maintain water flow and critical elements of water quality within the range of natural variability on both seasonal and event basis; • to maintain the character of the riparian area and the full-length integrity of the stream channel system • to minimize deposition of fine sediment and sand in the channel system and maintain the quality and quantity of spawning gravels; and • to maintain the structural diversity of channels by maintaining the volume, stability, and distribution of LWD, and to manage the riparian area to assure a continued supply of this debris
		Temperature	
		Turbidity	
		Velocity and discharge	
		Water/channel stage ¹⁴	
	• Monitoring the Coastal Zone ¹⁵ Herring spawn sites, shellfish beds Beaches and intertidal zones	Dissolved O ₂	The goal in the coastal zone is to maintain the integrity of littoral and inshore marine ecosystems Objective: • to maintain the physical integrity of the littoral and inshore marine zone (including all waters and inlets and embayments with restricted circulation)
		Specific conductance	
		Nutrients	
		Organic drift matter (allochthonous input)	

¹¹ (p.198-199)¹² Measured at fixed points with bucket gauges¹³ Both measurements require continuous monitoring over an extended period of time (10->30 years - thus is expensive). Measurements should be in areas to be developed and in undeveloped watershed (e.g. Meguin River). These measurements have been recognized as the responsibility of two specialized government agencies (both agencies of Environment Canada).¹⁴ The level of the water as measured from a fixed datum (which may be arbitrary)¹⁵ More detail can be seen on p. 200

Monitoring for biological diversity must initially test two major assumptions made by the Panel in its efforts to make maintenance of biological diversity an attainable, practical goal to manage areas:

- maintaining recognized habitats serves to maintain biological diversity;
- Panel recommendations for planning of reserves and maintenance of a diverse forest through new silviculture strategies, which centre on habitat, will serve to attain the goals and objectives. (p.201)

Table 8– Biological Diversity, Goals and Objectives

CSSP Report	Monitoring Biological Diversity ¹⁶
5	Goal for maintaining biological diversity: • to maintain all naturally-occurring species and genetic variants such that they are able to persist over the long term and adapt to changes in their environment within the normal range of variation; • to maintain the functional integrity of ecosystems recognizing the connections between terrestrial, freshwater, and marine processes Objectives¹⁷: • to maintain ecosystem function by protecting the integrity of riparian areas from the terminus to the headwaters of watersheds; • to protect habitats of known importance to particular species; • to maintain old-growth and forest-interior habitats; and • to use forest management techniques that produce stand structures, species composition, and landscape patterns similar to those generated by the natural disturbances of forests in Clayoquot Sound.

¹⁶ Biological diversity (or biodiversity) is considered at three levels of organization: genetic, species, and community or ecosystem levels. There is recognition of ecological processes or function as well

¹⁷ Biodiversity objectives depend on attaining objectives for watershed integrity (p. 201)

Table 9– Biological Diversity, Genetic Variation

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
5	Monitoring Biological Diversity • Monitoring Genetic Variation ¹⁸		
	Genetic variation within the biota	Visible variation within species	Objectives: • To maintain known genetic variation with the biota; • To ensure sufficient connectivity within naturally widely distributed populations such that viable populations of all indigenous species and their genetic richness are maintained; and • To maintain the <i>total</i> genetic variation within species comprising naturally isolated populations
	Connectivity among habitats ¹⁹	Dynamics of species ranges ²⁰ Continuity of habitat ²¹	
	Maintenance of the total genetic variation within species comprising naturally isolated populations	Use of cross watershed linkages by particular species ²² Degree to which the natural range of habitats or ecosystems is represented within the reserve system ²³	

Table 10– Biological Diversity, Vulnerable and Rare Indigenous Species

5	• Monitoring Vulnerable and Rare Indigenous Species ²⁴		Objective: • to ensure that particular species known or suspected to be at risk are monitored and their habitats protected
	Monitor species ²⁵ (and habitat jointly)	Morphological characteristics ²⁶	
		Growth and reproductive output ²⁷	

¹⁸ Usually genetic diversity is undetectable without costly and time-consuming laboratory work. This type of effort could be justified for only a few species (p. 203). The first step should be to maintain visible variation.

¹⁹ Panel recommendations are intended to maintain habitats either through reserves or retention of habitat elements, and are meant to avoid habitat fragmentation

²⁰ Are ranges shrinking, or are new gaps appearing in the interior of the range? Measured at the watershed and subregional level

²¹ This approach is necessarily indirect, and must be augmented by research to ensure that habitat linkages that ensure connectivity are effective in allowing movement of organisms.

²² Measured at the subregional level

²³ In Clayquot sound the most species-rich habitat islands are hydroprarian systems in deep (enclosed) valleys where species confined to such area have existed as local, reproductively isolated populations for long periods of time. It follows that both species and habitats should be monitored diligently in those systems. Because this indicator is especially indirect, more intensive inventory and research effort is particularly important (p.204)

²⁴ To meet this objective, species at greater risk may require greater monitoring effort (p.204)

²⁵ Each species is unique and advice on monitoring procedures must be sought from appropriate experts (p.205)

²⁶ May be useful for some species (e.g. regression of weight to length in some amphibians reflects decreases in population health)

²⁷ Possible indicator for the monitoring of plant species (p.205)

Table 11— Biological Diversity, Subregional Terrestrial Environments

CSSP Report	Monitoring Recommendation	Recommended Indicator(s) ²⁸	Objective/goal
5	Monitoring Biological Diversity • Monitoring Terrestrial Environments – Subregional Level ²⁹		
	Assess whether objectives are being achieved	Forest age-class distribution	Goal for maintaining biological diversity: • to maintain all naturally-occurring species and genetic variants such that they are able to persist over the long term and adapt to changes in their environment within the normal range of variation; • to maintain the functional integrity of ecosystems recognizing the connections between terrestrial, freshwater, and marine processes Objectives: • to maintain ecosystem function by protecting the integrity of riparian areas from the terminus to the headwaters of watersheds; • to protect habitats of known importance to particular species; • to maintain old-growth and forest-interior habitats; and • to use forest management techniques that produce stand structures, species composition, and landscape patterns similar to those generated by the natural disturbances of forests in Clayoquot Sound.
		Rate-of-cut ³⁰	
		Frequency distributions of patch sizes	
		Age-class distributions for major forest types	
	Effectiveness of cross-watershed linkages	Location and extent of linkages between habitat units (or extent of fragmentation)	
		Road density	
	Maintenance of genetic diversity	Amounts of edge (natural vs. managed forests)	
		Corridor use of a particular species	
		Distribution of species	

²⁸ The indicators that are monitored should fall into two broad categories: those that indicate harm to the maintenance of biodiversity, and those that indicate maintenance of biodiversity. Those that indicate maintenance of biodiversity operate over a wide range of spatial and temporal scales and monitoring must incorporate those scales.

²⁹ See Table 21 for monitoring and planning context

³⁰ Includes rate of remove by all causes

Table 12– Biological Diversity, Watershed Level Terrestrial Environments

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
5	Monitoring Biological Diversity • Monitoring Terrestrial Environments – Watershed Level ³¹		Goal for maintaining biological diversity: • to maintain all naturally-occurring species and genetic variants such that they are able to persist over the long term and adapt to changes in their environment within the normal range of variation; • to maintain the functional integrity of ecosystems recognizing the connections between terrestrial, freshwater, and marine processes Objectives: • to maintain ecosystem function by protecting the integrity of riparian areas from the terminus to the headwaters of watersheds; • to protect habitats of known importance to particular species; • to maintain old-growth and forest-interior habitats; and • to use forest management techniques that produce stand structures, species composition, and landscape patterns similar to those generated by the natural disturbances of forests in Clayoquot Sound.
	Assess whether objectives are being achieved	Forest age-class distribution	
		Rate-of-cut	
		Frequency distribution of patch sizes	
		Patch shape	
	Potential habitat effects on species that should occur at the watershed level ³³	Events of natural disturbance ³²	
		Road density	
		Indicators of Watershed Integrity (see Tables 5, 6, and 7)	
		Forest age-class distribution	
		Amounts of edge (natural vs. managed forests)	
		Snag abundance	
		Retention of habitat elements/maintenance of representative habitats ³⁴	

³¹ See Table 21 for monitoring and planning context³² Detailed accounts of wildfires, blowdown, landslides, stream avulsions, disease, (and other events that influence the natural disturbance regime) should be recorded for developed and undeveloped areas to help document the range of natural variation (p.206)³³ Species data will be collected at the site level and be aggregated at the watershed level.³⁴ Panel assumption that current measures of habitat usefulness represent the organisms themselves; this assumption needs to be evaluated by research and long-term monitoring which would involve both organisms (*indicator sp.*) and habitats must be monitored in complementary contexts. Monitoring at the species and genetic level will be largely indirect (p.201)

Table 13– Biological Diversity, Site Level Terrestrial Environments

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
5	Monitoring Biological Diversity • Monitoring Terrestrial Environments – Site Level		Goal for maintaining biological diversity: • to maintain all naturally-occurring species and genetic variants such that they are able to persist over the long term and adapt to changes in their environment within the normal range of variation; • to maintain the functional integrity of ecosystems recognizing the connections between terrestrial, freshwater, and marine processes Objectives: • to maintain ecosystem function by protecting the integrity of riparian areas from the terminus to the headwaters of watersheds; • to protect habitats of known importance to particular species; • to maintain old-growth and forest-interior habitats; and • to use forest management techniques that produce stand structures, species composition, and landscape patterns similar to those generated by the natural disturbances of forests in Clayoquot Sound.
	Habitat diversity and utility ³⁵	Patchiness	
		Forest vertical structure	
		Gaps and larger openings ³⁶	
		Habitat elements ³⁷ such as: wide branches of living trees ³⁸ , dead-topped and dead trees, wildlife trees ³⁹ , downed wood ⁴⁰ , root wads of downed wood, and wetlands ⁴¹	
	Biological diversity	Species composition Frequency and extent of invasive exotic species	
	Hydrological changes	Changes in the extent and flora of wetlands	

³⁵ It is important to monitor both habitats and their elements, and the amount and kind of use that they receive, i.e. count wildlife trees, but also monitor a representative sample to determine what the species use is (before and in intervals after logging) (p.206)

³⁶ Created by the death of a tree or group of trees

³⁷ Panel assumption that current measures of habitat usefully represent the organisms themselves; this assumption needs to be evaluated by research and long-term monitoring which would involve both organisms (*indicator sp.?*) and habitats must be monitored in complementary contexts. Monitoring at the species and genetic level will be largely indirect (p.201)

³⁸ That support beds of moss

³⁹ Including hollow trees, and tree of distinct structure, i.e. dominant large trees (often remnants from an earlier stand) which are broad crowned, very limby, or trees with “witches’ broom”.

⁴⁰ Classified by degree of decay

⁴¹ Location, extent, and type of wetlands should be mapped

Table 14– Biological Diversity, Site Level Terrestrial Environments (Species)

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
5	Monitoring Biological Diversity		
	● Monitoring Terrestrial Environments – Site Level		
	Species ⁴²	Check lists⁴³: ● Pioneer species⁴⁴ ● Non-motile organisms: -vascular plants, mosses, macro-fungi, liverworts, many lichens ● Motile organisms: -mammals, birds, amphibians, molluscs Indicator species⁴⁵: ● fish species ● vulnerable species ● eel grass ● elk, Vaux's swift, marten ● black bear, hairy woodpecker ● pileated woodpecker and common merganser ● bald eagle, great blue heron ● northwest and clouded salamanders ● beaver, river otter, and mink	Goal for maintaining biological diversity: ● to maintain all naturally-occurring species and genetic variants such that they are able to persist over the long term and adapt to changes in their environment within the normal range of variation; ● to maintain the functional integrity of ecosystems recognizing the connections between terrestrial, freshwater, and marine processes Objectives: ● to maintain ecosystem function by protecting the integrity of riparian areas from the terminus to the headwaters of watersheds; ● to protect habitats of known importance to particular species; ● to maintain old-growth and forest-interior habitats; and ● to use forest management techniques that produce stand structures, species composition, and landscape patterns similar to those generated by the natural disturbances of forests in Clayoquot Sound.

⁴² Monitored at the site level for interpretation at all three levels – two approaches recommended: Indicator species and checklists (a simple listing of all species found in an area, including native and non-native plants).

⁴³ Checklists can be very limiting, but provide an overview of species diversity. Checklists should be analyzed primarily for the identities of species presence. Especially useful when applied in conjunction with monitoring of habitat elements (e.g. snags and downed wood, forest type and age class, forest patch size, etc.). When compared across a range of sites they help to address questions concerning how much of an element should be retained, or reveal “holes” or empty areas in a species range. Good for extent of invasive plant species. Can be impractical for organisms like insects, spiders and other arthropods, soil biota; and upper canopy epiphytes (which are practically inaccessible). **Standardized methods of data collection must be established and used consistently – locations must be coordinated with habitat monitoring.** Most effective approach is likely a nesting hierarchy with focal sites in selected watersheds (monitored seasonally to annually) nested with more extensive monitoring done every two to five years (p.208)

⁴⁴ Upward trends in populations may indicate the intentions of old growth characteristics are not being met – fireweed, savannah sparrows

⁴⁵ Eel grass associated with estuaries – elk, Vaux’s swift and marten thought to be associated with older forests – black bear and hairy woodpecker thought to be associated with mixed conifer deciduous trees – pileated woodpecker and common merganser associated with wildlife trees – bald eagle and great blue heron associated with large trees – northwest and clouded salamander associated with downed wood – beaver, river otter, and mink associated with riparian habitats.

Monitoring of old-growth characteristics should address two broad questions:

- Does the current system defining forest age classes accurately reflect differences in biological diversity among stands of different ages?⁴⁶
- At what rate are microhabitats or habitat elements created in the aging process?

Table 15– Biological Diversity, Old-Growth Characteristics

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
5	Monitoring Biological Diversity		Goal for maintaining biological diversity: • to maintain all naturally-occurring species and genetic variants such that they are able to persist over the long term and adapt to changes in their environment within the normal range of variation; • to maintain the functional integrity of ecosystems recognizing the connections between terrestrial, freshwater, and marine processes Objectives: • to maintain ecosystem function by protecting the integrity of riparian areas from the terminus to the headwaters of watersheds; • to protect habitats of known importance to particular species; • to maintain old-growth and forest-interior habitats; and • to use forest management techniques that produce stand structures, species composition, and landscape patterns similar to those generated by the natural disturbances of forests in Clayoquot Sound.
	• Monitoring Old-Growth Characteristics ⁴⁷		
	Pre & post harvest old-growth characteristics	Size and age class distribution of each tree species (pre & post harvest)	
	Accuracy of current system of defining age classes to represent biological diversity	Site level assessment of habitat elements correlated with age classes ⁴⁸	
	Rate at which habitat elements develop with aging forests ⁴⁹	Establishment of large plots ⁵⁰ (permanent sample plots). Measure indicators listed in Tables 10 – 14.	
	Special habitats of streams and rivers of old-growth forests	See Table 6 ⁵¹ ,	

⁴⁶ The panel considers age classes 8 and 9 (>141 years) as late successional, but old-growth features are thought to appear at different rates: canopy gaps at 100-200 years, multi-storied canopies at 250-300 years, large snags at 300-400 years. Development of an old-growth index or designation of one or more, older age classes should be considered. Subdivision of the oldest age class (>400 years) may be important (p.209).

⁴⁷ One of the Panel's objectives in maintaining biological diversity is the maintenance of species associated with old-growth and forest-interior habitats. Interpretation of checklists at the watershed and site level (Table 13) will help evaluate the effectiveness of reserves in maintaining such species. Large old trees are interpreted as being the major structural elements in the forest, so considerable attention is paid to the monitoring of elements associated with large old trees.

⁴⁸ The development of an old-growth index will be more accurate, but designation of one or more new, older age classes may be more practical in the short term. The diverse array of microhabitats and their elements is a defining characteristic of old-growth forests, and offers promise for creating an index of old-growth features, i.e. the diversity of habitats results from the range of tree sizes and ages; the presence of dying, dead, or fallen trees, among healthy, growing trees; and consequent canopy gaps with associated productive understory (best monitored by means of checklists of features known or suspected of being important (p.210))

⁴⁹ This monitoring effort follows after the establishment of additional old-growth age classes or index of old growth

⁵⁰ Equivalent to permanent sample plots for the purpose of estimating rates of habitat development. To be established in an array of harvested and un-harvested forest types. This monitoring contributes to planning by evaluating the utility of age-class or habitat elements in assessing resident biological diversity.

⁵¹ Indicator and checklist approaches recommended.

Table 16 – Biological Diversity, Aquatic Environments

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal ⁵²
5	Monitoring Biological Diversity ⁵³ • Monitoring Aquatic Environments ⁵³		
	Freshwater aquatic environments ⁵⁴	- fish species composition⁵⁵, - salmon stocks (adult and juvenile)⁵⁶, - benthic invertebrates	Goal for maintaining biological diversity: - to maintain all naturally-occurring species and genetic variants such that they are able to persist over the long term and adapt to changes in their environment within the normal range of variation; - to maintain the functional integrity of ecosystems recognizing the connections between terrestrial, freshwater, and marine processes Objectives: - to maintain ecosystem function by protecting the integrity of riparian areas from the terminus to the headwaters of watersheds; - to protect habitats of known importance to particular species; - to maintain old-growth and forest-interior habitats; and - to use forest management techniques that produce stand structures, species composition, and landscape patterns similar to those generated by the natural disturbances of forests in Clayoquot Sound.
	Brackish-water (estuarine) and saltwater (marine) environments ⁵⁷	- Logs escaping from booms, - eelgrass bed viability, - viability of shellfish and herring spawn areas	

⁵² The Panel's objective in managing and monitoring these areas is to maintain a functioning ecosystem without significant loss of biological diversity (p.211)

⁵³ Monitoring of physical habitat characteristics has been listed in Table 6. Biological monitoring is also necessary to ensure organisms are flourishing in the environment. Sampling will occur at the site or stream reach level for interpretation at the watershed level for resident organisms and subregional level for migratory species (anadromous fish, many species of waterfowl, and shorebirds)

⁵⁴ Rivers, streams, lakes, ponds, bogs, fens, and swamps

⁵⁵ This is a potentially useful, but incomplete element of monitoring. Must be representative of the fish community including a cross section of habitat units
⁵⁶ Because of several external factors, this does not appear to represent ideal bio-monitors (p.212)

⁵⁷ Sampling any aquatic environment encounters the problem of separating human-induced changes from considerable natural temporal variability. Panel recommends monitor periods be once every five years, but more frequently in areas of suspected degradation. Sampling can include measuring changes and human influence on intertidal and shallow sub-tidal areas (and other important inshore marine habitats). Sampling of organisms that are long-lived and recruit young sporadically (which include many marine organisms) make interpretation of results difficult (p.212)

Table 17 – Human Activities and Values, Sites Important to First Nations

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
5	Monitor cultural areas and resources ⁶⁰	• Monitoring Areas and Sites Important to First Nations ⁵⁹	Objective: Recognition and protection of heritage values
		• Sacred areas/sites • Historic areas/sites⁶¹ • Current use areas	
		• Variety of populations of culturally important plants	
		• Variety of habitats of culturally important animal species	

⁵⁸ See CSSP Report 3 for detailed First Nations' perspectives in relation to forest practices in Clayoquot Sound, and Tables 3 and 4 of this summary report

⁵⁹ Areas and resources of special significance to them should be monitored by First Nations or under their direction

⁶⁰ i.e. monitor how well these sites have been protected from CSSP forestry activities

⁶¹ Some areas contain sites where visible artifacts such as unfinished canoes, culturally modified trees, and pictographs that may require protection. Other less obvious examples may include places featured in traditional stories, used for spiritual training, or providing important medicines (knowledge of these areas may be restricted to very few individuals)(p.213).

Table 18 – Human Activities and Values, Goals & Objectives

CSSP Report	Goals & Objectives
	Monitoring Human Activities and Values Monitoring Scenic, Recreational, and Tourism Values⁶²
5	Goals for Maintaining Scenic Values: - to manage scenic resources to maximize the enjoyment of those present by ensuring that opportunities for tourism and recreation reflect the inherent quality of resources in an area; and - to ensure that First Nations [peoples] and other residents are satisfied that the essential elements of the scenery around them are maintained Objectives for Maintaining Scenic Values: - to provide for a range of visual landscape experiences, and to plan these experiences in relation to existing and potential recreation routes; - to conduct sustainable forest practices and related educational and integrative programs [for the benefit of the public]; - to apply landscape design principles in all areas; and - to maintain examples of different types of landscape in a relatively unaltered state.
	Goals for Recreation and Tourism: - to manage resources to protect features that are important to tourism and recreation; and - to provide recreational and tourism opportunities that reflect the inherent quality of the resources in Clayoquot Sound and the recreational desires of residents and visitors to the area. Objectives for Recreation and Tourism: - to provide for a range of recreation and tourism opportunities...that are sensitive to and based on the area's natural resources; - to protect valuable resources for recreation and tourism; and - to integrate into recreation planning the use patterns and needs of tourist and resident groups including First Nations.

⁶² Because of strong interrelationships among scenic, recreational, and tourism values, it is efficient to monitor them jointly (p. 213-216)

Table 17 – Human Activities and Values, Sites Important to First Nations

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
5	Monitoring Human Activities and Values ⁵⁸		
	• Monitoring Areas and Sites Important to First Nations ⁵⁹		
	Monitor cultural areas and resources ⁶⁰	• Sacred areas/sites	Objective: Recognition and protection of heritage values
		• Historic areas/sites ⁶¹	
		• Current use areas	
• Variety of populations of culturally important plants			
• Variety of habitats of culturally important animal species			

⁵⁸ See CSSP Report 3 for detailed First Nations' perspectives in relation to forest practices in Clayoquot Sound, and Tables 3 and 4 of this summary report

⁵⁹ Areas and resources of special significance to them should be monitored by First Nations or under their direction

⁶⁰ i.e. monitor how well these sites have been protected from CSSP forestry activities

⁶¹ Some areas contain sites where visible artifacts such as unfinished canoes, culturally modified trees, and pictographs that may require protection. Other less obvious examples may include places featured in traditional stories, used for spiritual training, or providing important medicines (knowledge of these areas may be restricted to very few individuals)(p.213).

Table 19 – Human Activities, Scenic, Recreation and Tourism Values

CSSP Report	Monitoring Recommendation	Recommended Methodology / Indicator(s)	Objective/ goal
5	• Monitoring Human Activities and Values - Monitoring Scenic, Recreational, and Tourism Values⁶³ • Monitor for scenic and recreation values⁶⁴	• Perceptions and experiences of people in the area:⁶⁵ • The way people feel about scenery and recreation⁶⁶, to determine⁶⁷: ○ their enjoyment and level of satisfaction with scenic and recreational resources in specific areas; ○ their satisfaction with the range of experiences and opportunities available; ○ factors contributing to positive and negative perceptions; ○ future interest in areas and given characteristics Analysis of the physical condition of the resources perceived and used: • Monitoring of the perceived physical condition of scenic and recreational resources where logging or other development has occurred; landscape design: compatibility of cutblocks with the landform, visual dominance of structures, visual prominence of roads; actual physical and biological condition of scenic and recreational resources⁶⁸ • Use patterns⁶⁹	See Table 18

⁶³ Most forms and methods of monitoring are the same at all planning levels; monitoring at all three planning levels and using information as appropriate at all levels is critical. Sub-regional: resources over large areas (e.g. major use corridors) considered as a whole to account for cumulative effects. This information is useful for guiding watershed and site-level activities. Watershed scale monitoring will provide information on the effects of alteration. Site level monitoring will be useful in guiding design criteria. Most assessments of potential negative impacts of recreation and tourism will occur at the site level.

⁶⁴ Any alteration or development affects scenic values. Important for areas where there is existing or potential recreational use, alteration, development, and other activities (even recreation) that can effect recreational values. One major alteration or activity can have significant effects, or incremental use can have cumulative effects. Experts can provide detailed information on how resources have been affected by alteration, and can identify steps to meet objectives.

⁶⁵ This is an indication of their sense of the "health" of the resources. This should include interviews with a range of groups including First Nations and other residents, recreationists and tourists, and tourism operators. An important topic is the level of alteration, development, and use that people consider appropriate to specific activities or key areas (including logging, other developments, level of recreational use, etc.). Some activities best conducted by recreation experts.

⁶⁶ This is accomplished by asking the appropriate people. The perceptions of recreationists, tourists, and general public, can be obtained from questionnaires given to clients by tourism operators and the end of a trip, distributed at tourism information centres, and administered in local areas such as Tofino or Hot Springs Cove. For tourist operators and local residents, questionnaires and workshops are potential monitoring methods.

⁶⁷ Monitoring over time is important in areas where scenic and recreational resources are changing (i.e. logging or development), or where visually effective green-up of previously logging areas is occurring.

⁶⁸ Physical and biological consequences of recreation and tourist activity should be monitored. Reserve areas designated to maintain ecosystem integrity are not meant to provide recreational opportunities and may be harmed by relatively low levels of human use

⁶⁹ This can be monitored with questionnaires to recreation groups and tourism operators or by conducting user counts in the field. User counts require more effort than questionnaires but are a more accurate survey method.

Table 20 – Human Activities and Values, Regional Production⁷⁰

CSSP Report	Monitoring Recommendation	Recommended Indicator(s)	Objective/goal
5	Monitoring Human Activities and Values • Monitoring Regional Production ⁷¹	• Wood and fibre⁷³, Natural foods, Medicines, Materials traditionally used by First Nations, Tourism and recreation products	Viability of local communities Sustainability of all forest values
	Production of commodities from the forest ⁷²	Non-traditional forest products: • Edible mushrooms, other botanical forest products, clean, fresh water	
		Major subsistence: • Commercial fisheries (shell fish, crab, fish) • Recreational fisheries (shell fish, crab, fish)	

Implementation:

Environmental monitoring is labour-intensive and expensive if undertaken entirely by professionals. Monitoring is in the general public interest as it helps ensure the integrity and productivity of the land in the long term. It must be undertaken or directed by the public or public agencies (although the Panel believed it is probably unrealistic to expect continuous attention to monitoring programs for public agencies over long periods of time). Therefore, local interest and involvement in monitoring are essential to ensure a successful monitoring program.

As some aspects of monitoring require technical expertise, the Panel believed a professional land manager with a broad mandate is required. This manager must be charged with effective coordination of all monitoring programs at the subregional level to assure timely collection and archiving of data, continue data analysis, and to take actions as the results indicate.

Because of labour requirements and the value of cumulated experience in many aspects of monitoring, the Panel believed that many aspects of monitoring should be the responsibility of local participants. This approach will require training (the Streamkeepers program can provide training for schools and community groups⁷⁴) and an administrative structure that includes local individuals. The Panel feels the establishment of wardenship of community watersheds would be an effective first step.

⁷⁰ The viability of local communities and sustainable development of the land and sea resources are inextricably linked

⁷¹ The Panel did not give a detailed discussion of criteria for monitoring regional production due to social and economic complexities (p.217)

⁷² This is different than the flow of forest products. Wood and fibre constitute only a part (albeit a major part) of the resources of forests. Production of commodities from the forest will remain a significant factor in the overall regional productivity (p.217).

⁷³ Estimated harvest is noted as one objective of subregional planning (p.164)

⁷⁴ Since the writing of the CSSP, there has been the development of Wetland Keepers, and Shoreline Keepers training programs (ed.)

Panel Recommendations emphasise monitoring to evaluate success in obtaining objectives, this requires a long term monitoring program covering areas that are reserved from land-use practices and areas that will experience land-use practices. (p. xix-report 5)

Table 21 – CSSP Planning Levels

Planning area	Map scale	Planning objectives	Time frame	Other comments
Subregional planning level				
Large areas consisting of aggregations of watersheds; generally greater than 60 000 ha.	1:50 000 to 1:250 000	To identify watershed-level planning units and plan linkages among them. To assess and plan for resources (e.g., scenery, recreation, habitats for wide-ranging wildlife populations) that span large areas. To coordinate and plan monitoring activities for subregional, watershed, and site levels.	100 years with major revisions every 10 years or as required.	Maps should be compiled that integrate all resource information, land-use zones, and locate corridors for recreation or animal migration. Extraction activities that cross watershed boundaries, and locations of cultural, scenic, and recreational resource areas should be identified.
Watershed planning level				
A single watershed or a group of contiguous watersheds; 6 000–35 000 ha.	1:10 000 to 1:20 000	To identify and map reserves and harvestable areas within the watershed planning unit.	100 years, showing projected activities in 10-year increments; revisions every five years or as required.	Reserves are intended to maintain long-term ecosystem integrity, protect First Nations' culturally important areas, and protect recreational and scenic values. Each working unit within the harvestable area must be planned in relation to other existing and potential units.
Site planning level				
One or more discrete units ("working units") proposed for a specific management activity; one hectare to several tens of hectares.	1:2000 to 1:5000	To develop management plans within harvestable areas. In areas identified for resource extraction or development, to determine appropriate levels of retention and appropriate harvesting methods.	10 years, starting five or more years ahead of the work, with revisions every year during active operations.	Site-level planning covers many types of sites and working units; e.g., areas proposed for logging (cutting units), recreation (recreation units), or specifically managed habitat for species at risk (wildlife units).